Zbornik druge nacionalne konferencije sa međunarodnim učešćem pod nazivom

Primena slobodnog softvera i otvorenog hardvera PSSOH 2019

U Beogradu, oktobra 2019. godine

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Primena slobodnog softvera i otvorenog hardvera
PSSOH 2019

u Beogradu, oktobra 2019. godine

University of Belgrade – School of Electrical Engineering

Proceedings of the Second National Conference with International Participation titled

Application of free software and open hardware PSSOH 2019

in Belgrade, October 2019.

Predgovor drugoj PSSOH konferenciji

Sa velikim zadovoljstvom nastavljamo održavanje PSSOH konferencije (Primena slobodnog softvera i otvorenog hardvera) koju smo započeli u 2018. godini sa željom da se u Republici Srbiji organizuju i sa posebnom pažnjom neguju nacionalni skupovi. PSSOH je dvojezična konferencija i zvanični su i srpski i engleski jezik, pa su radovi u celini i rezimei štampani u ovom zborniku i na srpskom i na engleskom jeziku.

PSSOH konferencija nije menjala svoj društveno odgovorni karakter i teme. U 2019. godini, naša predavanja po pozivu uključuju teme iz otvorene nauke, slobodnog softvera u obrazovanju, i trenutnu i prošlu poziciju žena u elektrotehnici i računarstvu. Proširili smo izbor tema u odnosu na prošlu godinu i dodali smo predavanje na temu lokalnih zajednica koje su okupljene oko slobodnog softvera i otvorenog hardvera u Srbiji, Wikipedia podatke i primenu slobodnog softvera u elektromagnetici, humanistici i medicini.

PSSOH konferencija je jednodnevni događaj koji uključuje niz predavanja po pozivu koja će se održati u 5 sesija. Dodatno, planirane su tri post-konferencijske radionice na temu uređivanja Wikipedia članaka, otvorenih podataka za istraživače i rešavanja električnih kola primenom slobodnog softvera.

Kako smo prošle godine i najavili, u ovom broju se nalaze i promotivni materijali otvorenih elektronskih udžbenika i pomoćnih nastavnih materijala koji su objavljeni na Univerzitetu u Beogradu – Elektrotehničkom fakultetu (https://www.etf.bg.ac.rs/sr/studiranje/elektronski-udzbenici).

Svi naši gosti i predavači su dobrodošli ako žele da pomognu u skladu sa svojim mogućnostima i sve tretiramo ravnopravno, što je tradicija pokreta slobodnog softvera i otvorenog hardvera.

Organizacija PSSOH konferencije je podržana od strane velikog broja koleginica i kolega, ustanova, kompanija i udruženja i ovde ih je nemoguće sve pobrojati. Najzahvalniji smo našim donatorima iz Akademske Misli iz Beograda. Zahvalni smo i svim predavačima na učešću i na nesebičnom doprinosu u održavanju druge PSSOH konferencije.

P.S. U duhu PSSOH tema i sa željom da promovišemo slobodan softver, ovaj Zbornik smo pripremili u programskom paketu LibreOffice.

u Beogradu, 4. oktobra 2019. godine

Urednički i organizacioni odbor PSSOH konferencije

Foreword to the Second PSSOH Conference

With great pleasure, we continued with the organization of the PSSOH conference (in Serbian: “Primena slobodnog softvera i otvorenog hardvera”) that we started in 2018 with a desire to contribute to embroider selection of high-quality national events in the Republic of Serbia. PSSOH is dual language conference and both Serbian and English languages are official and abstracts and full papers presented in this Proceedings are submitted and published in both languages.

PSSOH conference has not changed its socially responsible character and topics. This year, we covered a variety of topics like open science, free software in education, and current and past position of women in electrical engineering and computer science. We expanded our topics by adding lectures on local communities gathered around free software and open hardware in Serbia, Wikidata, and free software applications in electromagnetics, humanities, and medicine, etc.

PSSOH conference is one-day event and consists of invited lectures in 5 sessions. Post-conference workshops on editing Wikipedia articles, open research data, and solving electrical circuits with free software are planned.

As announced last year, we present promo materials of open electronic textbooks and adjunct teaching materials published at the University of Belgrade – School of Electrical Engineering (https://www.etf.bg.ac.rs/sr/studiranje/elektronski-udzbenici).

All our guests and speakers are welcome to participate according to their own abilities and wishes. We treat everyone equally according to the traditional values of the free software movement and open hardware initiative.

The PSSOH organization presents the effort of many colleagues, institutions, companies, and associations and it's impossible to list them all here. We are most grateful to our grantor Academic Mind from Belgrade. We thank speakers for their kind contribution and participation in the Second PSSOH conference.

P.S. According to the PSSOH themes and with aim to promote application of free software, this Proceedings is prepared in LibreOffice.

in Belgrade, October 4, 2019.

Organizational and Editorial Board of the PSSOH Conference

Sadržaj / Table of Contents

Open source in autonomous driving. Accelerating development towards automation

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Abstract

Developing Autonomous Driving Systems is a complex endeavor that very few institutions are able to accomplish on their own. The safety and performance requirements expected from commercial automated vehicles are forcing car makers and automotive suppliers to look beyond traditional in-house software development. Thus, the road to automation is becoming an industry wide effort in which automotive industry collaborates with academics, research institutions, governments, and private parties to collaborate and bring different expertise to build on each other's shoulders.

In this talk Ignacio will provide an overview on the importance of open-source software for the development of Autonomous Driving Systems with examples from Intel Lab contributions to automated driving simulation, safety, and system development tools. You will learn how to access and use these tools for learning autonomous driving fundamentals, but also how the same tools are employed to test and benchmark in the industry and how you can start contributing today.

Keywords: open source; autonomous driving systems; software development; vehicle.

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Python in science and engineering and its integration in higher education curricula

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Abstract

An increasing number of scientists and engineers today abandon the use of proprietary closed source software for their work and transition to platforms based on free software. One of the prime reasons behind this paradigm shift is the unanimity of the core values of open science and those of the free software movement built by Richard Stallman. Indeed, the four freedoms defined by the Free Software Foundation effectuate the creation and advancement of technology through the joint efforts of the whole of humanity.

Spearheading this transition is the Python phenomenon. Originally created as a general purpose programming language by Guido Van Rossum, Python has grown to be the core of a powerful scientific/engineering ecosystem. This environment can be used for a host of applications ranging from statistical analysis, linear algebra, signal (image, audio, speech and video) processing, mathematics, machine learning, and artificial intelligence. In fact, in the hot topic of deep learning, all of the state-of-the-art platforms backed by the largest IT corporations, are based on Python. The adoption of Python in the scientific/engineering world has also been reflected in its integration in education curricula, especially in higher education.

The talk will give a brief summary of the use of free software in science/engineering, and then give an overview of the development of Python and its scientific ecosystem. Finally, we will discuss the adoption of Python in the higher education curriculum in Macedonia, our region, as well as worldwide.

Keywords: Python; education; free software; electrical engineering.

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Digital technologies in humanities

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Abstract

The presentation outlines the key issues related to the application of digital technologies in humanities scholarship with a special focus on the role of open-source software in this area.

Although the application of computers in humanities scholarship dates back to the mid-20th century and spans a wide range of outputs and practices from concordance indices, text tagging, quantitative methods in history and archaeology, to modern-day digital humanities, it is still often inferred that the poor uptake of digital technologies in humanities and the prevalence of print culture have to do with the poor computer skills of humanities scholars and their lack of interest in digital services and infrastructures. At the same time, it is also argued that major services, databases and infrastructures are designed for science and technology, while failing to meet the specific needs of humanities scholars (e.g. multilingual and multi-alphabet support, complex publishing requirements, variety of outputs beyond journal articles and their visibility, etc.).

The major areas of development in digital technologies for humanities include text encoding, text and data mining, natural language processing, semantic tools, visualization tools, publishing management software, library and repository software, and web publishing software. The corpus of available solutions is diversified but it is also marked by the lack of interoperability and coordination among the active projects, which is a significant challenge for long-term sustainability.

As an area of scholarship that is by far less likely to engender profit than science and technology, humanities rely on a considerably smaller research community and are less attractive for investors and IT developers, which is another crucial sustainability challenge. This is one of the reasons why open-source software plays an important role in humanities-related digital technologies. Bearing in mind the fear of proprietary lock-in, which has followed recent research infrastructure acquisitions by commercial publishers, and efforts towards creating open and interoperable international infrastructures (esp. European Open Science Cloud), it is reasonable to expect that the role of open-source software will be even greater in future.

Keywords: humanities computing; digital humanities; open-source software; interoperability; sustainability.

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Open-source business model – GitLab case study

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Abstract

Open-source software doesn’t have to be free software. Free software doesn’t have to be devoid of monetization. You can monetize both open-source and free software. There are various business models you can exploit to achieve this. Some are based around services, others around licensing advanced features. Companies need to fulfill two prerequisites to be able to monetize their product: broad adoption and primary credibility. They need to have a diverse, spread out user base. They also need to have primary credibility within their community. This allows companies to capture more value and achieve a higher market cap. The main ways companies monetize open-source projects are through: (1) support, (2) hosting, (3) restrictive licensing, (4) hybrid licensing, and (5) open-core. These approaches can be layered on top of each other. Most often, a business model consists of two or more approaches.

GitLab's approach uses an open-core model as its base. There's no separation between the type of users - commercial or non-commercial. Often, there's a struggle to maintain a balance between contributors and users. Using hybrid licensing allows providing enough rigidity and flexibility at the same time. Having enough rigidity allows you to support a business model. On the other side, enough flexibility attracts customers, users and contributors. Overall, a business model needs to balance these concerns and capture value to be viable.

Keywords: open-source; GitLab; business; monteization.

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Case study in digital humanities: Roman inscriptions in Serbia

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Abstract

The aim of the paper is to present the project of the Institute for Balkan Studies of the Serbian Academy of Sciences and Arts (SASA) "EpiDOc XML Encoding of Roman Inscriptions from Serbia: Digitization of Ancient Epigraphic Heritage". The project focuses on research, training, digital documenting, and digital edition of Roman inscriptions form the territory of Serbia (the Roman province of Upper Moesia and parts of Lower Pannonia, Dalmatia, and Thrace), aiming to form a national e-archive of inscriptions encoded in EpiDoc TEI-XML format. This collection of digital corpora will represent a completely new apigraphic edition that is furhtermore born-digital, freely accessible, and ready for interchange. The project mission is to educate, inspire, and instigate collaborative work and new concepts in epigraphic research. It is envisioned as a core for networking and intensifying the collaboration between research and cultural institutions.

Keywords: Roman inscriptions; Digital epigraphy; EpiDoc XML; Digital humanities.

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Building free education

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Abstract

Building Free Education is a talk that provides an abstract overview of the current educational system virtues and flaws, considers education from a design and architecture point of view and discusses human collective effort to leverage technology in the internet era to build online education. Throughout the first part of the lecture, successes and failures of internet education is presented to provide an intro to discuss about Education 2.0. The lecture will go into analysis of current online platform, conventional schools and failures of MOOCs and similar attempts, and will try to make a parallel observation on economical principles that free software uses.

The talk moves to present a model for "free education", a School 2.0 model that is driven by similar principles to the ones of free software, and which aims to be sustainable for a common, crowdsourced, universal infrastructure that will power knowledge sharing and a new generation of schools. Some of the successes and failures are observed from two free school implementations, *Zamphyr*, which is online, and *Pionir*, an offline free school. The talk is concluded with a call to action and exploration of different segments that interested parties can contribute to.

Keywords: free; open; education; school; MOOC.

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Wikidata: Structured data repository that anyone can edit

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Abstract

Wikidata is an open collaborative multilingual knowledge base that deals with structured data. It is based on facts and references, it allows links to other databases and it is made for both humans and machines. It was created as a central repository of structured data for Wikimedia projects, especially Wikipedia, the well-known free online encyclopedia, so it is by extension also free: it is released under Creative Commons Zero license.

One of the most important purposes of Wikidata is answering questions that couldn't be answered before, such as "What are the biggest cities with a female mayor?". For querying the Wikidata database, users can use SPARQL (semantic query language for RDF – Resource Description Framework), and there are various tools for representing queried data in many visualization forms.

The other important usage of Wikidata is to have a centralized repository for data that could be used on Wikipedia, both in infoboxes that are later used by Google and other crawlers, but also in article text. That way, for instance, updating census information for countries could require changing data solely on Wikidata, without the need to update articles of all the cities in all the language versions on Wikipedia.

Since most users of Wikidata are machines, the purpose of humans is to create content and annotate it properly. For most people that might seem tedious, so several web-based games have been developed to help out with gamifying Wikidata, thus providing quality data without people having to go through the process of directly editing Wikidata pages.

Keywords: data; OER; open repository; collaboration.

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Primena slobodnog sotvera za elektromagnetsko modelovanje

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Rezime: Softver za elektromagnetsko modelovanje nezaobilazan je alat mikrotalasnih inženjera, a značajan je i studentima kurseva iz oblasti elektromagnetike, antena i mikrotalasa. Na internetu je dostupan izvestan broj otvorenih softvera za ovu namenu. Odabrali smo jedan takav softver, baziran na FDTD (*Finite Difference Time Domain*) metodi, uverili se u njegove mogućnosti i predstavljamo ga u ovom radu. U kratkom crtama osvetljavamo i nastanak klasične elektromagnetike i principe rada FDTD metode, koja oličava esenciju oblasti – direktno rešavanje Maksvelovih jednačina.

Ključne reči: elektromagnetsko modelovanje; slobodan softver; antene; rasejači.

I. Uvod

Oblast pod nazivom klasična elektromagnetika zasnovana je na tzv. Maksvelovim jednačinama, izloženim u znamenitom radu iz 1864. godine [1]. Predviđanja Maksvelove teorije prvi je eksperimentalno potvrdio Herc 1888. godine [2], a jednačinama je moderan oblik podario Hevisajd [3]. Maksvelove jednačine opisuju vezu između elektromagnetskog polja, njegovih izvora i osobina okolne sredine. Naime, tokom stotinak godina druge polovine osamnaestog i prve polovine devetnaestog veka, zapažanje da pojedina tela međusobno deluju silom dovelo je do otkrića svojstva naelektrisanosti. Sile koje među naelektrisanim telima u mirovanju i kretanju deluju nazvane su električnim i magnetskim silama. Da bi se „objasnilo“ ovo dejstvo „na daljinu“, uveden je koncept električnog i magnetskog polja, kao posrednika. Tako naelektrisanja, nepokretna i pokretna (struje), „postaju“ izvor elektromagnetskog polja. Taj uzbudljiv period opisan je u Vitakerovoj monumentalnoj knjizi [2].

Premda je šezdesetih godina dvadesetog veka došlo do produbljivanja spoznaje o elektromagnetskim pojavama i uveden je tzv. standardni model za opisivanje inerakcije svih poznatih čestica, klasična elektromagnetika i danas predstavlja pouzdan alat za analizu elektromagnetskih pojava u prirodi, izuzev onih na nivou čestica [4]. Moderni servisi za zemaljsku i satelitsku komunikaciju, radari za vojne i civilne potrebe, medicinski uređaji na bazi stavaranja mikrotalasne slike i senzori za najrazličitije potrebe i dalje se uspešno projektuju primenom klasične elektromagnetske teorije. U tu svrhu potrebno je rešiti Maksvelove jednačine u nekom obliku, tj. izvršiti elektromagnetsku analizu . Za realne probleme rešenje se ne može dobiti u analitičkom obliku, pa se primenjuje numeričko rešavanje.

Elektromagnetsko modelovanje je postupak izrade geometrijskog modela strukture od interesa, opis elektromagnetskih osobina te strukture, zadavanje odgovarajuće pobude i elektromagnetska analiza tako definisanog problema. Elektromagnetska analiza može se sprovesti u vremenskom ili frekvencijskom domenu, a rešavaju se diferencijalne ili integralne jednačine elektromagnetskog polja. Rešavanjem diferencijalnih jednačina elektromagnetskog polja direktno dobijamo vektore tog polja. Tipična metoda ove vrste je Metoda konačnih elemenata (FEM-*Finite Elements Method*). Rešavanjem integralnih jednačina elektromagnetskog polja dobijamo izvore (struje i naelektrisanja) tog polja. Tipična metoda ove vrste je Metoda momenata (MoM-*Method of Moments*). Svaka od metoda ima svoje prednosti i nedostatke [5].

Pored komercijalnih softvera za elektromagnetsko modelovanje, postoji i izvestan broj slobodnih softvera ovoga tipa. Ovde ćemo prikazati OpenEMS [6], otvoren (GNU GPL) softver za elektromagnetsko modelovanje korišćenjem FDTD (*Finite Difference Time Domain*) metode. Rad je u nastavku organizovan na sledeći način: u poglavlju dva izložićemo osnove FDTD metode, u poglavlju tri opisaćemo rad sa OpenEMS softverom, u poglavlju četiri prikazaćemo rezultate numeričke analize korišćenjem OpenEMS softvera i u petom poglavlju dajemo zaključak.

II. FDTD Metoda

FDTD metoda, u slobodnom prevodu metoda konačnih razlika u vremenskom domenu, je iterativni postupak za rešavanje Maksvelovih jednačina, prikazanih na slici 1.

$$\operatorname{rot}\mathbf{E} = -\mu\frac{\partial \mathbf{H}}{\partial t}$$

$$\operatorname{rot}\mathbf{H} = \mathbf{J}_i + \sigma\mathbf{E} + \varepsilon\frac{\partial \mathbf{E}}{\partial t}$$

$$\operatorname{div}\mathbf{E} = \frac{\rho}{\varepsilon}$$

$$\operatorname{div}\mathbf{H} = 0$$

Slika 1. Maksvelove jednačine za izotropnu linearnu sredinu

Cilj je odrediti vektore električnog i magnetskog polja, **E** i **H**, ukoliko su poznati parametri sredine: permitivnost ε, permeabilnost μ i specifična provodnost σ, te vektor gustine pobudnih struja $\mathbf{J}_i$. Ako se pretpostavi da su sva polja i svi izvori u početnom trenutku nula, u okviru FTDT metode mogu se posmatrati samo prve dve jednačine sa slike 1 [7]. One se, na određeni način, vremenski i prostorno diskretizuju i koriste za računanje vektora polja **E** i **H** u iterativnoj šemi. Najčešće se koristi šema koju je predložio Yee [8], a u kojoj se prostor od

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interesa prekrije pravougaonom mrežom, u čijim se tačkama izračunavaju vektori polja. Pozicioniranje ove mreže i njena gustina su od izuzetnog značaja za FDTD analizu. Kriterijum za okončanje iterativnog postupka zavisi od pobude: ako je pobuda prostoperiodična, potrebno je da se u sistemu uspostavi ustaljen režim, a ako je u pitanju Gausov impuls, energija u sistemu treba da iščezne.

FDTD analiza može se sprovesti samo u konačnom prostoru (zbog ograničenosti računarskih resursa). Ako se analizirana struktura prirodno nalazi u slobodnom prostoru (npr. predajna antena), neophodno je simulirati iščezavanje elektromagnetskog talasa u beskonačnosti. To se postiže apsorpcionim tehnikama, od kojih su najčešće Murova (ABC) [9] i PML [10]. Objekat od interesa se okruži apsorpcionim slojem čiji je zadatak da talas koji nailazi oslabi, a da istovremeno obezbedi da se taj talas ne reflektuje.

Ako se traže veličine koje se definišu na velikom rastojanju od analizirane strukture (daleko polje antena i rasejača), pribegava se izračunavanju ekvivalentnih izvora elektromagnetskog polja, na odabranoj površi koja okružuje analiziranu strukturu u zoni bliskog polja (near field). Zatim se ti izvori koriste za izračunavanje polja na vrlo velikim rastojanjima (eng. *far field*) [11].

III. OpenEMS softver

OpenEMS [6] je otvoren softver za elektromagnetsko modelovanje. Podržani su operativni sistemi Windows i Linux. Program ne poseduje grafički interfejs za modelovanje, već se model opisuje skriptom, a kao platforma se koriste Matlab ili Octave [12], otvoren softver koji je alternativa Matlab-u. Budući da govorimo o otvorenom softveru, u nastavku ćemo koristiti Octave.

OpenEMS se može preuzeti sa adrese http://openems.de/start/index.php. U verziji za Windows nema klasične instalacije, dovoljno je da se preuzeta arhiva raspakuje na željenu lokaciju - mi biramo folder "openEMS" na disku "C". Da bi se otpočelo sa radom, potrebno je samo da se OpenEMS subfolder sa m-fajlovima ("matlab") doda u Octave putanju m-fajlova, sa addpath('C:\openEMS\matlab'). Svaki openEMS model priprema se u vidu jednog Octave skripta – niza naredbi za opis modela, pokretanje elektromagnetske analize i pregled i skladištenje rezultata. (Skriptovi se snimaju u fajlove sa ekstenzijom ".m") Pored specijalizovanih OpenEMS m-funkcija, u skriptu se koriste uobičajene Octave strukture i operacije. U "openEMS" folderu nalaze se i izvršni fajlovi za grafički prikaz modela (AppCSXCAD), elektromagnetsku analizu (openEMS) i transformaciju bliskog u daleko polje (nf2ff). Pomenimo da se na OpenEMS sajtu, u sekciji Tutorials, mogu naći primeri skriptova za modelovanje tipičnih struktura, kao i uputstvo za upotrebu softvera (*Online manual*), koji daju osnov za početak rada. Ipak, u vezi sa mnogim detaljima korisnik će morati da „konsultuje“ izvorni kod openEMS m-funkcija i da tako proba da dođe do određenih zaključaka.

U skriptu koji opisuje elektromagnetski model potrebno je definisati: strukturu modela, pobudu, FDTD Grid (mrežu tačaka za računanje elektromagnetskog polja korišćenjem FDTD metode) sa graničnim uslovima, kriterijume za okončanje elektromagnetske analize i rezultate analize. Formalno, sve ovo definišemo u okviru dva objekta: objekat koji sadrži informacije o tipu analize ("FDTD") i objekat koji sadrži informacije o strukturi ("CSX").

Strukturu modela čine geometrijski opis i podaci o korišćenim materijalima. Na raspolaganju je nekoliko geometrijskih primitiva, koje opisuju dvodimenzionalne (2D) ili trodimenzionalne (3D) objekte. Izdvajamo: Box (2D ili 3D), Sphere (3D), Cylinder (3D), Polygon (2D) i Polyhedron (3D). Primitiva Box zadaje se sa dve dijagonalne tačke (AddBox), pa može biti i pravougaonik i paralelepiped. Primitivom Polygon može se opisati proizvoljan 2D, a primitivom Polyhedron proizvoljan 3D objekat, tako da se, teorijski, mogu opisati proizvoljni oblici. Prilikom kreiranja, svaku primitivu moguće je skalirati, translirati, rotirati, ili sve to istovremeno, korišćenjem transformacione matrice. Pored toga, moguće je definisati koordinatni sistem u kojem je primitiva definisana (Dekartov ili cilindrični) i tako odstupiti od globalnog koordinatnog sistema za pojedine primitive. Za svaku primitivu zadaje se prioritet – ako se dve ili više primitiva prostorno preklapaju, smatra se da taj deo prostora ispunjava primitiva sa najvišim prioritetom (najvećim zadatim brojem za prioritet). Za svaku geometrijsku primitivu mora se zadati materijal (AddMaterial). Savršeno provodan materijal dobio je rezervisano ime "Metal" (AddMetal), a za druge materijali moraju se zadati ime i parametri. Osnovni parametri su oni prikazani na slici 1: permitivnost, permeabilnost i (specifična) električna provodnost, uz dodatak magnetske provodnosti, koja nije fizička veličina, ali se pod određenim uslovima može uvrstiti u jednačine i koristiti za dobijanje rešenja. Postoje i parametri za disperzivne materijale-mi se u numeričkim eksperimentima njima nismo bavili, a ima ih previše da bismo ih ovde nabrajali.

Pobuda se odlikuje oblikom u vremenskom domenu i fizičkom izvedbom. U vremenskom domenu moguće su Gausova pobuda (SetGaussExcite), koja se zadaje centralnom učestanošću u spektru Gausovog impulsa i 20 dB graničnom učestanošću i prostoperiodična (SetSinusExcite) pobuda. U smislu fizičke izvedbe razlikujemo pobudu poljem i pobudu putem portova (pristupa). Pobuda poljem može biti „standardna“ (AddExcitation), gde se u delu prostora zadaje električno ili magnetsko polje, ili pobuda ravnim talasom (AddPlaneWaveExcite), gde se zadaje pravac prostiranja i smer vektora polja pobudnog ravnog elektromagnetskog talasa. Za obe pobude poljem definiše se oblast dejstva putem Box primitive. Portovi su realizovani pomoću naponskih i strujnih sondi i drugih potrebnih elemenata i materijala. Portovi omogućavaju razdvajanje incidentnog i reflektovanog signala, tj. određivanje refleksije (za proizvoljni port) i transmisije (između različitih portova). Koncentrisani port (AddLumpedPort) simulira tačkasti

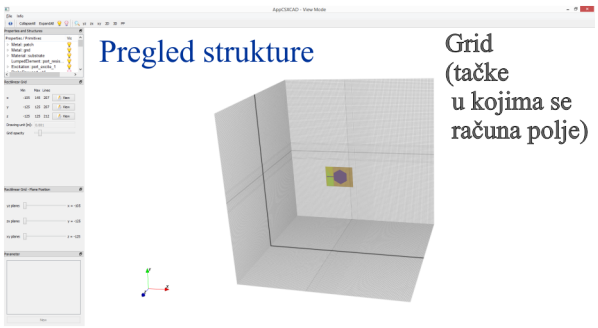
izvor i treba da je definisan u domenu čija je maksimalna dimenzija mnogo manja od radne talasne dužine. Pored toga, postoje portovi prilagođeni za mikrotrakaste vodove (AddMSLPort), kružne (AddCircWaveGuidePort) i pravougaone (AddRectWaveGuidePort) talasovode. Nakon izvršene elektromagnetske analize potrebno je pokrenuti potprogram za računanje napona i struja na portovima, u vremenskom i frekvencijskom domenu.

FDTD Grid je mreža tačaka-diskretizovani prostor za primenu FDTD metode. Ovde govorimo o pravougaonoj mreži tačaka, a openEMS omogućava i rad u cilindričnim koordinatama (tj. cilindričnu mrežu). Finija mreža (sa manjim prostornim korakom) obezbeđuje tačniju analizu, ali i povećava CPU vreme i memorijsko zauzeće, pa je nužno pronaći kompromis. Ne preporučuje se korak manji od desetine talasne dužine. Premda je najlakše formirati uniformnu mrežu, ona nije i najefikasnija. Naime, u blizini razdvojnih površi metala i dielektrika postoji brza promena elektromagnetskog polja, koja zahteva finiju mrežu. Softver nudi mogućnost kreiranja uniformnih linija za mrežu (SmoothMeshLines), ali dozvoljava korisniku da ručno doda linije po želji, ili da se pokrene automatsku detekciju kritičnih delova strukture i dodavanje linija (DetectEdges). Nakon što se sve linije generišu u promenljivoj "mesh" (koja sadrži nizove brojeva-linija "x", "y" i "z"), treba kreirati mrežu (DefineRectGrid) - ovo je jedina funkcija u kojoj se definiše jedinica za dužinu, u kojoj su zadate sve geometrijske dimenzije. Mreža se mora zatvoriti graničnim površima, kojih ima četiri vrste. PEC se koristi ako je neka granična površ savršeno provodna, PMC se postavlja samo u ravni simetrije (ako želimo da iskoristimo simetriju), a MUR [9] i PML [10] su apsorpcione površi za simulaciju slobodnog prostora, o kojima smo govorili ranije.

Kriterijumi za okončanje elektromagnetske analize zadaju se pri inicijalizaciji "FDTD" objekta (InitFDTD). Jedan je maksimalan broj vremenskih koraka "NrTs" (vremenski razmak između koraka određuje se automatski), a drugi "EndCriteria", broj koji pokazuje u kojoj meri je energija iščezla (ako je pobuda Gausov impuls), odnosno u kojoj meri je uspostavljen ustaljeni režim (ako je pobuda prostoperiodična). Analiza se završava ako je broj koraka veći od zadatog maksimalnog broja koraka, ili ako je tekući EndCriteria manji od zadatog. U praksi, orijentacione vrednosti za NrTs su oko 20000, a za EndCriteria oko 1e-4.

Izlazni rezultati mogu biti direktni (elektromagnetsko polje u tačkama FDTD grida) i indirektni (sve veličine od interesa koje se mogu izračunati korišćenjem direktnih rezultata). Ako je potrebno izračunati dijagram zračenja antene ili rasejano polje, pre početka analize potrebno je zadati površ po kojoj se računa blisko polje (CreateNF2FFBox). Na osnovu izračene i nailazeće snage moguće je izračunati radarski odraz objekta. Ako su kao pobuda definisani portovi, nakon FDTD analize pokreće se dodatna obrada portova (calcPort) za izračunavanje incidentnih i reflektovanih napona portova, na osnovu kojih se mogu izračunati s-parametri (koji su od velikog značaja pri analizi uređaja poput antena i filtara).

Pre pokretanja openEMS analize, potrebno je model snimiti u fajl (WriteOpenEMS), nakon čega se može vizuelno proveriti model (CSXGeomPlot), kao na slici 2.



Slika 2. Vizuelni pregled openEMS modela

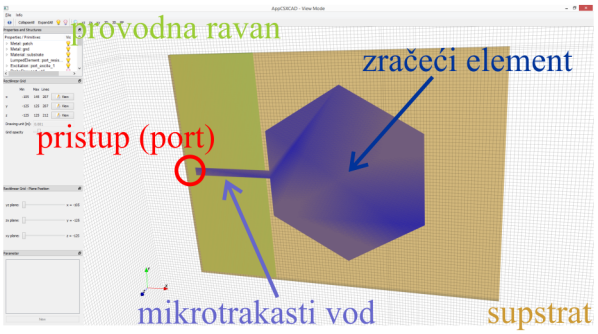
Nakon pokretanja openEMS analize (RunOpenEMS) u Octave tabu Command Window može se pratiti napredak iterativne analize. Analiza se može prekinuti pre postizanja izlaznih kriterijuma ubacivanjem fajla sa imenom "ABORT" u folder sa openEMS projektom.

Po okončanoj analizi, može se izvršiti prikaz rezultata korišćenjem slobodnog softvera ParaView [13], ili se rezultati mogu obraditi, prikazati i snimiti pomoću Octave naredbi i dodatnih openEMS funkcija.

IV. Numerički primeri

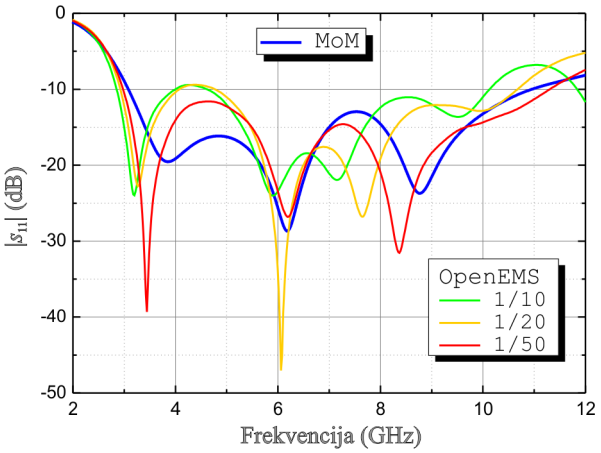
Razmotrićemo dva primera, slična onima iz openEMS tutorial-a: UWB štampanu antenu (UWB Radar) i sferni metalni rasejač (Metal Sphere RCS). Rezultate dobijene openEMS analizom uporedili smo sa identičnim rezultatima dobijenim MoM analizom korišćenjem bazisnih funkcija višeg reda [14]. Za openEMS izlazni kriterijum koristili smo NrTs=20000 i EndCriteria=1e-4.

Model UWB antene [15] u openEMS-u prikazan je na slikama 2 i 3. Korišćena je opcija "DetectEdges", pa je mreža gušća na pojedinim mestima. Zračeći element i vod modelovani su jednom primitivom Polygon, a svi ostali elementi primitivom Box. Za napajanje je iskorišćen koncentrisani port od 50 W, postavljen između kraja mikrotrakastog voda i provodne ravni, sa Gausovim impulsom centralne i granične učestanosti 6 GHz.

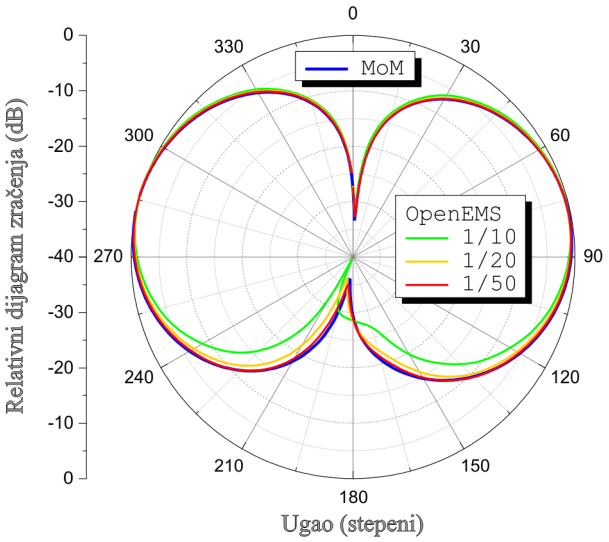


Slika 3. Model UWB štampane antene u openEMS-u

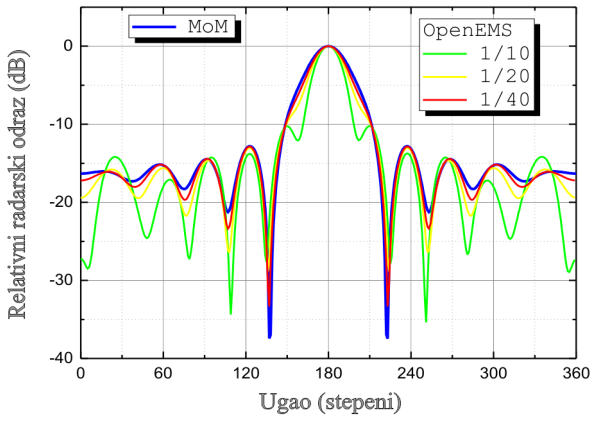
Parametar s_{11} prikazan je na slici 4. Smanjenjem koraka FTDT Grid-a (sa 1/10 na 1/50 talasne dužine u vakuumu) openEMS rezultat približava se MoM rezultatu, ali daljim smanjivanjem koraka (na 1/70, nije na slici) ne dolazi do većih promena. Imajući u vidu da je



Slika 4. s11 parametar UWB antene – poređenje openEMS i MoM



Slika 5. Dijagram zračenja UWB antene – poređenje openEMS i MoM



Slika 6. Radarski odraz metalne sfere – poređenje openEMS i MoM

reč o veoma širokopojasnoj anteni, možemo reći da je poklapanje rezultata zadovoljavajuće. Relativni dijagram zračenja UWB antene u E-ravni, na 6 GHz, prikazan je na slici 5. Ovde već korak od 1/20 talasne dužine daje zadovoljavajuće rezultate.

Relativni radarski odraz metalne sfere u vakuumu, čiji je poluprečnik jednak talasnoj dužini (pobuda je ravan prostoperiodičan linijski polarizovan elektromagnetski talas), prikazan je na slici 6. Smanjenjem koraka FTDT Grid-a (sa 1/10 na 1/40 talasne dužine) openEMS rezultat približava se MoM rezultatu. Poklapanje rezultata pri koraku 1/40 talasne dužine je odlično.

V. Zaključak

Slobodan softver za elektromagnetsko modelovanje openEMS omogućava analizu antena, filtara i drugih mikrotalasnih sklopova, raznih vodova, talasovoda i proizvoljnih rasejača. Integrisan je sa drugim otvorenim softverima: modelovanje se obavlja putem Octave skripta, rezultate je moguće pregledati korišćenjem ParaView-a, a najavljena je i verzija koja će koristiti Phyton. Numerički primeri koje smo sproveli pokazuju dobro poklapanje sa MoM rezultatima, koje smatramo referentnim. Softver za rešavanje Maksvelovih jednačina koristi FDTD metodu, na čiju tačnost značajno utiče gustina FDTD mreže i pozicioniranje njenih linija. O kreiranju ove mreže, kao i o mnogim drugim detaljima, brine prevashodno korisnik, što je potencijalno i vrlina i mana ovog softvera. Utisak je, ipak, da veštom korisniku openEMS može biti veoma dobar alat za elektromagnetsko modelovanje.

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Symbolic analysis of linear electric circuits with Maxima CAS

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Abstract: Symbolic analysis of electrical circuits, implemented in software, SALECx, is presented. SALECx is developed in Maxima CAS and it is offered to students, educators, engineers, and others, as free/libre open-source software. SALECx operation is exemplified by several distinct circuits.

Keywords: electric circuit; symbolic analysis; Maxima; SALECx.

I. Introduction

Symbolic simulation is a formal technique to calculate the behavior or a characteristic of a system (e.g. digital system, electronic circuit, or continuous-time system) with an independent variable (sample index, time, or frequency), the dependent variables (sample values, signals, voltages, and currents), and (some or all) the element values represented by symbols [1].

A symbolic simulator is a computer program that receives the system description as input and can automatically carry out the symbolic analysis and thus generate the symbolic expression for the desired system characteristic [2].

Symbolic computation has been used for modeling, simulation, and synthesis of analog circuits and VLSI systems [3] [4] [5].

This paper presents a novel symbolic simulator, SALECx, implemented in the Maxima CAS (**C**OMPUTER **A**LGEBRA **S**YSTEM) [6] programming language.

The underlying theory of the SALECx operation can be found in many good textbooks, e.g. classical [7] [8], contemporary [9] [10] [11] [12] [13], on computer-aided analysis [14], with network synthesis [15], with advanced topics [16], for power engineering [17] [18], on transmission lines [19].

Several recent books present various Maxima CAS applications [20] [21] [22] [23].

In addition, Maxima CAS has been used and recommended to students at the University of Belgrade, School of Electrical Engineering, Electric Circuit Theory course [24].

In this paper we assume that the circuit simulated by SALECx is linear, time-invariant, and finite. All basic circuit elements are contained in the SALECx element catalog. The ABCD element implements an arbitrary two-port element with known *a*-parameters (chain parameters, transmission parameters).

The electric circuit graph is assumed to be connected. If the graph is not connected then one should (1) identify the disconnected components, (2) choose one node in each component, and (3) connect the chosen nodes to make the graph connected.

As a free/libre open-source software package SALECx can be directly recommended and distributed to students, which are a price-sensitive community willing to minimize their expenses. On the other hand, SALECx can be included in Electric Circuit Theory teaching and learning, at initial learning stages, to motivate and encourage students (1) to solve their homework and numerous circuit problems by automated computer-aided symbolic analysis, and (2) to verify their designs and confirm circuit analyses obtained traditionally by hand, i.e. by paper and pencil. Finally, the SALECx free open-source code reveals the underlining algorithm in full detail, promotes a better understanding of the corresponding circuit analysis method, and might prompt some students to edit the code and add their on extensions and contributions.

SALECx can help students to solve much more real-life circuit example problems compared to the relatively smaller number of problems they are willing to solve by hand. Therefore, the example-problem-based learning paradigm can be supported, which allows novice students to grasp concepts and phenomena from circuit theory with higher learning performance and lower mental effort, until they reach expert levels. Consequently, the role of a student might change from passive to active learner under the new learning paradigm.

Mastering circuit analysis requires some degree of practice and one must be adept in algebraic manipulation. Often, the burden of algebraic manipulation causes the student to lose sight of the wood from the trees. In the classic method of study a student must overcome the difficult barriers of mathematics, which makes the subject very unattractive.

When doing mathematics, instead of burdening the brain with the repetitive job of redoing numerical operations which have already been done before, it's possible to save that brainpower for more important situations by using symbols, instead, to represent those numerical calculations (Ernst Mach, 1883). Today, with computer algebra systems, such as Maxima/ Macsyma, it is possible to calculate in minutes or hours the results that would (and did) years to accomplish by paper and pencil. Accordingly, SALECx can help students acquire a "functional understanding" of Electric Circuit Theory and foster mastery of the MNA (**M**ODIFIED **N**ODAL **A**NALYSIS) equation formulation.

Symbolic circuit response generated by SALECx, i.e. closed-form analytic expressions for circuit voltages and currents, can provide better insight than numerical solutions, e.g. obtained by SPICE. By inspection of the symbolic response, it might be immediately clear how a parameter (or an element value) contributes to the performance and behavior of the electric circuit.

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II. SALECx in a Nutshell

SALECx is a Maxima program for solving linear time-invariant electric circuits in the complex domain of the Unilateral Laplace Transform or Phasor Transform. SALECx stands for **S**YMBOLIC **A**NALYSIS of **L**INEAR **E**LECTRIC **C**IRCUITS with Ma**x**ima.

SALECx has been developed by Dr. Dejan Tošić, Full Professor, tosic@etf.rs, at the University of Belgrade – School of Electrical Engineering, Belgrade, Serbia.

Reserved symbols and circuit specification:

s – complex frequency [radian/second], symbol, the Laplace variable

I[label] or **I**[label, node] – MNA current variables, symbols

V[0], **V**[1], **V**[2], **V**[3] … – MNA voltage variables, symbols, node voltages, V[0] is set to zero, 0

SALECxPrint – verbose variable

The circuit to be analyzed is specified as a netlist [circuitElement_1, circuitElement_2 …].

A circuit element is specified as a list of the form:

[type, label, a, b, p]
[type, label, a, b, p, IC]
[type, label, [a1,a2], b]
[type, label, [a1,a2], [b1,b2], p]
[type, label, [a1,a2], [b1,b2], p, IC]

type – string that specifies the element type: "R", "L", "C", "I", "V", "Z", "Y", "OpAmp", "VCVS", "VCCS", "CCCS", "CCVS", "IT", "K", "T", "ABCD".

label – string that uniquely identifies circuit element, e.g. "Vgen", "Is", "Rin", "Cfb", , "Lprim", "Y2", "Zload".

For one-port elements:

a – positive terminal,
b – negative terminal.

For two-port elements except OpAmp

a1 – positive terminal of the 1st port,
a2 – negative terminal of the 1st port,
b1 – positive terminal of the 2nd port,
b2 – negative terminal of the 2nd port.

p – parameter or parameters if p is a list.

IC – initial conditions at 0-minus: Vo for capacitors, Io for inductors, [Io1,Io2] for linear inductive transformers.

Calling SALECx:

Laplace Transform s-domain

SALECx[circuitSpecification]

Phasor Transform j*omega-domain, sinusoidal steady state

SALECx[circuitSpecification, omega]
omega [radian/second] – angular frequency

See the SALECx syntax details and element catalog in **SALECx.mac** script file that accompanies this paper.

III. SALECx Symbolic Simulation Examples

Assume that SALECx has been installed in the directory "C:\SALECx\" as the mac file "SALECx.mac".

A simple capacitor circuit is shown in Fig. 1. The capacitor is initially charged and its preinitial voltage is V_0. Current of the ideal voltage source is presented to specify the reference direction.

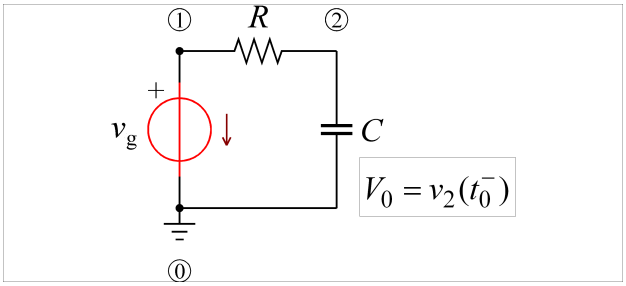


Figure 1: Simple capacitor circuit.

SALECx is loaded by the Maxima command

```
(%i1)   load("C:\\SALECx\\SALECx.mac");
(%o1)   C:\SALECx\SALECx.mac
```

The circuit is textually specified as a list (netlist) of element specifications.

```
(%i2)   VgRCVo_Shema: [
          ["V", "Vg", 1, 0, Vg],
          ["R", "R", 1, 2, R],
          ["C", "C", 2, 0, C, Vo]];
(VgRCVo_Shema) [[V,Vg,1,0,Vg],[R,R,1,2,R],[C,C,2,0,C,Vo]]
```

First, SALECx is invoked to carry out the Phasor Transform domain analysis, the steady-state sinusoidal analysis, at a frequency omega (ω) [radian/second]. All inital conditions are ignored.

```
(%i3)   VgRCVo_Response_PT: SALECx(VgRCVo_Shema,omega);
Phasor Transform at angular frequency  ω
(VgRCVo_Response_PT) [V1=Vg, V2=Vg/(%i C R ω+1), IVg=-(%i C Vg ω)/(%i C R ω+1)]
```

The complex capacitor voltage is V_{20} and it is obtained from the V[2] variable.

```
(%i4)   V2PT: V[2], VgRCVo_Response_PT;
(V2PT)  Vg/(%i C R ω+1)
```

Next, SALECx is invoked to perform the Unilateral Laplace Transform domain analysis for the complex frequency s [radian/second].

```
(%i5)   VgRCVo_Response: SALECx(VgRCVo_Shema),
          SALECxPrint: true;
```

The option "SALECxPrint: true" instructs SALECx to print some analysis details.

```
Symbolic Analysis of Linear Electric Circuits with Maxima
SALECx version 1.0, Prof. Dr. Dejan Tošić, tosic@etf.rs
Number of nodes excluding 0 node:  2
Electric circuit specification:  [[V,Vg,1,0,Vg],[R,R,1,2,R],[C,C
,2,0,C,Vo]]
Supported element:  [true,true,true]
Element values:  [Vg,R,C]
Initial conditions:  [false,false,Vo]
MNA equations:  [(V1-V2)/R+IVg=0, V2 C s-C Vo+(V2-V1)/R=0, V1=Vg]
MNA variables:  [V1,V2,IVg]
(VgRCVo_Response) [V1=Vg, V2=(C R Vo+Vg)/(C R s+1), IVg=-(C Vg s-C Vo)/(C R s+1)]
```

The corresponding complex capacitor voltage depends on the initial condition, now. The excitation is assumed to be a step function.

```
(%i6)   V2s: V[2], VgRCVo_Response, Vg=Vstep/s;
(V2s)   (Vstep/s+C R Vo)/(C R s+1)
```

The time-domain capacitor voltage, for $t > 0$, can be computed by the Maxima **ilt** function, which performs the Inverse Unilateral Laplace Transform.

```
(%i7)    v2ilt: ilt(V2s,s,t), expand;
```

$$(v2ilt)\quad -Vstep\ \%e^{-\frac{t}{C\,R}} + Vo\ \%e^{-\frac{t}{C\,R}} + Vstep$$

The result can be rewritten for a desired form, e.g.

```
(%i8)    v2t: factorout(v2ilt,Vstep,Vo);
```

$$(v2t)\quad \left(Vo - Vstep\right)\ \%e^{-\frac{t}{C\,R}} + Vstep$$

In both analyses the source current is a MNA variable because it cannot be expressed in terms of the node voltages. That is, the ideal independent voltage source is not a voltage-controlled element.

Figure 2 presents an OTA-C (**O**PERATIONAL **T**RANSCONDUCTANCE **A**MPLIFIER with **C**APACITORS) lowpass and highpass 2nd-order filter realization.

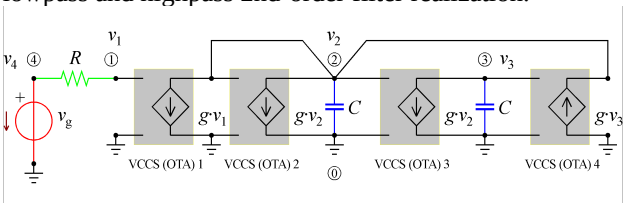


Figure 2: OTA-C filter realization.

The corresponding netlist and response generated by SALECx follow.

```
(%i2)    OTA_C_shema: [
          ["V", "Vg", 4, 0, Vg],
          ["R", "R", 4, 1, R],
          ["VCCS", "OTA1", [1,0], [2,0], g],
          ["VCCS", "OTA2", [2,0], [2,0], g],
          ["VCCS", "OTA3", [2,0], [3,0], g],
          ["VCCS", "OTA4", [3,0], [0,2], g],
          ["C", "C1", 2, 0, C],
          ["C", "C2", 3, 0, C]
         ]$
```

```
(%i3)    OTA_C_response: SALECx(OTA_C_shema);
```

$$[V_1 = Vg,\ V_2 = -\frac{C\,Vg\,g\,s}{C^2\,s^2 + C\,g\,s + g^2},\ V_3 = \frac{Vg\,g^2}{C^2\,s^2 + C\,g\,s + g^2},\ V_4 = Vg,\ I_{Vg} = 0]$$

```
(%i4)    Hs2bandpass: V[2]/Vg, OTA_C_response;
```

$$(Hs2bandpass)\quad -\frac{C\,g\,s}{C^2\,s^2 + C\,g\,s + g^2}$$

```
(%i5)    Hs3lowpass: V[3]/Vg, OTA_C_response;
```

$$(Hs3lowpass)\quad \frac{g^2}{C^2\,s^2 + C\,g\,s + g^2}$$

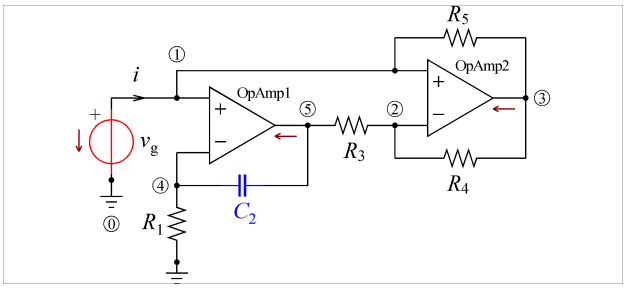


Figure 3: Riordan gyrator synthetic inductor.

Synthetic inductor, which is realized with the Riordan gyrator network, is shown in Fig. 3. The proof-of-concept symbolic analysis follows. The circuit is inductorless but, theoretically, the impedance seen by the source is purely inductive.

Wilkinson power divider, which is realized with ideal lossless transmission line sections, is shown in Fig. 4. The corresponding symbolic analysis with SALECx, performed in the Phasor Transform domain, verifies that the circuit equally splits (divides) input power to the loads $R_2 = R$ and $R_3 = R$, i.e. $V_2 = V_3$.

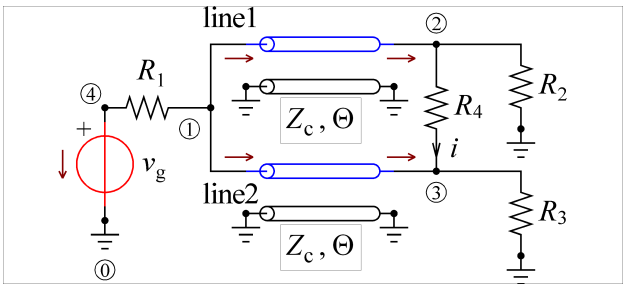


Figure 4: Wilkinson power divider.

Doubly terminated lossless transmission line section is shown in Fig. 5.

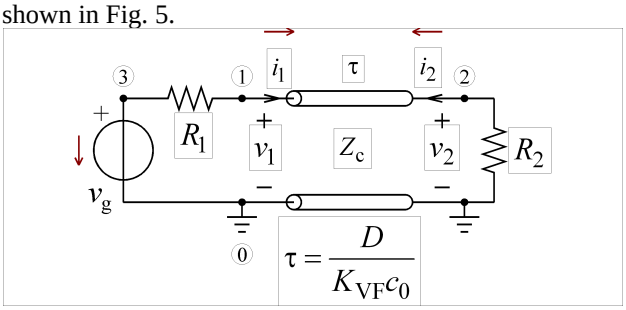
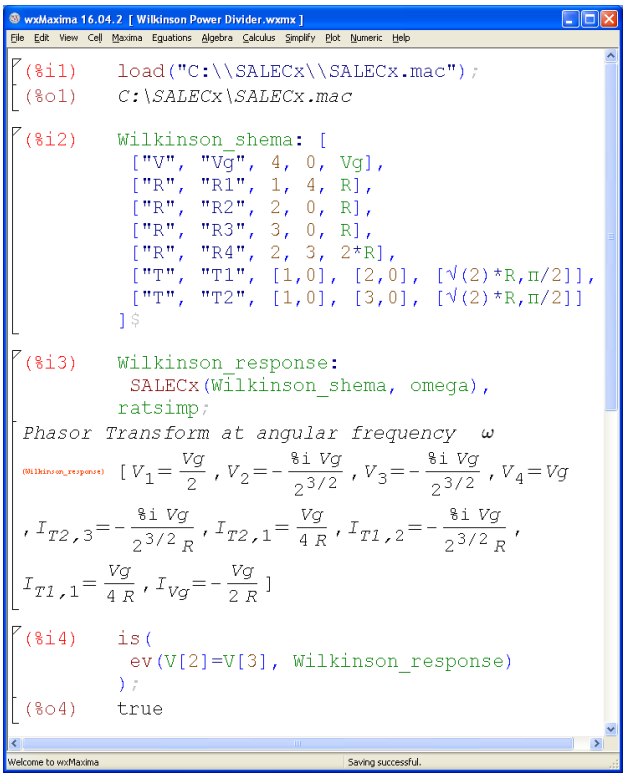


Figure 5: Transmission line circuit; the Laplace transform domain.

The corresponding symbolic analysis with SALECx, performed in the Unilateral Laplace Transform domain, verifies that the circuit acts as a delay line.


wxMaxima 16.04.2 [Wilkinson Power Divider.wxmx]

File Edit View Cell Maxima Equations Algebra Calculus Simplify Plot Numeric Help

```
(%i1)    load("C:\\SALECx\\SALECx.mac");
(%o1)    C:\SALECx\SALECx.mac

(%i2)    Wilkinson_shema: [
          ["V", "Vg", 4, 0, Vg],
          ["R", "R1", 1, 4, R],
          ["R", "R2", 2, 0, R],
          ["R", "R3", 3, 0, R],
          ["R", "R4", 2, 3, 2*R],
          ["T", "T1", [1,0], [2,0], [√(2)*R,π/2]],
          ["T", "T2", [1,0], [3,0], [√(2)*R,π/2]]
         ]$

(%i3)    Wilkinson_response:
          SALECx(Wilkinson_shema, omega),
         ratsimp;
Phasor Transform at angular frequency  ω
```

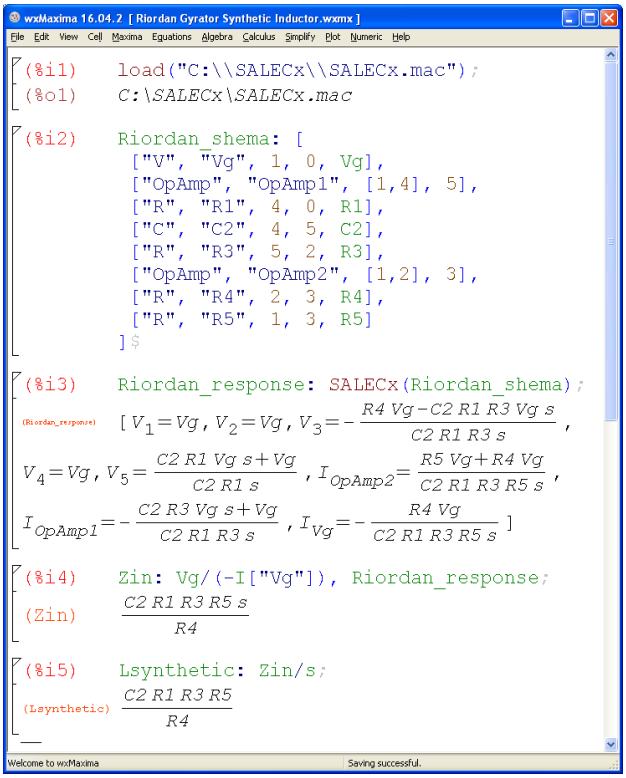
$$[V_1 = \frac{Vg}{2},\ V_2 = -\frac{\%i\,Vg}{2^{3/2}},\ V_3 = -\frac{\%i\,Vg}{2^{3/2}},\ V_4 = Vg,$$

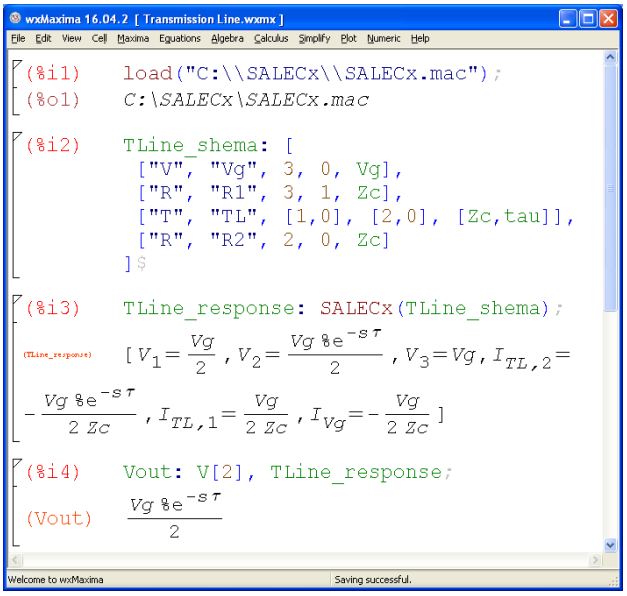
$$I_{T2,3} = -\frac{\%i\,Vg}{2^{3/2}\,R},\ I_{T2,1} = \frac{Vg}{4\,R},\ I_{T1,2} = -\frac{\%i\,Vg}{2^{3/2}\,R},$$

$$I_{T1,1} = \frac{Vg}{4\,R},\ I_{Vg} = -\frac{Vg}{2\,R}]$$

```
(%i4)    is(
          ev(V[2]=V[3], Wilkinson_response)
         );
(%o4)    true
```

Welcome to wxMaxima Saving successful.





IV. Conclusion

Automated computer-aided symbolic analysis of linear time-invariant electric circuits, implemented in software SALECx, has been presented. Symbolic simulator SALECx, written in Maxima CAS, receives a textual circuit description in the form of a netlist and generates closed-form analytic expressions for the circuit response. The analysis is performed in the complex domain of the Unilateral Laplace Transform or the Phasor transform.

Engineers, educators and students can benefit from SALECx when exploring design alternatives, verifying the circuit performance, or carrying out the proof-of-concept analyses. The future directives might be an integration of SALECx with a schematic capture editor so the user can specify circuits pictorially.

Acknowledgments

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Statistical software for medical professionals

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Abstract: Statistical data analysis is inherent part of medical research method. The choice of certain statistical software in the medical research depends on many factors. Although the popularity of free statistical software is rising, an ease of use and inertia of the professional surrounding might not be less important factors in the decision-making process and choosing the "right" statistical package. However, new free software that focuses on non-programmers' looking to point-and-click their way through analyses may be the "free software answer" to both efficient, free, and easy to use.

Keywords: statistical analysis; medical research; free software.

I. Introduction

Medical statistics has been introduced in medical research by sir Austin Bradford Hill through in the late 1930s [1][2][3]. During the 1940s, 1950s, and 1960s, the use of formal statistical methods in medical research grew and statistical data analysis subsequently became an inherent part of medical research method.

The optimal situation in medical research environment is that medical researchers have at least critical level of statistical understanding, while a statistical researcher (if there is any) should sufficiently understand the nature of data. Unfortunately, this is not a common situation, and sometimes, statistical software tools may damage statistical practice if they distract attention from statistical goals and tasks, onto the tools themselves [4]. Considering this circumstance, the engineers of statistical software should create tools that should prevent this misuse; general statistical software has, however, been criticised for failing to trap misuse in medical research [4] [5]. Statistical computer software has been criticised for giving its users false confidence when performing analyses and thereby distancing relevant statistical appreciation from common research practice [4][5].

The question of choice of the statistical software for handling medical data is wide and depends on many rational and some not so rational and yet, potentially much influential factors.

Our main interest in this paper is to make an overview of the most popular statistical software in medical research. The statistical software that is used for handling medical data in the segment of health service such as pharmaceutic, economics, management and administration, policy analysis and policy implications of health care research, public health focus, and financing/insurance focus remained beyond the scope of our overview.

Figure 1: Sir Austin Bradford-Hill has introduced statistics in medical science with the series of articles in the journal The Lancet in the late 1930s and dedicated most of his career to work in this field [1][2][3]. Photo: By Unknown, CC BY 4.0, https://commons.wikimedia.org/w/index.php?curid=33258846

II. How do we choose data analysis tool?

The choice of a particular software package for a particular medical research depends on the study's specific analytical needs, the nature of our data, the suitability of a particular software application for a specific analysis, on the choice of the packages that are available to us, on the investigators' skills and experience, on the budget for statistical software if we have to buy it, and on the time that has to be spent on learning the software. Among the less rational but not less important and decisive factors of selecting the "right" statistical software is the what is used in local professional milieu (albeit not knowing if that one is the most adequate one). Sometimes this inertia may not be significant issue, since there are many similarities between statistical software packages (SPSS, SAS, R, Stata, JMP, …) [6] in the logic and wording they use even if the interface is different. But, if we are limited with the budget and the skills for command-line interfaces than these similarities are not especially helpful.

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The comprehensive approach on the key factors that are important for the choice of the right statistical software in the form of "matrix of factor classification" has been presented by Cavaliere [7]. It consists of the system of subjective and objective, endogenous and exogenous factors that has an impact on the decision process. An interesting model of the decision process related to the choice and acquisition of the statistical software has also been presented. As mentioned earlier, this is strongly context dependent process that is marked by the functional requirements, the level of statistical and programming needs, knowledge of the researchers and IT infrastructure.

III. Overview of prevalence of statistical software in medical research

In an interesting and regularly updated review on the frequency of the statistical software, prof. Muenchen [8] lists the most usual ways of analysing the frequency of statistical tools: job advertisements, scholarly articles, survey of use, books, blogs, discussion forum activities, programming popularity measures, sales and downloads, and competition use growth in capability.

The frequency of requirements for certain data analysis software in *job advertisements*, give us an estimation of how much is that software demanded. Job advertisements are comprehensively designed with the detailed description of the needed software skills and are backed by money. Therefore, they should be a trustful source of the need and popularity of certain data analysis software. However, medical research in our local community are seldom sponsored on a regular basis. So, my feeling is that the more comprehensive way of estimating the popularity of statistical software for medical data handling would be analysing the data science tools used in *scientific articles*.

Although expensive proprietary software, SPSS is still the most dominant package. After analysing 80000 articles for 2018 found on Google Scholar, Prof. Muenchen [8] shows that SPSS is by far most dominant package (about 50% in all academic articles). It has been so for over 20 years. He suspects that this might be due to its balance between power and ease of use. R is in the second place with around half as many articles. It offers big power, but less ease of use. However, his extensive analysis also shows some trends of change: decline of the traditional software packages and increase of use of data software associated with AI/ML; cheap or free software is in increase in demand, expensive is down.

Our subjective impression of the still unperturbed dominance of the SPSS in medical research articles is backed up with the finding in Prof. Muenchen's analysis [8]: despite consistent decline during previous 10 years, SPSS is still extremely dominant for scholarly use. This analysis shows that R and SAS are still the right behind it. Similar pattern, but in much smaller figures followed SAS and GraphPad Prism.

Surveys of use give us different estimations on the popularity of statistical software, may be a bit too strongly dependent of the undertaker of the survey itself. According to the Rexer Analytics survey [8][9] of data scientists R has a more than 2-to-1 lead over the next most popular packages, SPSS Statistics and SAS. Microsoft Excel Data Mining software is slightly less popular.

According to the results of Lavastorm Analytics Community Group, Data Science Central and KDnuggets. from 2013 [10], Excel comes out as the top self-service analytic tool and R comes out as the top advanced analytics tool with 35.3% of respondents, followed closely by SAS. MS Access position in 4th place is a bit of an outlier as no other surveys include it at all. A review of statistical analysis of software programs used in biomedical research, based on a Labome survey [8][11] of randomly selected, formal publications that has been updated in August 2019, the list of the main brands of data analysis and graphing software and the number of articles among the articles is as follows: Prism, SMP, StatView, Excel, Origin, while SPSS and R are found to be in the lower half of the 10-item list of statistical software most frequently used in biomedical research [11] [12][13][14][15][15][16].

Books. The frequency of showing up a software name in the book title may give us an estimation on the software popularity. Considering the effort that accompanies the risk-taking process of writing and publishing that preceded by research of the market demand, the number of published books mirrors the requirements for a specific software. According to the number of books that include a software name in its title, the most popular software packages are SAS, SPSS Statistics, R, JMP…) [8].

The rise of software that uses the workflow (or flowchart) style of control has been observed as a trend, recently. Software that uses this approach includes: KNIME, Microsoft Azure Machine Learning, RapidMiner, SPSS Modeler, SAS Enterprise Miner, SAS Studio, Dotplot Designer and Microsoft Azure Machine Learning. Workflow-driven software is almost as easy to learn as menu driven software and they are also time-saving since we can save and re-use the work. The wide use of this interface is allowing non-programmers to make use of advanced analytics, but we have not observed significant rise in popularity of these potentially useful packages in medical research.

As mentioned before, successful data analysis is based on both statistical knowledge, mustering of the statistical software and the ability to interpret results.

Although medical professional seek a comprehensive statistical software, if the research team do not have fully designated statistical engineer or statistically educated team member, most of "lay" statistician seek software which is intuitive (obvious; second nature; mustered by instinct), cross-platform (available for more than one operating system, such as Windows, Mac OS X, Linux), menu-driven (instead of having to issue commands, most of the procedures can be accessed via pull-down menus in the graphical user interface (GUI)

and do not have steep learning curve (or takes considerable time and effort to learn).

On the opposite side from the user friendly on the spectrum of the statistical data tools are text-based user interfaces, typed command labels or text navigation, steep learning curve of command-lines interfaces which require commands to be typed on a computer keyboard are not user friendly toward medical professionals. So far, and despite of sharp ten years drop, SPSS is still the most frequently used statistical software. Its use was still 66% higher than R in 2018 [8]. It seems that (lay) statisticians are motivated to find the way to pay for ease of use. Recently arrived free software that uses graphic user interface that is menu driven and is similar in style to SPSS such as JASP, jamovi, and BlueSky Statistics might meet the needs of medical researchers who are not willing to invest their time in learning command line- based software. For example, BlueSky Statistics is a free and open source, cross platform, graphical user interface for the R software that focuses on beginners looking to point-and-click their way through analyses [17]. It remains to be seen whether these easy to use, free, and open source software will chip away at SPSS dominance.

IV. Conclusion

Although the popularity ranking of each package varies depends on the criteria used, we can still see major trends: SPSS, R, SAS, and Stata tend to always be in the top. Medical professionals who are doing statistics on their own in the research strive to the ease-of-use in a software and that is how quickly and effortlessly they can find out how to do what they want without time consuming prior instruction, consultation of manuals or third-party help. Trustful free software which fulfil these requirements would probably meet the needs of the most of them.

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Gender gap in electrical engineering at the University of Belgrade (1923-2010): Analysis of graduates' structure using R

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Abstract: This paper introduces exploratory analysis of graduates at the University of Belgrade from 1923 to 2010, with the focus on their gender structure. The underrepresentation of women in electrical engineering and computer science is a global issue, and precise data on the local situation is mostly absent from the literature. Preliminary results of objective assessment of gender gap by analysing graduates' gender, graduation age, and module preferences for 87 years are presented. This analysis might be valuable for decision makers in the area of electrical engineering and computer science for designing gender-motivated institutional changes in order to alter male-dominated culture.

Keywords: electrical engineering; computer science; gender equality; gender disparities; women in STEM.

I. Introduction and motivation

A recent StartIT article published in December 2018 promoted a positive trend of number of females applied for entrance exam at the University of Belgrade – School of Electrical Engineering (ETF) [1]. This percent was ~33% in 2018 and 2019 as it increased for ~13% since 2006 [2]. There is a relatively high correlation of these percents of interested females for the studies at ETF and the number of those who passed the exam and became freshwoman (personal communication with the Vicedean for academic affairs at the ETF, [1]). These positive trends are to some extent in line with the tendancy of women choosing more major in computer science more often as seen at the Stanford University in 2015 [1][3]. Gender gap is definitely decreasing, but the process is rather slow (participation of women in engineering is 20% worldwide [4]). It seems that the climate in the tech world did not foster gender gap closedown. At least, not yet [4]. Despite world-wide efforts towards more diversity, electrical engineering is still male-dominant, and adequate efforts are needed to narrow this gap further [5]. In order to direct and plan appropriate actions, assessment of gender gap is required. We believe that a historical perspective and an insight into the number of female graduates in electrical engineering that are presented in this paper by analysis of available data from the address book of graduates from the University of Belgrade (UB) for a period 1923-2010 [6] will be valuable for decision makers to direct more diversity at UB and ETF.

We aimed to answer following research questions: (1) how did gender gap change over the years at the UB, (2) are there any gender differences in age at the time of graduation, and (3) are there "masculine" and "feminine" modules at ETF and UB. Possible origins of the obtained results were discussed.

II. Methods and materials

All processing steps were performed in R environment and programming language [7] using R Studio IDE (Rstudio, Inc., Boston, MA, USA), and LibreOffice (The Document Foundation, Berlin, Germany) was used for storing and handling data. We used dplyr [8], ggplot2 [9], and readODS [10] R packages from an official repository of R packages CRAN (The Comprehensive R Archive Network).

A. Available data and historical background

In 1905 Technical faculty was founded at the UB with three modules (civil engineering, architecture, and mechanical engineering). Lectures in electrical engineering were held at the module of mechanical engineering. University regulation adopted in 1922, envisioned that students could apply for their diploma work in electrical engineering and the first graduates in mechanical and electrical engineering appeared in 1923.

In 1946, mechanical and electrical engineering were separated and the first graduates in electrical engineering appeared in the same year. ETF was formed shortly after, in 1948, under UB as an umbrella institution with two modules. In following years the number of modules and their names changed. The last accreditation included in the available dataset dates back from 2003/04 academic year when Bologna process and educational reforms were implemented [11]. In 2003/04 6 modules were introduced: OG (Power Engineering), OE (Electronics), OT (Telecommunications and Information Technology), OS (Signals and Systems), IR (Computer Engineering and Information Theory), and OF (Physical Electronics), and in 2004/05 the 7th module SI (Software Engineering) was introduced. [6]

In 2010, the address book titled "Address book of graduates in electrical engineering at the University of Belgrade 1923-2010" (original title in Serbian "Imenik inženjera elektrotehnike koji su diplomirali na Univerzitetu u Beogradu 1923-2010") was edited by prof. Miodrag Popović (ETF Dean 2007-2011) and late prof. Dimitrije Tjapkin (ETF Dean 1975-1977) [6]. They merged forgotten address book from 1956 with graduates for a period 1923-1956, an adress book published for the

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50th ETF anniversary, and ETF archive. The [6] book contains the following information: graduation year, name, abbreviated middle name, surname, module, and year, place and state of birth for 19596 graduates. For the period 1923-1948 states are available either in abbreviated format (S for Serbia, Sl for Slovenia, M for Macedonia, etc.) or with full names (Russian, Polland, Germany, etc.). For a period from 1948 to 2010, in some cases states were added and in some not (the majority already existed for foreign[1] countries). Authors of this paper had the address book [6] available in an open pdf format (portable document format, ISO 32000-2 standard) stored at the digital optical disc data storage *i.e.* CD (Rainbow books standard) prepared for the 70th ETF anniversary in 2018.

The available data were not in machine-readable format and the graduates' gender[2] was missing. Therefore, the main idea behind the transformation of the available pdf from [6] was to add information on gender based on the graduates' names in a machine-readable format in order to enable analysis of the gender gap in electrical engineering and computer science in UB and ETF.

B. Data formatting and cleaning

In order to analyse given data, we tried to read pdf file directly in RStudio with available R package pdftools [13]. This was not possible without additional and extensive workaround due to a non-consistent formatting (available pdf presents a combination of other documents). Hence, manual manipulation was required. Firstly, we copied text manually (page by page) by Select tool in Adobe Acrobat (Adobe Systems, Inc., San Jose, CA, USA) from [6] into Lexilogos [14] for conversion from Cyrillic to Latin Serbian letters for straightforward analysis in R. Secondly, we copied data in a LibreOffice Writter document with odt (open document text) extension. Thirdly, we converted text to table in LibreOffice Writter with one space as separator and then copied table in LibreOffice Calc with ods (open document spreadsheet) extension. This was done for each graduation year. Column with graduation year was added manually in odt file and excess columns were deleted manually (e.g. additional column was created if the place of birth consisted of more than one word, such as Smederevska Palanka). Also, NAs (Not Available) were added manually for the missing columns. When neccessary, additional corrections due to variety of formatting styles in the original pdf were applied including typos correction (Nikla into Nikola, Nend into Nenad, etc.). In some cases, we added states into the final ods file. However, this cleaning wasn't completed, as this paper is focused on gender gap. N. M. was responsible for filling in the gender column in the dataset, based on the graduates' names, and B. S. performed an additional inspection. The gender was determined for 98.8% of graduates. For inconclusive cases, the raws were filled with "?". This was the case with following unisex names (number of names is given in brackets): Saša (156), Sava (12), Vanja (11), Dobrica (8), Vladica (8), and other unisex and foreign names (33 in total with one replica). We placed NAs for birth year in all graduates older than 80 and younger than 20 at the time of graduation (15 graduates). For Serbian Latin letters (š, č, ć, ž, and đ) representation in R, we used UTF-8 encoding. Then, we added the 10th column of age at the time of graduation by subtracting birth year from graduation year in R. Finally, we recorded data in a text file for further analysis. To summarize, the final dataset consisted of 284 (1.5%) missing abbreviated middle names, one missing module (<0.1%), 70 missing birth years (0.4%), 74 missing birth cities (0.4%), and 14688 missing countries (75.0%).

C. Exploratory data analysis

In order to get an insight into historical trends of gender gap in electrical engineering and computer science at UB and ETF, we visualized data and performed simple descriptive statistics (calcuated mean, standard deviation with Bessel's correction (SD), and the appropriate proportions of females and males, and their age). For comparison of graduation age, we used Welch two sample t-test (significant difference was set at $p<0.01$). We used bar graphs and mirror bar chart for visualization.

III. Results and discusion

The results are presented for 19588[3] graduates in a period from 1923 to 2010 (except for the year 1945[4]). During this 87 years range there were 3518 females (~18%) and 15840 males (~82%) graduating in Electrical Engineering at UB. Percentage of females for each year is presented in Figure 1.

The first woman graduated in mechanical and electrical engineering at UB in 1931, only 8 years after the inception of this program. However, the presence of women graduates at UB remained a rare occurrence for the next three decades – women made under or around 10% of graduates until 1970[5]), when women made almost quarter of graduates, although that was an isolated occurrence until the end of the 1980s.

The maximal percent of female graduates (30.6%) was in 1993, which might be the consequence of the breakup

1 The term foreign should be taken with precaution, since Belgrade and UB changed countries during the turbulent history. Following states (with corresponding territories and authority) had Belgrade as capital from 1882: Kingdom of Serbia; Kingdom of Serbs, Croats and Slovenes; Kingdom of Yugoslavia; German-occupied Serbia; Federal People's Republic of Yugoslavia; Socialist Federal Republic of Yugoslavia; Federal Republic of Yugoslavia; Serbia and Montenegro; and from 2006 Republic of Serbia. For more see, https://en.wikipedia.org/wiki/History_of_Belgrade, Assessed in Aug. 2019.

2 Here, we use gender as a common term for both sex and gender. However, sex is commonly used to point out to the person's biological characteristics and gender is frequently used to describe person's internal awareness (https://en.wikipedia.org/wiki/Sex_and_gender_distinction, Assessed in Aug. 2019). For more appropriate and extensive explanation on gender and sex, please see [12].

3 There is a slight difference of reported number of graduates in [6] and this number (8 graduates) and an additional crosscheck is adviced.

4 There were no graduates in 1945. This pause was probably caused by the Belgrade Offensive at the end of the World War II. It resulted in goods shortage, famine, and other unfortunate events which deteriorated significantly during bombardment. Technical faculty of the UB was also damaged during bombing conducted by Serbian allies in a period April-September 1944. Offensive brought also street fights and explosions [15].

5 Except for 11 years when there were no women graduates – 1932-1934, 1939-1940, 1943-1944, 1946-1948, 1950.

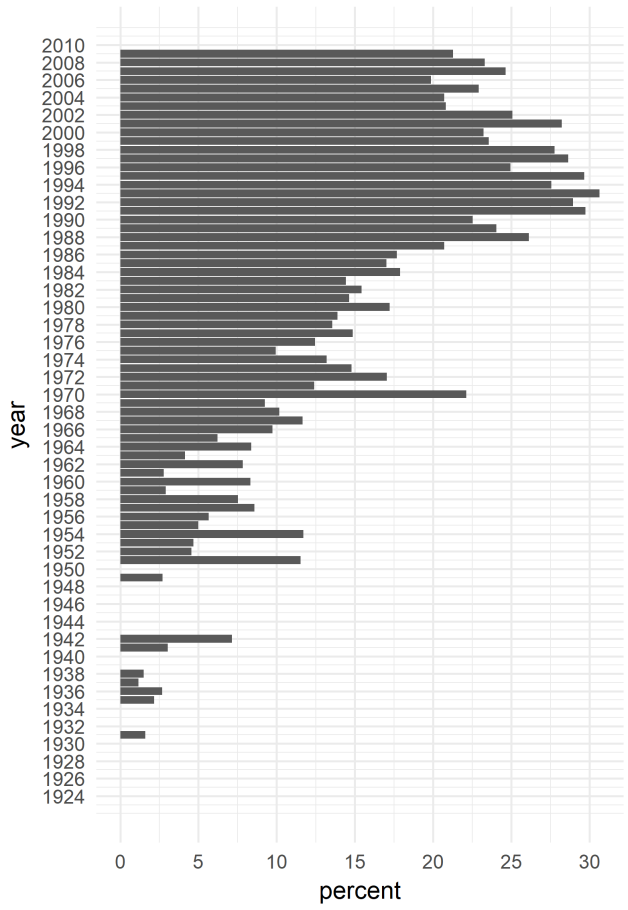

Figure 1: Percents of female graduates per year for a period 1923-2010.

war in Yugoslavia when large refugee migrations (including so-called brain drain migration [16]) and military recruitment took place.

Overall, the larger percent of females in certain historical periods might be the consequence of historical events, as well as other societal changes: during 23 years (out of 87 years range), the number of female graduates was >20%; and for the period (1988, 1991-1995, 1997, 1998, 2001-2002) it was >25% (see Figure 1). The largest number of students was in 2007 (755 students) with 24.6% of females.

On average, during graduation, females were 25.98±2.59 years old (range from 20 to 48 years) and males were 26.85±3.48 years old (range from 20 to 61). Mirror bar in Figure 2 presents comparison of age for female and male graduates for each graduation year. SDs are not presented Figure 2 as they would not be visible (on average SDs were 9.15±3.06% and 12.51±2.28% for females and males, respectively). T-test showed statistically significant difference of average age during graduation per year between males and females for 1923-2010 ($p = 0.007$), and for 1952-2010 ($p < 10^{-8}$) indicating probably more efficient studying of females. A number of reasons could be at the root of this difference, many of them "gendered" in nature – e.g. girls are under bigger pressure to finish schooling so they can marry and have children (since their "biological clock is ticking") and, on the other side, there was a compulsory military service

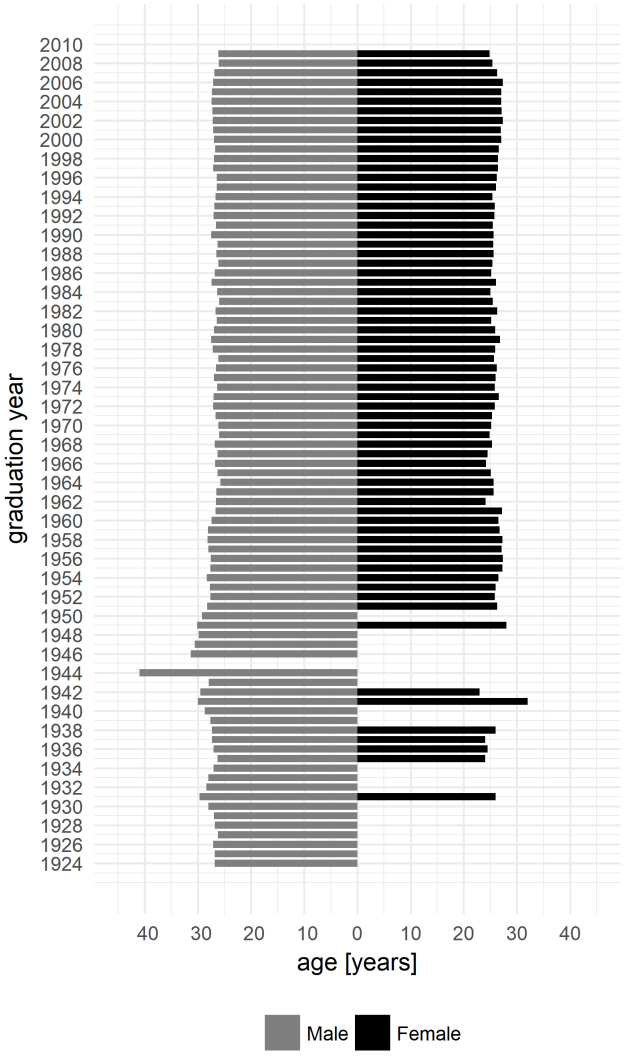

Figure 2: Mirror bar chart of average graduates' age.

for men in Serbia (which was suspended in 2011) that could have delayed their graduation.

We calculated percents of females per modules that were introduced by the accreditation and Bologna reform in 2003/2004 academic year for period 2007-2010 for 7 modules. Results are presented in Figure 3. Females' share for 2007-2010 was 33.0% for OT (Telecommunications and Information Technology), 30.2% for OS (Signals and Systems), 26.9% for OF (Physical Electronics), 15.6% for OE (Electronics), 14.4% for IR (Computer Engineering and Information Theory), 13.9 for OG (Power Engineering), and 11.7% for SI (Software Engineering). Data presented in Figure 3 was analyzed for 1636 graduates, which encompasses only 8.4% of the entire dataset. When looking at the more comprehensive analysis of top modules for 87 years, which is presented for 7665 graduates (39.1% percent of the dataset), the results are fairly similar[6]. TE (Electronics and Telecommunications) had 27.4% of females, EL (Electronics with Automatic control) 21.3%, and EN (Power Engineering) with 17.6%. This shows that males'

6 The number of enrolled students at the module should be taken into account for appropriate discussion of these results, as we determined these top modules by the largest proportion of females entering the field.

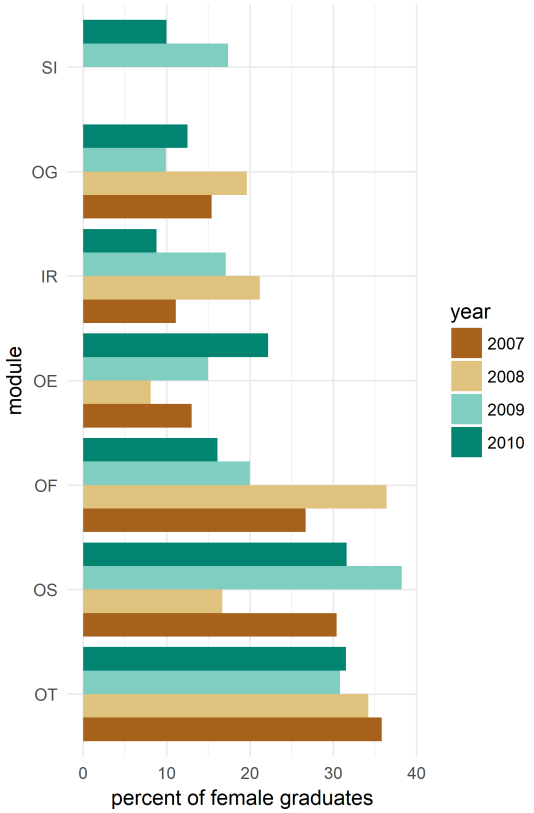

Figure 3: Percents of female graduates per year for modules introduced in 2003/2004 academic year (SI module was introduced in 2004/2005).

preference is Electronics and females' preference is Telecommunications. However, a more comprehensive analysis is necessary, that would include a larger proportion of the sample and also look into separate periods with different modules. But, even this partial insight into the gender structure across modules indicates that it reproduces some typical gender stereotypes when it comes to the professional interests and choice of career.

One interesting result when it comes to historical trends is related to computer science: RT (predecessor of IR) had 29.9% females (1923-2010) and this number decreased over years to 14.4% for IR. Further research is needed to adequately interpret this trend. Another interesting phenomenon is SI. There were no females during the first graduation year (2008), although it should be mentioned that only 7 males graduated in 2008. Higher gender gap in SI can be explained by discouragement of females to enter a newly opened field. Namely, although other modules in Figure 3 were introduced one year before, they already existed under other names. Sadly, but it appears the females might not be as bold as males for entering novel field [17].

IV. Instead of a conclusion

We did not present an exhaustive analysis, rather an insight into gender gap over 87 years long period. Future work will be focused on a more detailed analysis as we will try to acquire information on enrolled students for a period 1923-2019 and on their careers after graduation.

Even with this scratch of the gender gap surface, there are strong evidences that pervasive gender gap exists. Institutional and planned actions should be performed to close the gap permanently and efficiently [5].

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When do open science practices lead to higher quality data?

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Abstract: Open science initiatives and practices are gaining almost universal support. For example, the registered report manuscript format, designed with the aim to increase transparency and quality of science, is starting to make an impact across different fields. The second line of action focuses on creating standards for sharing research materials, analysis scripts, and databases. Third, the pressure on publishers to make published manuscripts openly accessible is increasing. Finally, scientific collaborations set the standards in data collection and enable the collection of high-quality data. In this paper, we discuss the mechanisms by which these practices may improve the quality of scientific data and offer a critical perspective on their outcomes and effectiveness.

Keywords: open science practices; registered reports; open data; collaborations.

I. Introduction

In the past two decades, there has been a number of initiatives supporting open science, e.g., [1], [2], [3], [4], and the idea of openness seems to be almost undisputed and widely promoted [5]. This resulted in a list of radical changes in recommended research practices for empirical sciences aimed to discourage the so called questionable ones (for a brief overview see [6]). In this paper, we argue that, as with all innovations, academic community should not take the positive impact of open science practices for granted, but should instead scrutinize it and carefully consider their benefits, as well as potential risks and drawbacks (this same sentiment was voiced in, for example, [7]). To this end, we will delve into the mechanisms by which open science practices could benefit science, and, more specifically, lead to higher quality data and we will discuss the yet unresolved issues related to open science practices.

II. Registered reports

By pre-registering their study, researchers commit to specific hypotheses and analysis plans before collecting research data (as seen in [8][9]). In a rather straightforward manner, this practice prevents some of the most common questionable research practices, such as post hoc hypothesizing (HARK-ing: Hypothesizing After the Results are Known), searching for statistically significant results (p-hacking), selective reporting (reporting only on significant findings and omitting the non-significant ones), etc. In this way, pre-registering a study ensures that the database which will be the result of a study is complete and known in advance. Additionally, if the pre-registered plan is peer-reviewed before the data is collected it should also make sure that study samples are large enough to enable a valid test of the research hypothesis, i.e., that the studies have enough statistical power to detect the effect of certain size.

The design of the study is not the only output that can be peer-reviewed - instead of the fully completed manuscript, researchers can now submit the whole manuscript omitting only the exact results to solicit feedback from the experts in the field. In general, the practice of results-blind reviews should guarantee that a manuscript is evaluated on the basis of the relevance of the research question it poses, its methodological stringency, the soundness of the data analytic approach, and not the significant and “attractive” results it is expected to obtain. This practice makes it more probable for both significant (hypothesis confirming) and non-significant results to be published, thus helping future studies determine the focus of their research. If a finding is repeatedly proven to be non-replicable, this is an important signal for other researchers that their resources can be better used to explore different, more promising research lines and to collect databases with higher usability.

III. Sharing materials, databases, and scripts

Let us go through the most important arguments for the claim that sharing is the most obvious way to improve the quality of scientific data. Firstly, making the data public means that the results obtained on those data are verifiable - i.e., other members of the community can engage in its quality control and point out to eventual omissions or errors that can be corrected. This mere fact, in turn, increases the researcher’s responsibility to double-check both the data and all the results, consequently reducing the probability of both unintentional errors and questionable research practices. Sharing the data also requires the researcher to make the database readable to others (e.g., labeling raw variables, describing the scale and calculated scores) thus increasing the likelihood of it being (re)used (for example, see [10]). Moreover, open databases can be aggregated into large secondary databases. This allows for analyses that would not be possible on single-study data alone (one such attempt which is known to a wider public is the Gapminder Foundation, https://www.gapminder.org/).

Closely related to sharing data is sharing analysis scripts, as these two types of open resources complement each other. Sharing scripts further increases both the

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verifiability and the communicability of research data, so it improves scientific practices in a way similar to that of sharing data. But more than that, by sharing their scripts, researchers make it easier for others to build upon their work, extend their analyses and generate secondary data (e.g., by proposing new indices calculated from the raw data). It also prevents loss of resources, as the researchers do not need to start from scratch but can build upon what has already been done - unfortunately, it is very common in science to have several independent teams of researchers working on the same tasks simultaneously or having to redo what has already been done but not shared. Additionally, sharing scripts encourages the use of free/open software, since it makes the script more accessible to a larger audience.

Finally, by sharing their research materials, researchers provide necessary information for understanding the scope and generalizability of the data they have collected and the results they have obtained. It is also a prerequisite for testing the replicability of findings, which is an important step in the development of any empirical science.

IV. Opening access to published manuscripts

Empirical analyses show a growing trend of open access publishing in the past four decades [11]. But how exactly is this contributing to the quality of science? The paywall is notorious for fueling a disparity between researchers depending on the number of resources available to them through the institutions they work in. Opening access to academic journals makes academic research widely available thus reducing these inequalities. While this is a valuable goal per se, having more researchers keeping up to date with the newest scientific findings also increases probabilities for scientific break-throughs, enhances the collaborative potential of scientists in deprived countries and supports cumulative science in general.

Researchers can now also share the pre-print versions of their manuscripts on one of the many designated websites (e.g., ArXiv, OSF, bioRxiv, PrePubMed) and thus recruit the help of the scientific community. After receiving comments from a number of peers, the researcher is bound to make better use of the collected data.

V. Scientific collaborations

Even though the sheer quantity of data does not guarantee its quality, collaborative efforts (whether they are widely known mega collaborations such as CERN [12] or less formalized ones such as Psychological Science Accelerator [13]), make it more likely that the data is being collected in an optimal way for testing a research hypothesis. Large databases that are created as a result of collaborative studies are high-powered for drawing conclusions and, in the case of human participants, most often include people from diverse cultural contexts or of different racial/ethnic backgrounds, which may be important for understanding the generalizability of findings (especially in, for example, medicine and psychology). Mega collaborations are also more likely to have an academic impact (for a review of how the number of citations relates to team size see [14]) and be visible in the mainstream media. They also enable knowledge sharing, especially through empowering the "weaker" partners to conduct future research, thus improving the quality of future data. In some instances, such as the Psychological Science Accelerator [13], collaborations also encourage a greater diversity of research topics, by employing a bottom-up approach to selecting projects that will be funded.

VI. Open questions on open science practices

Even though the advantages of open science practices are clear, we should be cautious about their potential to backfire, and for the practical issues they bring up. For example, relying on study materials shared by primary researchers may lead to an over-standardization, i.e., a lack of diversity of research data, which may put the generalizability of results in question. Some critiques voiced their concerns that focusing on only robust and replicable findings could discourage creative explorations that are supposed to be the "engine of science" [15][16], thus the recommended practice is now to clearly label confirmatory and exploratory analyses.

Regarding open data - special care must be taken to ensure that the data is properly anonymized so that no sensitive information on participants is disclosed and so that no participants can be identified based on their responses (see [10]). Full openness of data also allows non-experts to look into them and analyze them, which in some cases might lead to inaccurate conclusions or data interpretations.

Another issue is data ownership - as soon as the data is shared with the public, it is free to be used by anyone. Sometimes, substantial resources, e.g., government resources of a specific country taxpayers, such as GESIS panel in Germany [17] have gone into data collection, and yet the collected data is available to researchers from all over the world. However, this is a notable exception since, usually, the more time and effort had gone into data collection, the more the original authors are reluctant to share their data, at least immediately after collection/publication.

Finally, open science practices are cumbersome and can sometimes seem like an unnecessary bureaucratic burden that slows down the research and publishing process, thus making the open science research proponents less competitive. Therefore, the researchers should be made aware of all the benefits these practices bring but also incentivized to actually follow them. To this end, there have been a number of initiatives coming from academic publishers. For example, awarding badges for pre-registration, open data, and open materials has proven a good method for increasing transparency [3]. More importantly, following open science practices

should be viewed as an advantage, if not a prerequisite when evaluating projects or job applicants.

VII. Conclusion

This is most certainly not an exhaustive list of potential issues that open science faces. Many of the practices we have mentioned are rather new and we are still learning how to be open, so running into some issues seems inevitable. It is, therefore, crucial to be transparent about the decisions we make and to acknowledge the limitations of our practices.

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Toward open-source robotics – ROS use case in industrial and mobile robotics

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Abstract: Many industrial facilities use robots daily, for a variety of tasks. Besides this, service robots are playing an increasing role in our lives, starting from vacuum cleaning robots to robots that serve as hosts in many hotels nowadays or robots that assist people in recovery of injuries. Increasing demand in the market for the number of robots is also occurring in a large number of robot manufacturers. Each of them has its closed architecture and software. In this way, manufacturers provide specified characteristics, but also limiting end-users and force them to use specific software solutions. In the past decade, great effort has been made by the open-source community to make robotics available to a wider range of users. To this end, a Robot Operating System (ROS) was developed. ROS is a meta operating system that provides developers a large number of libraries and tools for easy and fast development of robotic applications. In this paper, the main concepts of ROS and how it can be used in industrial and mobile robots will be presented.

Keywords: open-source; Robot Operating System; robotics; industrial robots; mobile robots.

I. Introduction

In 2017, robot sales increased by 30% to 381,335 units. Robot sales in the automotive industry increased by 22% and remain still the major customer of industrial robots with a share of 33%. The electrical/electronics industry has been catching up with 32% of the total share [1]. Many of these robots use commercial softwares. The reason for this is safety features that robot manufacturers can guarantee by remaining close to end-users. Open-source software today doesn't offer real safety features, and developers/end-users need to develop their safety systems. Without these safety systems, robots can not be part of the factory.

When it comes to service robots, there are a lot of these robots, but still, we aren't seeing many of them in our homes and in our everyday use. This type of robot must deal with the unstructured human environment. If they are capable of dealing with these conditions, they can perform tasks like vacuum cleaning, cooking, or hosting people in hotels [2][3]. A technological breakthrough, especially in the field of artificial intelligence (AI), gives robots a possibility to work in the human's environment [4]. Besides technology readiness, robots need to be cheaper and more open to users in order to be widely adopted.

Nowadays, modern factories work on the popular concept of Smart Industry or Industry 4.0 that focuses on flexible and smart automatization [5].

ROS (Robot Operating System) community is trying to overcome all these obstacles to introduce open-source concepts to robotics [6]. The main concept of ROS, besides being open-source, is modular and reusable software in order to make robot programming accessible to everyone [7]. In this way, ROS promotes flexibility and accelerates deploy time. Because of its good features ROS is a part of academic research for a while. For it to become a part of an industrial environment standardization is very important. ROS community recently released ROS 2.0 that has increased safety and synchronization being one step closer to real-time framework [8]. ROS community is trying to become open-source middleware for robotics systems that will be running in factories, homes, hotels, etc.

In section II, basic ROS tools and libraries for fast prototyping are presented. Section III and Section IV point out an industrial robot and a mobile robot ROS use cases respectively while concluding remarks are given in Section V.

II. ROS tools and packages

ROS provides a set of software libraries and tools to help developers to build robot applications. Since it is an open-source platform, the main goal of the community is to introduce ROS as a standard in robotics. ROS allows researchers and developers to use different programming languages for creating their applications. ROS works with C++, Python, and Lisp. There is a beta version of client libraries that supports Java, C#, R, and other languages.

ROS program is called a node. Nodes can communicate with each other. Communication between ROS nodes is peer-to-peer. There are three methods of communication: through topics, services, and action services.

A. ROS tools

The main tools ROS provides are *rviz*, *rosbag*, *rqt_bag*, *rqt_plot*, *rqt_graph*, *command-line* tool, and other. For 3D visualization *rviz* is used as presented in Figure 1. This tool can let you combine sensor data, robot models, and for example work cell 3D model for a better understanding of the ongoing scenario. For data logging and visualization of sensor data, ROS use *rosabg* and *rqt_bag*. The tool for making plots is *rqt_plot*. By selecting the desired topic, this tool automatically generates a plot from its data. And to see what nodes, topics, and services are running on the system *rqt_graph* is needed. Gazebo software can be used to run physics simulation on the ROS platform.

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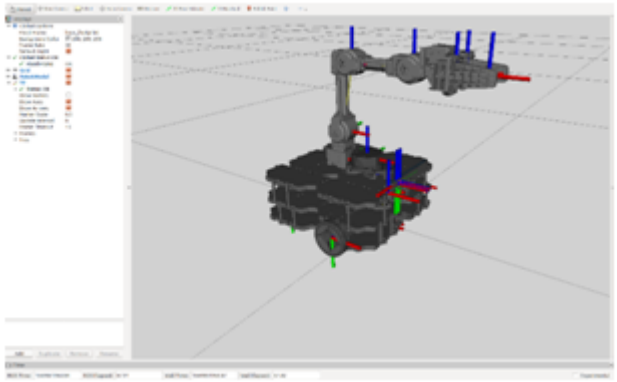

Figure 1: Rviz UI.

The Gazebo provides a necessary interface between simulations and robots. Weall know that in every robotic application good and precise simulations are precious for fast and accurate prototyping and algorithm testing. Also, without simulations, practically most of the AI robotic tasks can not be trained. Therefore, in reinforcement learning, you need to let robot to explore the environment. This action for real robot can lead to robot damage.

A. ROS packages

ROS software is organized in packages. A package might contain nodes, independent libraries, configuration files, third-party software, or anything else that constitutes a useful module. The main goal of organizing software in packages is to provide easy-to-consume and reusable software. ROS packages follow a "Goldilocks" principle: enough functionality to be useful, but not too much that the package is heavy-weight and difficult to use from other software.

In order to control a robot from ROS, appropriate drivers need to be installed. Also, all drivers for any device are organized in packages.

One of the most valuable ROS packages for industrial robots is *ros_control*. The *ros_control* is a set of packages that includes controller interface, controller managers, transmissions, and hardware interface. The package takes as input joint state data form the robot's encoders and an input set point. It uses a generic control loop feedback mechanism to control the output sent to actuators. Also, tracking of coordinate frames is very important in robotics. The package that lets users keep tracking of multiple coordinate frames over time is *tf*. In a robotic system, there are many 3D coordinate frames that change over time, such as a world frame, base frame, gripper frame, etc. This is very important if there is a need, in an application, for calculating pose of the object in robot gripper relative to its base. Or if information about the current pose of the base frame in the map frame is needed.

For mobile robotics, there are a couple of important packages, such as *move_base*, *navigation*, *robot_pose_ekf*, *gmapping*, etc. The *move_base* provides an implementation of the algorithm that, for a given goal in the world, will try to reach it with a mobile robot base. The *navigation* package combines information from odometry, sensor streams, and tries to compute safe velocity commands. These commands use as input to *the move_base* package. Because of noise, slippage, and incorrect modeling of robot geometry odometry might not give a correct robot position. The *robot_pose_ekf* package applies Extended Kalman Filtrar (EKF) to sensor data to improve "the belief" of robot position. In the end, the robot needs to know the environment and use *gmapping* package for map building. This package uses OpenSlam Gmapping algorithm for mapping. As the output from this package user gets 2-D occupation grid map.

Most robotic applications have demands for image processing. In order to provide a real-time computer vision, *vision_opencv* package is implemented for ROS. This package provides a popular OpenCV library for ROS. Also, nowadays AI algorithms are common part of robotics applications. ROS provides *openai_ros* package with complete infrastructure for Reinforcement Learning. This package can execute learning algorithms using Gazebo simulator in order to collect data necessary for learning algorithms.

III. Industrial use case for ROS

Industrial robotics has always been tied to manufacturer of industrial robots. Robotics solutions were primarily implemented via the framework provided by manufacturers. System integrators, main users of these frameworks, made programs per clients specifications. ROS - Industrial, ROS - I for short, offered open-source based framework with the idea to replace the manufacturer's one. Main idea is to create a framework that should work on all industrial robots regardless of size and type of the controller. Additional support for this idea came from research that showed the main focus for industrial robotics in the last 24 years was welding and material handling [9]. Figure 2 shows distribution from research.

Industry lacked flexibility, an adaptation of new technologies, lacking vision systems, and connectivity to Industry 4.0. Additional problem for ROS came in a form of standardization and real-time ROS for control. All of these problems will be solved from ground up in ROS2 which will strongly emphasize on real-time part of robot operations.

The use case for ROS in the industry is presented through H2020 project RAMPup [10]. The main idea of

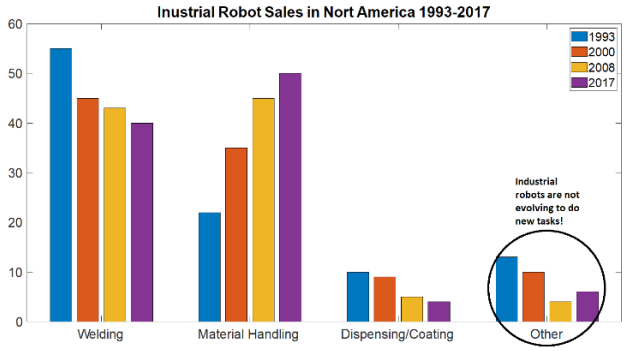

Figure 2: Industrie use of robots.

this 4-year project is to develop complete solution for common industrial tasks, screwing, riveting, gripping, and gluing for example. Each of these tasks will be constructed as a module. This included hardware as well as software and it needs to be ROS centered. An additional task is to enable easy to use and safe programming for the robot with this RAMPup module. Main users and testers will be SME which have small batches, 50 - 1000 units per batch, of a similar product and need to reprogram industrial robot with RAMPup module on a weekly basis. This will empower SMEs to use industrial robots as easy to use and safe tools to accelerate production and improve quality. The subtask of this project is a force-based insertion. Robot task is to pick up an object on a known location and carry it to the area of insertion. The area is roughly known. Robot task is to probe the area with object and measure force and torques to get an idea about the hole location. The second stage is to guide object into a hole. The object can have multiple pegs for multiple holes. A task can be opposite, the object can have holes and needs to be fitted onto multiple pegs. This was a task for SME which tested this module.

Future goals of the force based were to:

1) Create plug-and-play module that provides force based insertion which will be tested in real factory production line.

2) Modul should be agnostic toward type of robot as well as type of force-torque sensors attached to robot flange. Configurations should be available and easy to use. This is the main power of ROS.

3) Simulation of work should be available before testing on real robot workcell. This is valuable for testing real-life simulations of workcell, debugging possible solutions, and testing how force sensor should interact.

4) End users can program and modify robot's task enabling modularity.

5) Modul should be independent of its hardware as much as possible. If user needs different piece of equipment, for example larger gripper. Software side is constructed for modularity in mind.

ROS proved to be a useful tool in handling different sensors. Module main sensing of force and torque came from force and torque sensor attached to the robot end flange. Three industrial grade sensors were used, Robotiq FT300, Optoforce HEX – E model, and ATI sensor Delta SI 330 – 30. Robotic sensor had ROS enabled driver by manufacturer, Optoforce and Delta had their driver written by community for community. Because ROS is built upon nodes, changes were needed to be done only in one node that published on topics /sensor/force and /sensor/torque. The second thing that needed change is correction in orientation of coordinate system of force sensor as well new dimensions of end tool point. ROS provided drivers to communicate to KUKA controller which controlled KUKA Agilus KR10. This communication provided critical information about robot current status, for example internal coordinates of robot motors. Sending points of trajectory was also done via this open-source experimental ROS KUKA packet.

ROS2 will be the next step towards real-time constraint systems and industrial standard for the future.

- Links 1 and 2 are video demonstration of RAMPup current progress, and Link 3 provides demonstration of enforcement learning.

- Link 1 - basic functionality
- Link 2 - RAMPup demonstrations
- Link 3 - Demonstration of enforcement Learning on High-Precision Assembly Tasks with ROS - Industrial

ROS-I needs to become a stable base for research as well as industry so that use of industrial robots can be offloaded to ROS and only solving one problem. Open-source community had many issues because lack of availability of industrial robots. ROS-I is collaborating with robot manufacturers to enable simulating robot as much as possible.

IV. Mobile robots use case for ROS

The mobile robotics use case is closely related to an ongoing course at the University of Belgrade, School of Electrical Engineering on Autonomous Mobile Robots. In this course, students learn how to develop their nodes and how to exchange data through topics. Also, they learn how to control differential drive robot, how to use lidar data to detect walls, and how to implement EKF for correction of localization estimation. For this course TurtleBot3 is used, presented in Figure 3. Designed by ROBOTIS, this robot uses as an educational platform for learning ROS and Autonomous Mobile Robot basic principles.

TurtleBot3 is a differential drive robot equipped with cost-effective and small-size Single Board Computer (SBC) that is suitable for the robust embedded system, lidar sensor, and 3D printed technology. The core technologies are SLAM, Navigation, and Manipulation, making this robot suitable for home service tasks. With appropriate ROS packages, this robot can be controlled using PC, joypad, gamepad, and any wifi or Bluetooth controller. Because of the modularity of ROS packages and the topic principle of communication, this is possible.

Firstly, students need to establish communication between the robot and their PC. Applying the correct configuration of the network parameters, communication can be automatically established. That means if any of the nodes is publishing some data, collecting that data can be performed from any device that is part of ROS network. Using one command, ROS allows running every service that will bring up the robot. At that moment, users can collect data from the actuator encoders, a point cloud of lidar data, IMU data, and robot status information.

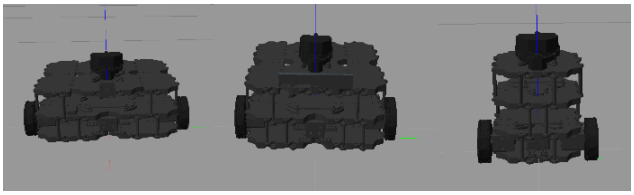

Figure 3: TurtleBot 3, left: Burger, center: Waffle, right: Waffle PI.

Also, the user can send commands to the robot to manipulate them. The second thing that students need to learn is how to develop an algorithm for moving robot around. Using proper drivers, there is no need to worry about motor control or to think about how communication works. Students only need to focus on the algorithm that they develop.

Following link demonstrates TurtleBot3 performing SLAM: Link 4 – TurtleBot3 SLAM.

If you need to focus on research of a new algorithm for robot control or testing algorithm for processing of point cloud data, the ROS packages provide an interface for your robotics project.

V. Conclusion

This paper presented how ROS can lead to open-source robotics. Although, ROS is not on a level like a commercial manufacturer, because of safety standards and real-time features, the ROS community is making efforts to overcome these problems. This paper also presented basic tools and packages that can accelerate the process of developing and deploying. Use case for industrial robots shown that ROS poses capabilities for running applications in which a force/torque sensor integration. In the case of mobile robots, it has been shown that students can easily learn basic postulates with ROS. Using ROS packages developing specific algorithms becomes an independent task.

ROS community is showing that in the future ROS might become a robotic standard for industrial and mobile robots. Also, they are making efforts to introduce robotic programming as easy to learn and modular.

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Lokalne zajednice okupljene oko slobodnog softvera

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Rezime: Ovaj rad je pisan sa ciljem da se prikaže razvoj lokalnih zajednica okupljenih oko slobodnog softvera, od pojave prvih zajednica do današnjeg dana, sa posebnim naglaskom na trenutno aktivne zajednice. Pored samih zajednica u radu će biti spomenuti i svi važniji događaji koji su uticali na ove zajednice, doveli do njihovog stvaranja ili bili organizovani od samih zajednica. U zaključku rad sagledava širu sliku razvoja i daje pretpostavku na koji način će se zajednice dalje razvijati.

Ključne reči: slobodan softver; lokalne zajednice; operativni sistem; projekti; hakerspejs.

I. Uvod – ili kako je sve počelo?

Tokom osamdesetih godina u Laboratoriji za veštačku inteligenciju na MIT-u (eng. *Massachusetts Institute of Technology*), dolazi do promene u distribuiranju softvera, gde proizvođači počinju da postavljaju licence na softver koji dolazi uz hardver, ova promena nije baš obradovala hakersku[7] zajednicu nastalu u ovoj laboratoriji. U duhu hakerske kulture, članovi laboratorije su navikli da mogu između sebe da dele softver, da ga menjaju i prilagođavaju po potrebi, iz tog razloga i iz želje da svoj rad deli sa drugima, jer je to u duhu klasične naučne saradnje, jedan od članova laboratorije, Ričard Stolman (eng. Richard Stallman) dolazi na ideju da započne GNU projekat (skr. *GNU's not Unix*), potpuno slobodni operativni sistem. 1985. objavljivanjem manifesta GNU-a je definisao 4 slobode softvera [1]:

- Slobodu pokretanja programa po sopstvenom nahođenju, za bilo koju svrhu (sloboda broj 0).
- Slobodu proučavanja načina rada programa i prilagođavanja programa Vašim potrebama (sloboda broj 1). Preduslov za ovo jeste obezbeđivanje pristupa izvornom kodu.
- Slobodu raspodeljivanja primeraka programa (sloboda broj 2).
- Sloboda da raspodeljujete kopije Vaših izmena drugima (sloboda broj 3).

Ubrzo nakon toga je osnovana Fondacija za slobodan softver (eng. *Free Software Fondation*) sa namerom da se podrži pokret za slobodan softver, a pogotovu GNU projekat. Napravivši softverske alate za razvoj softvera, i objavivši uopštenu licencu koja se mogla primeniti na bilo koji softverski projekat, Stolman je olakšao drugima da pišu slobodan softver nezavisno od GNU projekta, i upravo je 1991. jedan takav nezavisan projekat, započet kao lični projekat finskog studenta Linusa Torvaldsa, izrodio Linuks jezgro. Ovo jezgro je moglo biti lako kombinovano sa sistemom GNU i tako činiti potpun operativni sistem. U narednih par godina sve više ljudi počinje da koristi ovaj operativni sistem i da prepoznaje vrednosti koje stoje iza ideje o slobodnom softveru. Nakon što je internet postao dostupniji većem broju korisnika na našim prostorima 1996. godine, već 1997. godine se pojavljuje prva zajednica okupljena oko slobodnog softvera.

II. Zajednice i događaji u Srbiji[8]

Krajem 1997. godine na internetu se pojavljuje elektronska dopisna lista koja okuplja zagovornike upotrebe slobodnog softvera i linuks operativnog sistema, ova lista se zvala LUGY što je bila skraćenica za *Linux User Group of Yugoslavia* [3]. Kako će se kasnije ispostaviti ova lista će biti polazna tačka za sve projekte okupljene oko slobodnog softvera u narednih par godina. U narednih godinu dana zajednica okupljena na LUGY listi formira *Open Source Network of Yugoslavia* (skr. OSNY), organizaciju entuzijasta koji imaju jedinstven cilj - popularisanje slobodnog softvera kao modernog modela razvoja sve većeg broja uspešnih projekata [4]. OSNY je zaslužan za organizaciju nekoliko bitnih stvari tokom početka širenja ideje slobodnog softvera kod nas, pre svega treba izdvojiti LinuxFest koji su organizovali 16. decembra 1999. godine u Domu Omladine, ovaj događaj je prošao izuzetno uspešno i upoznao je mnoge ljude sa idejom slobodnog softvera, a nakon prvog izdanja ovaj događaj je organizovan 2000. i 2001. godine [5][6]. Pored toga, kao značajne projekte ove organizacije treba spomenuti OSNY resursni centar – to je server na kom su se nalazile kopije (eng. *mirrors*) nekih najpopularnijih arhiva slobodnog softvera, i vrlo uspešan projekat lokalizacije KDE grafičkog okruženja. U tom periodu se pojavljuje jedna manje zapažena organizacija koja je povezana sa OSNY, a to je Srpsko računarsko društvo Uliks, i glavni fokus ove organizacije se uglavnom svodi na lokalizaciju [7]. Važno je napomenuti da je lokalizacija ili prevođenje na srpski jezik, popularnog softvera otvorenog koda veoma značajno u tim trenucima za svetski popularne projekte slobodnog softvera jer je jedna od glavnih barijera za širu upotrebu tog softvera upravo bilo nerazumevanje engleskog jezika od strane potencijalnih korisnika tih programa.

7 U ovom radu se koristi izvorno značenje reči haker ili hakerka koja označava osobu koja je dobar poznavaoc računara, dizajner, programer ili inženjer. Hakere i Hakerke vodi pozitivna radoznalost da u potpunosti razumeju funkcionisanje sistema (najčešće računara) i svojim znanjem poboljšaju ili sebi prilagode sistem. Pogledati više na linku [2].

8 Napomene: U ovom radu nisu spomenute sve zajednice, projekti i događaji koji su postojali ili još postoje kod nas. Nijedna ličnost nije spomenuta u radu, već su svi projekti predstavljeni kao produkt zajednice koju čini ta osoba, iako je u nekim slučajevima samo jedna osoba zaslužna za taj projekat.

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U Novom Sadu 11. maja 2001. godine nastaje ns-linux.org sajt i nova zajednica koju čine ljudi koji su se prethodno upoznali na LUGY listi, kasnije će svima biti poznata pod imenom LUGONS (eng. *Linux User Group of Novi Sad*) [8]. Lugons je najdugovečnija zajednica u Srbiji i zaslužna je za stvaranje mnogih projekata i događaja koji su bili pokretači za dalje širenje ideje o slobodnom softveru i formiranje novih zajednica. Do osnivanja Balkon (eng. *BalcCon*) konferencije, Lugons je bio najaktivnija lokalna zajednica i organizovao niz Dana instaliranja linuksa (eng. *Linux Install Days* – LID) na kojima su pomagali korisnicima da prvi put instaliraju slobodan softver na svoje računare, a pored ovih događaja više puta je organizovan Lugons Barkamp, antikonferencija sa javnim radionicama i predavanjima, čiji sadržaj i proces su razvijeni od strane učesnika na početku same konferencije, a razrađuju se u daljem toku [8].

Ono što je primetno bilo tada, a i isposatviće se do dana današnjeg, većina događaja i zajednica koje su vezane za neko geografsko područje, su iz Novog Sada ili Beograda. Izuzetaka je svakako bilo, a najvažnija je Mreža za slobodan softver Srbije (skr. FSN – *Free Software Network*) – neprofitna, nevladina organizacija koja je osnovna u Kraljevu i delovala od 2004. do 2011. godine [9]. Ova organizacija se zalagala za razvoj, primenu i popularizaciju slobodnog softvera i zaslužna je za pokretanje nekoliko bitnih zajednica od kojih treba spomenuti zvanične lokalne korisničke grupe Ubuntu, Debijan, Slekver i Fedora operativnog sistema, i ove grupe danas u svom radu autonomno nastupaju. Od decembra 2007. do 2010. godine u saradnji sa Matematičkim fakultetom u Beogradu, FSN je realizovala lokalizaciju u tom trenutku najpopularnijeg slobodnog kancelarijskog paketa OpenOfis (eng. *OpenOffice*), a danas je ova lokalizacija uključena u kancelarijski paket Libreofis. Važan projekat ove zajednice o kom će biti malo više reči u narednom poglavlju je elektronski časopis Gnuzila (eng. *Gnuzilla*) [9].

Jedna od karakteristika perioda nakon 2005. godine je naglo povećanje zajednica koje postoje na internetu, a koje su okupljene oko neke distribucije - najveći deo komunikacije je obavljan preko foruma. Pre toga su i tokom devedesetih godina postojali forumi kao što su forum LUGY zajednice i zajednice okupljenje oko BSD operativnog sistema, ali period povećane aktivnosti na forumima su obeležile zajednice Ubuntu Srbija, Fedora Srbija, Debian Srbija i Lugons. Pored prethodno spomenutih, sve veći broj popularnih distribucija dobija svoje zajednice i forume u Srbiji, a neke od tih distribucija su Arč linuks, Mint, Slekver, Džentu linuks, osim distribucija i projekti poput Mozile i Libreofisa imaju svoje forume, ali i zajednica okupljena oko FOSS (eng. *Free and Open Source Serbia*) sajta. GNU-Linuks centar je organizacija koja je za kratko vreme svog postojanja ostvarila nekoliko dobrih akcija, par koje su se odnosile na lokalizaciju i jedna koja prepoznata i podržana od strane Uneskoa, a to je instaliranje slobodnog softvera u pet srednjih škola u Srbiji [10].

Od 2010. polako se smanjuje uticaj Mreže za slobodan softver Srbije, ali aktivnost Ubuntu Srbije raste i ova zajednica postaje sve aktivnija van interneta i organizuje razne prezentacije i okupljanja kao što su prezentacija na sajmu tehnike i okupljanje u galeriji Ozon. Jedna od čestih tema na forumima i okupljanjima je bila ujedinjenje svih manjih zajednica u jednu veću, ali kako je vreme pokazalo nijedan od tih pokušaja nije bio uspešan. Me]utim, jedna tema na Ubuntu Srbija forumu koja je doživela uspeh, je ideja o ponovnom pokretanju časopisa o slobodnom softveru. Uz podršku Lugonsa nastaje LiBRE! Časopis 2012. godine koji je i dalje aktivan. Iste godine je osnovan i prvi beogradski hakerspejs, Haklab, a već naredne godine je Lugons prvi put organizovao konferenciju Balkon. Od početka je bilo jasno da će Balkon biti od velikog značaja za celu zajednicu i to ne samo zato što je doveo stručnjake iz celog sveta, već i zato što je to događaj koji inspiriše ljude na pokretanje novih projekata i dešavanja u lokalnoj zajednici, a najznačajniji takav projekat za lokalnu zajednicu je definitivno Tilda centar, hakerspejs u Novom Sadu. Na Božić 7. januara 2014. godine Debian Srbija zajednica objavljuje prvo izdanje Serbijan operativnog sistema koji predstavlja klasičan derivat Debijana namenjen svim korisnicima koji žele da koriste računar na srpskom jeziku.

Još jedna zajednica koja se u ovom periodu pojavila u Novom Sadu je udruženje Mejker koje ima za cilj edukaciju sa glavnim fokusom na otvoreni hardver (*Arduino* i *Raspberry Pi*) [11]. Zajednica okupljena oko Fedora operativnog sistema 2016. godine. započinje sa organizovanjem sada već tradicionalnih Fedora žurki objave (eng. *Fedora Release Party*) na Prirodno-matematičkom fakultetu u Novom Sadu, a zahvaljujući članovima ove zajednice koji rade na Prirodno-matematičkom fakultetu, studenti ovog fakulteta od nedavno rade laboratorijske vežbe na slobodnim računarima.

Poslednja novina od značaja jeste upravo konferencija Primena slobodnog softvera i otvorenog hardvera (PSSOH), i autor se nada da će zahvaljujući ovoj konferenciji nastati nove zajednice i projekti okupljene oko slobodnog softvera, jer kao što i je sama ideja slobodnog softvera nastala na fakultetu u Americi, tako je i dalje akademska zajednica potrebna kako bi pokrenuli nove projekte.

U nastavku rada će posebna poglavlja biti posvećena projektima i hakerspejsovima, zato što autor smatra da su to dve glavne stvari koje će zajednice okupljene oko slobodnog softvera držati na okupu.

III. Projekti

Uzimajući u obzir da je jedna od karakteristika sveta slobodnog softvera velika raznovrstnost operativnih sistema, popularno nazivanih linuks distribucijama, potpuno je očekivano da je to jedan od najčešćih projekata koje su prethodno spomenute zajednice ili pojedinci započinjali. Trenutan broj aktivnih linuks distribucija prema distrovoč sajtu je 288, a prilikom

pisanja ovog rada autor je uspeo da otkrije postojanje 20 različitih distribucija na prostoru Srbije [12]. Velika raznovrsnost je primetna u ovoj maloj grupi, koju su činile distribucije čija je glavna karakteristika bila dobra lokalizacija, usko određena namena ili čak nastala za ličnu upotrebu. Od distribucija koje danas više nisu aktivne, treba spomenuti Tuliks (eng. *Toolx)*, distribuciju namenjanu za administraciju i servis računara koju je razvijalo Lugons udruženje, TRIOS distribucija bazirana na Debijanu ali bez SistemD-a (eng. *SystemD*) i koja nažalost nije stigla da stabilnog izdanja, ŠaleOS (eng. *ChaletOS*) distribucija koja je po izgledu podsećala na Vindouz (eng. *Windows*) i imala nameru da omogući korisnicima jednostavniji prelazak na linuks operativni sistem, a na ovaj spisak nekada aktivnih distribucija se našao i *cp6linux*, distribucija koja je razvijena na Elektrotehničkom fakultetu u Beogradu i finansirana od strane Vlade Republike Srbije [13].

Od aktivnih distribucija, u trenutku pisanja ovog rada, autor je upoznat sa tri: Serbian, Septor i Ekvilibrijum. Serbian distribucija zaslužuje sve pohvale jer objavljuje već šest godina svakog januara novo izdanje, korisnicima je pružen izbor koji menadžer prozora žele da koriste (KDE ili Openboks) i izbor između 32-bitne ili 64-bitne arhitekture, a drugi operativni sistem koji je nedavno napravila Debijan Srbija zajednica je Septor, glavna karakteristika ovog operativnog sistema je obavljanje saobraćaja preko Tor mreže, koja u sadašnjem vremenu važi kao jedan od najsigurnijih načina komunikacije na internetu [14]. Ekvilibrijum je moderna 64-bitna distribucija, zasnovana na *Kubuntu*-u, a karakteristika ove distribucije je da se prvenstveno oslanja na veb-aplikacije i onlajn servise, s tim da veb aplikacije korisnici sami kreiraju po sopstvenim izboru i sopstvenim potrebama (u dva jednostavna koraka) [15].

Zanimljiva informacija je da je do sada postojalo čak pet elektronskih časopisa čija je glavna tema bio linuks i slobodan softver, ali od tih pet dva časopisa možemo nazvati uspešnim, a to su Gnuzila i LiBRE!. Gnuzila je prvi uspešni elektronski časopis na srpskom jeziku posvećen slobodnim operativnim sistemima i slobodnom softveru uopšte. Prvi broj je izašao 31. decembra 2004. godine i ovo je prvi veliki projekat Mreže za slobodan softver (FSN). Gnuzila je imala zavidnu statistiku od prosečnih 5800 preuzimanja za prvih 25 brojeva, a u 16. broju su ispratili dolazak Ričarda Stolmana u Srbiju i objavili intervju sa njim [9][16]. LiBRE! časopis je za vrlo kratko vreme uspeo da uključi većinu zajednica u svoj rad i u prve dve godine postojanja je uspeo da održi redovnost objavljivanja svakog meseca, ali je takva politika objavljivanja kasnije promenjena zbog održivosti projekta [17]. Glavni cilj LiBRE! časopisa je da pored edukativnog materijala na srpskom jeziku obezbedi način za informisanje i oglašavanje za lokalne zajednice o svim novim projektima i dešavanjima.

U odnosu na različite modifikacije operativnih sistema, ostalih slobodnih softverskih projekata je bilo nešto manje, a kao najuspešniji se može izdvojiti program *Great Little Radio Player*. Od ostalih projekata postojalo je nekoliko dodataka za Fajerfoks i Libreofis, *Jfreesteel* slobodna javna biblioteka za čitanje elektronskih ličnih karti i Liberator, platforma za uređivanje i lektorisanje tekstova pokrenuta od strane LiBRE! časopisa [18][19].

Niz projekata je pokrenut od strane Tilde, hakerspejsa u Novom Sadu, o samoj ideji hakerspejsa i Tildi nešto više je napisano u narednom poglavlju, a u ovom će biti navedeni projekti započeti u ovom hakerspejsu. Jedan od najznačajnijih projekata sa kojim je upoznat veći deo zajednice koji prati i posećuje Tildu je *OneLove* projekat, koji predstavlja veb frontend za Ansible sa podrškom za više klaud provajdera (eng. *Cloud providers*). Pored ovog projekta, hakeri okupljeni u Tildi su napravili moćan fajervol (eng. *Firewall*) pod nazivom *FreeBSD PF* sistem za upravljanje sadržajem za konferenciju (eng. CMS – *Content Management System*) *Pyser*, a vredi spomenuti i CBSD - menadžer virtualnih resursa, Gnui - C++ biblioteka za rad sa prozorima i dugmićima, Fisean - XMPP klijent baziran na Gnui biblioteci i Maolan – softver za multikanalno snimanje i reprodukciju zvuka i MIDI poruka.

IV. Hakerspejsovi

Hakerspejs *(eng. Hackerspace)* je prostor u kojem se različiti ljudi sličnih interesovanja mogu okupiti, družiti i razmenjivati iskustva i znanja koja se tiču tehnologije, nauke, umetnosti i ostalih oblasti. Ovakvi prostori su često rukovođeni zajednicama i neprofitnim organizacijama. Potpuno je očekivano da su hakerspejovi bili oduvek mesta gde se čuvala i širila kultura slobodnog softvera i otvorenosti, a ono što ih je činilo efektivnijim u širenju ideje jeste što interakcija sa ljudima nije samo preko interneta. U Srbiji su trenutno aktivna dva hakerspejsa Haklab u Beogradu i Tilda u Novom Sadu, ali pre nastanka ova dva hakerspejsa, Lugons je imao svoje prostorije poznate pod nazivom Lugons lab, i iako ove prostorije nisu zvanično bile hakerspejs, po svojoj funkciji se može reći da to jesu [20]. Pored druženja i sednica, u ovim prostorijama su organizovani i prethodno navedeni događaji Dani instaliranja linuksa.

Poput nekoliko zajednica u spomenutih u ovom radu i Beogradski hakerspejs je oformila zajednica koja je pre toga bila okupljena na elektronskoj dopisnoj listi pod nazivom Razmena veština. Ljudi okupljeni na ovoj listi nakon nekog perioda razmene znanja u kafićima, 2012. godine dobijaju svoje prostorije u Daničarevoj 23 [21]. Kroz radionice sa ciljem razmene veština, polaznici u Haklabu su mogli da nauče od Pajton programskog jezika do adminstracije linuks operativnih sistema, neke od zajednica nastalih na internetu su se okupljale u Haklabu i radili lokalizaciju projekta oko kog su okupljeni, a takođe su više puta održani dani instaliranja linuksa. Najvažniji događaj u čijoj organizaciji učestvuje Haklab, jeste Deskon (eng. *Descon*), dvodnevni hakaton nakon kog se rešenja takmičara objavljuju kao slobodan softver i otvoren hardver.

Nekoliko članova Haklaba čini stalnu redakciju LiBRE! časopisa, a jedan od projekata nastalih u Haklabu jeste Kriptoparti Srbija, ogranak globalnog projekta čija je ideja da se kroz niz radionica korisnicima interneta i

digitalnih tehnologija, uglavnom aktivistima i novinarima, skrene pažnja na dostupnu tehnologiju putem koje mogu obezbediti privatnost svojih komunikacija u najširem smislu reči, a samo postojanje tih tehnologija ne bi imalo smisla da nisu slobodne i otvorenog koda [22].

Jedna od ideja koja nastala tokom trajanja Balkon konferencije je stvaranje hakerspejsa u Novom Sadu, i 2015. godine zahvaljujući saradnji članova Lugonsa sa novim članovima zajednice, nastala je Tilda. Ovaj hakerspejs karakteriše izuzetno aktivna zajednica čiji su doprinosi u poslednjih par godina od velikog značaja, a pored razmene znanja kroz radionice i doprinos kroz mnogobrojne projekte od kojih su neki spomenuti u prethodnom poglavlju, Tilda je zaslužna i za organizovanje konferencije Pajser - prve domaće konferencije posvećene Pajton programskom jeziku i projektima pisanim u Pajtonu. Članovi Tilde su aktivni u više lokalnih zajednica i učestvuju u kreiranju kako domaćih konferencija kao što su Balkon i Pajser (eng. *Pyser*), tako i regionalnih konferencija poput Barkampa u Banja Luci i *B-sides* u Ljubljani [23].

V. Zaključak

Ideja o slobodnom softveru se rasprostire poput mreže, pod spoljašnjim uticajem nastaje prva zajednica kod nas i to je LUGY lista za koju možemo reći da je koreni čvor, zatim članovi zajednice utiču na ostale ljude koji dalje formiraju nova čvorišta, koja interaguju dalje sa drugim ljudima i drugim čvorovima u mreži, nekada čvorovi umiru, ali je njihov uticaj na ostale obezbedio da mreža svih lokalnih zajednica nastavi da postoji. Kada sa distance pogledamo na sve događaje, projekte i zajednice okvirno možemo izdvojiti tri perioda. Početni period kada su zajednice bila aktivne na elektronskim doplisnim listama i glavni fokus je bila lokalizacija slobodnog softvera, nakon toga sledi period povećane aktivnosti na forumima, za koji je karakteristično da pored lokalizacije u velikoj meri pomažu korisnicima koji nailaze na poteškoće prilikom korišćenja slobodnog softvera, a samo određene zajednice iz ovog perioda napuštaju granice interneta i organizuju različite događaje. Vremenom su slobodni softver i linuks operativni sistemi znatno uznapredovali tako da je novim korisnicima retko kad potrebna pomoć oko instaliranja i korišćenja, i danas su ulogu foruma preuzele društvene mreže. Kako postoji manje potrebe za pomoći korisnicima i procesi lokalizacije za većinu bitnijih projekata slobodnog softvera su obavljeni, ostaju samo konkretni projekti koji će zajednicu održavati na okupu. Upravo iz tog razloga je pretpostavka autora da će projekti i hakerspejsovi nastaviti da budu glavna čvorišta u mreži koja širi ideju slobodnog softvera i održavaju zajednice na okupu, pa je samim tim u ovom radu je više pažnje posvećeno njima.

A. Kako se priključiti zajednici?

Poput slobodnog softvera, sve prethodno spomenute zajednice su potpuno otvorene, i ako biste želeli da postanete deo neke od trenutno aktivnih zajednica dovoljno je samo da stupite u kontakt sa njima preko veb sajta ili društvenih mreža, bez obzira na broj godina i znanje koje posedujete bićete prihvaćeni, jedino se podrazumeva da budete dobri prema ostalim članovima zajednice. Ukoliko želite da sami pokrenete zajednicu okupljenu oko slobodnog softvera, to vas definitivno ohrabrujem, trenutno aktivne zajednice će vrlo radi podržati novu zajednicu, projekat ili događaj.

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Digital factors promoting women's entry into the Serbian labour market

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Abstract: This paper presents the development of digital skills among women active in the Serbian labor market focusing on the need for such skills in the marketplace for those that do not already possess them. Based on the microdata received from the Statistical Office of the Republic of Serbia (SORS) and the application of proprietary SPSS, 34.2% of the populace of the Republic of Serbia are computer literate, while 14.8% are only partly computer literate (the remaining 51% are partially or entirely computer illiterate). While men are found to more likely have digital skills, women in possession of them are more likely to be employed. However, this paper finds that only 53.4% of female respondents have used a computer in the last three months, indicating insufficient opportunities and access to information regarding the employer market. Moreover, it is worrying that 38.3% of the respondents have never used a computer. It also may be concluded that implementing a strategy for the development of digital skills may bear a strong positive influence on the employment rate in such countries where there is a rift between digital skill development. These results may prove useful for further research into women's employability vis-a-vis their digital skills.

Keywords: digital skills; women; labour market; Serbia; ICT.

I. Introduction

The development of Information Communication Technologies (ICT) has led to changes in doing business throughout all sectors of the economy as well as has had a significant impact on individual career development. The number of experts in the labor market is evidence of the importance of ICT and the corresponding activities [1].

As demonstrated through current strategies such as Europe 2020 and Agenda 2030, digital skills are essential for competitiveness and economic development. Europe 2020 has launched seven flagship initiatives, among them is one focusing on digital-skills development. The Europe 2020 strategy also focuses on three interconnected priorities; the most important of which is smart growth that seeks the development of a knowledge and innovation-based economy, including the development of a digital society. Europe 2020 also envisages inclusive growth by raising the participation and integration of women in the labor market.

Furthermore, out of a total of 17 goals in Agenda 2030, the ninth goal is to build adaptable infrastructure, promote industrialization and achieve innovation, which implies the development of IT in all sectors of the economy and in society. In addition to the emphasis on the development of digital technology in society is women's empowerment in the labor market as a priority area, presented as the 5th goal of the 2030 Agenda. Therefore, both the Member States and States seeking to join the EU are educating teachers as well as primary and secondary school students on ICT. Based on the Agenda 2030 and Europe 2020, both EU and developing countries have been implementing strategies [2].

The Western Balkans are highly ranked in the use of digital technologies. In recent years, the region has begun to implement strategies that address the development of digital skills. In the Republic of Serbia, 34.2% of the populace are computer literate, while 14.8% are only partly computer literate (the remaining 51% are partially or entirely computer illiterate). The Digital Agenda of Serbia, implemented from 2010 to 2020, aims to improve the use of ICT. It states that development "should be geared towards harnessing the potential of ICT to increase efficiency, economic growth, higher employment and improve the quality of life of all people." The Strategy was created on the initiative of the Europe 2020 Strategy where ICT is recognized as a major factor influencing economic growth and innovation.

The aim of the paper is to present the development of digital skills in Serbia, with particular emphasis on the inequality of possession of them. Based on the microdata received from the Statistical Office of the Republic of Serbia (ROS) and the application of SPSS software, the result may prove useful for further research to be carried out into women's position in the labour market vis-a-vis their digital skills.

II. Literature review

The European Commission defines digital competence (also sometimes called digital literacy) as the confident and critical use of ICT for work, leisure and communication. Digital skills have become integrated into modern societies, economies, education and employment. The digital age has been characterized by the rise of the digital society [1][3] where a knowledge based economy and digital information are found ubiquitously in all areas of life. In the framework of globalization, digital skills have become globally considered to be the primary criteria for employment.

Several authors have recognized the impact of digital literacy on the labor market. On the basis of examining the disconnect between the needs of the labor market the digital skills available to Romanians, Titan, et al. (2014) found that there is a mutual link and impact between digital literacy and the labor market. Prizada and Khan (2013) measured the impact of digital skills on

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employability, concluding that all observed variables (computer, communication, internet, and advanced digital skills) were positively correlated with employability.

Expertise in the use of digital tools is one of the primary advantage's students may have when entering the job market as it allows them to establish a foothold based on already acquired experience and expertise. This claim may be substantiated by Van Doursen and Van Dijk (2010) who found that observed skill patterns in ICT differ across gender, age, and education, which are all crucial variables related to skill inequalities [4]. Age in particular, although not necessarily surprising, shows a decrease in ICT familiarity with an increase in age. Studies that account for both technical and substantial internet skills generally find that age has a negative relation with technical skills, while the relationship with substantial skills is not significant or even positive [4][5]. However, gain in operational and formal Internet skills do occur among those older in showing better performance on information internet skills, which still points to a lack of ICT familiarity.

What is more important is that Van Doursen and Van Djik (2008) also noted that education was not an equalizing factor among all groups, noting specifically that the higher educated one was, the higher the level of all four internet skills would be but not necessarily inversely true (i.e., lower educated individuals may have fewer internet skills) [6]. This indicates that a skill gap may be seemingly present between the higher educated, on the one hand, and the lower / middle educated, on the other. Bennett reports that those who are well-equipped with an understanding of the use of e-services have the distinct advantage over the long term in the form of educa tional progress, job enrichment and overall status [7].

Although a broad range of social sectors have been adopting an equally broad expanse of electronic means, the development of digital skills or tools for education and the job market has run together, thereby creating a teaching and learning environment [8].

ICT skills as a field of research must tackle measurement problems by creating more subtle classifications of internet skills of populations at large as stated by a number of researches [4][9][10].

III. Methodology

The data was obtained from SORS (2017). Using proprietary SPSS software, all characteristics of employed women are noted below.

1,763 female respondents participated in the study on the use of information technologies among women in Serbia. The demographic characteristics of the sample included 47.5% of respondents from Central Serbia, 28.2% from Vojvodina and 24.3% from Belgrade. Employment factors were also observed, where 26.1% were employed, 23% unemployed, 1.9% students and the remaining 48.9% not active in the labor force (pensioners or military service). The components taken into consideration as output variables were questions of: "What is your internet access at home? When was the last time you used a computer (at home, at work or elsewhere)? How often have you used a computer in the last 3 months? When was the last time you used the Internet (via a computer, laptop, mobile phone, or smartphone)? How often have you used the Internet in the last 3 months? How often have you used cloud services to store data (documents, pictures, music or video files) such as Google Drive, Dropbox, Windows ONE drive, iCloud, Amazon cloud drive? How often in the last 3 months have purchased or ordered goods or services over the Internet for private purposes (via a website or app from any device: desktop computer, laptop, mobile phone or smartphone)? How often have you purchased / ordered goods or services over the Internet for private purposes in the last 3 months? and What is the amount of money you have spent on the Internet for private purposes in the last 3 months?" The Software package SPSS was used for data analysis. The results of the survey are presented through the crosstabulation of the respondents' work status and the IT variables previously mentioned.

A. Research results

The survey results show that unemployed women more frequently do not have access to the Internet (Table 1) which may result in women having less ability to research employment opportunities. With a score of 17.8%, the majority of respondents who do not have internet access come from Central Serbia. Belgrade has the highest internet access, with only 5% not having access. A similar trend is noticeable for other variables relative to territory. Only 53.4% of female respondents have used a computer in the last three months, indicating insufficient opportunities and access to information regarding the employer market. It is worrying that 38.3% of the respondents have never used a computer (Table 2). Of those who use a computer every day, 39.8% are employed, 22.2% unemployed, and 22.8% not active (Table 3). A slightly higher percentage of internet usage is found to be through mobile phones (Tables 4-5). Modern cloud solutions usage is practically non-existent among women, as well as online purchases (Tables 6-9), but the data expresses that employed respondents are more likely to use online payments.

IV. Conclusion

Technological change does require that individuals maintain skill levels that can complement these changes if they wish to remain active in the labour market. While it may be true that it is difficult to acquire these skills and that technological change may limit job creation at lower levels, hope of finding and keeping employment does seem to be distinctly related to possessing digital skills.

In the framework of globalization, digital skills are becoming more extensive and are considered a prerequisite for securing professional employment all over the world. Education is probably the most consistent global predictor of the use of ICTs, especially concerning internet proficiency [10]. Men have more stereotyped attitudes regarding who is capable of using the internet

Table 1. Crosstabulation between respondents' work status and IT aspect on access to the Internet.

			Respondents' work status				Total
			Employed	Unemployed	Student	Others	
Do you or anyone in your household have access to the Internet at home, regardless of whether they use it?	No	Count	31	92	0	472	595
		% of Total	1.8%	5.2%	0.0%	26.8%	33.7%
	Yes	Count	430	314	34	390	1168
		% of Total	24.4%	17.8%	1.9%	22.1%	66.3%
Total		Count	461	406	34	862	1763
		% of Total	26.1%	23.0%	1.9%	48.9%	100.0%

Table 2. Crosstabulation between respondents' work status and IT aspect on last time they used computer.

			Respondents' work status				Total
			Employed	Unemployed	Student	Others	
When was the last time you used a computer (at home, at work or elsewhere)?	In the last 3 months	Count	403	242	34	263	942
		% of Total	22.9%	13.7%	1.9%	14.9%	53.4%
	More than 3 months ago (< 1 year)	Count	6	12	0	4	22
		% of Total	0.3%	0.7%	0.0%	0.2%	1.2%
	More than a year ago	Count	10	27	0	86	123
		% of Total	0.6%	1.5%	0.0%	4.9%	7.0%
	I have never used one	Count	42	125	0	509	676
		% of Total	2.4%	7.1%	0.0%	28.9%	38.3%
Total		Count	461	406	34	862	1763
		% of Total	26.1%	23.0%	1.9%	48.9%	100.0%

Table 3. Crosstabulation between respondents' work status and IT aspect on how often they use computer.

			Respondents' work status				Total
			Employed	Unemployed	Student	Others	
How often have you used your computer on average in the last 3 months?	Every day or almost every day	Count	375	209	30	215	829
		% of Total	39.8%	22.2%	3.2%	22.8%	88.0%
	At least once a week	Count	11	13	4	26	54
		% of Total	1.2%	1.4%	0.4%	2.8%	5.7%
	At least once a month	Count	14	15	0	17	46
		% of Total	1.5%	1.6%	0.0%	1.8%	4.9%
	Less often than once a month	Count	3	5	0	5	13
		% of Total	0.3%	0.5%	0.0%	0.5%	1.4%
Total		Count	403	242	34	263	942
		% of Total	42.8%	25.7%	3.6%	27.9%	100.0%

Table 4. Crosstabulation between respondents' work status and IT aspect on the last use of Internet.

			Respondents' work status				Total
			Employed	Unemployed	Student	Others	
When was the last time you used the Internet (via computer, laptop, mobile phone, smartphone)?	In the last 3 months	Count	417	271	34	279	1001
		% of Total	23.7%	15.4%	1.9%	15.8%	56.8%
	More than 3 months ago (< 1 year)	Count	8	6	0	9	23
		% of Total	0.5%	0.3%	0.0%	0.5%	1.3%
	More than a year ago	Count	2	11	0	45	58
		% of Total	0.1%	0.6%	0.0%	2.6%	3.3%
	I have never used one	Count	34	118	0	529	681
		% of Total	1.9%	6.7%	0.0%	30.0%	38.6%
Total		Count	461	406	34	862	1763
		% of Total	26.1%	23.0%	1.9%	48.9%	100.0%

Table 5. Crosstabulation between respondents' work status and IT aspect on how often they use Internet on average.

			Respondents' work status				Total
			Employed	Unemployed	Student	Others	
How often have you used the Internet on average in the last 3 months?	Every day or almost every day	Count	375	222	34	210	841
		% of Total	37.5%	22.2%	3.4%	21.0%	84.0%
	At least once a week	Count	35	37	0	52	124
		% of Total	3.5%	3.7%	0.0%	5.2%	12.4%
	At least once a month	Count	6	10	0	13	29
		% of Total	0.6%	1.0%	0.0%	1.3%	2.9%
	Less often than once a month	Count	1	2	0	4	7
		% of Total	0.1%	0.2%	0.0%	0.4%	0.7%
Total		Count	417	271	34	279	1001
		% of Total	41.7%	27.1%	3.4%	27.9%	100.0%

Table 6. Crosstabulation between respondents' work status and IT aspect on the use of cloud services to store the data.

			Respondents' work status				Total
			Employed	Unemployed	Student	Others	
Have you used cloud services to store data (documents, pictures, music or video files) such as Google Drive, Dropbox, Windows ONE drive, iCloud, Amazon cloud drive?	No	Count	321	226	21	255	823
		% of Total	32.1%	22.6%	2.1%	25.5%	82.2%
	Yes	Count	96	45	13	24	178
		% of Total	9.6%	4.5%	1.3%	2.4%	17.8%
Total		Count	417	271	34	279	1001
		% of Total	41.7%	27.1%	3.4%	27.9%	100.0%

Table 7. Crosstabulation between respondents' work status and IT aspect on purchase over the Internet.

			Respondents' work status				Total
			Employed	Unemployed	Student	Others	
Last time you purchased or ordered goods or services over the Internet for private purposes (via a website or app from any device: desktop computer, laptop, mobile phone, smartphone)	In the last 3 months	Count	110	60	15	32	217
		% of Total	10.2%	5.5%	1.4%	3.0%	20.1%
	More than 3 months ago (< 1 year)	Count	63	36	8	25	132
		% of Total	5.8%	3.3%	0.7%	2.3%	12.2%
	More than a year ago	Count	42	25	2	17	86

			Respondents' work status				Total
			Employed	Unemployed	Student	Others	
		% of Total	3.9%	2.3%	0.2%	1.6%	7.9%
	Never	Count	212	167	9	259	647
		% of Total	19.6%	15.4%	0.8%	23.9%	59.8%
Total		Count	427	288	34	333	1082
		% of Total	39.5%	26.6%	3.1%	30.8%	100.0%

Table 8. Crosstabulation between respondents' work status and IT aspect on purchase over the Internet in the last three months.

			Respondents' work status				Total
			Employed	Unemployed	Student	Others	
How often have you purchased / ordered goods or services over the Internet for private purposes in the last 3 months?	1-2 times	Count	57	37	12	16	122
		% of Total	26.3%	17.1%	5.5%	7.4%	56.2%
	3-5 times	Count	39	16	3	12	70
		% of Total	18.0%	7.4%	1.4%	5.5%	32.3%
	6-10 times	Count	8	6	0	1	15
		% of Total	3.7%	2.8%	0.0%	0.5%	6.9%
	More than 10 times	Count	6	1	0	3	10
		% of Total	2.8%	0.5%	0.0%	1.4%	4.6%
Total		Count	110	60	15	32	217
		% of Total	50.7%	27.6%	6.9%	14.7%	100.0%

Table 9. Crosstabulation between respondents' work status and IT aspect on amount of money purchased over the Internet.

			Respondents' work status				Total
			Employed	Unemployed	Student	Others	
What was the amount of money purchased or ordered via the Internet for private purposes in the last 3 months?	Up to 5000 dinars (up to 50 EURO)	Count	58	32	10	14	114
		% of Total	26.7%	14.7%	4.6%	6.5%	52.5%
	5 000 - 10 000 dinars (50-100 EUR)	Count	33	17	0	6	56
		% of Total	15.2%	7.8%	0.0%	2.8%	25.8%
	10 000 - 50 000 dinars (100-500 EUR)	Count	11	8	1	9	29
		% of Total	5.1%	3.7%	0.5%	4.1%	13.4%
	50 000 - 100 000 dinars (500-1000 EUR)	Count	5	1	0	0	6
		% of Total	2.3%	0.5%	0.0%	0.0%	2.8%
	Over 100,000 dinars (over 1000 EUR)	Count	0	0	1	1	2
		% of Total	0.0%	0.0%	0.5%	0.5%	0.9%
	I do not know	Count	3	2	3	2	10
		% of Total	1.4%	0.9%	1.4%	0.9%	4.6%
Total		Count	110	60	15	32	217
		% of Total	50.7%	27.6%	6.9%	14.7%	100.0%

NOTE: “Others” means “Others not included in the labor force (pensioners, on military service)” in Tables 1–9.

and self-assessments consistently showthat women exhibit lower levels of internet skills [11]. In actual performance tests, however, the measures of skills of men and women do not differ significantly [3][4]. Jung, JY, Qiu, JL, Kim, YC (2001) concluded that gender may not directly influence the level of internet skills, but it does come into play in one’s perception [3].

Currently, digitalization seems to favor women in the labour force, since the face a lower risk of being replaced by technology, as compared to men. It would therefore seem that digitalization offers a variety of opportunities for women in the workforce, as a levelling factor, resulting in possible more equalized female participation in the labour market.

European Union has introduced and back a number of programs aimed at increasing the digital literacy rate and increasing basic digital skills in order to ensure life skills and thereby increase employability, but these programs only train for basics over the short term. While that is good as a starting point, digital literacy and skills require long term development and use [12].

The results in the paper will be useful for the further development of future strategies in the field of digitalization where the Republic of Serbia, or similar countries, shall be better able to increase the employability of women in the labour market.

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Otvoreni nastavni materijali / Open educational resources

Електронски уџбеник "Нумеричка математика", Наташа Ћировић

https://www.etf.bg.ac.rs/uploads/files/udzbenici/Natasa%20Cirovic%20Numericka%20matematika%20CIP.pdf

Савремена електротехника и рачунарство подразумевају значајне примене нумеричке математике. Овај уџбеник развијан је током више од 10 година, колико ауторка учествује у настави нумеричке математике у склопу више предмета на основним академским студијама Електротехничког факултета Универзитета у Београду.

Уџбеник представља основне теме и методе нумеричке математике, и као такав представља полазну основу не само за студенте Електротехничког факултета, него за све оне који се са Нумеричком математиком први пут сусрећу.

Материјал прати теоријске поставке наставних јединица које се обрађују на предавањима, као и задатке који прате ове наставне јединице и раде се на часовима вежби. Додатно, за сваку наставну јединицу дати су задаци с резултатима који прате лабораторијске вежбе из ових предмета.

Текст је припремљен у систему LaTeX, а слике у пакету GeoGebra (http://www.geogebra.org).

У плану је да наредно издање књиге буде значајно унапређено мултимедијалним и интерактивним садржајима, пре свега са циљем да се унапреди процес наставе праћењем уџбеника, уместо да уџбеник прати наставу.

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Elektronski udžbenik "Laboratorijske vežbe iz električnih merenja", Predrag Pejović

https://www.etf.bg.ac.rs/uploads/files/udzbenici/Predrag_Pejovic_Laboratorijske_vezbe_iz_elektricnih_merenja.pdf

Udžbenik je namenjen dugoj godini Modula za elektroniku Elektrotehničkog fakulteta u Beogradu i sadrži uputstva za devet laboratorijskih vežbi i uvodna poglavlja koja se odnose na bezbednost i pravila ponašanja i rada u Laboratoriji za elektroniku i opise instrumenata koji se koriste na laboratorijskim vežbama.

Vežbe su koncipirane tako da osposobljavaju za samostalan rad u savremenim laboratorijama za elektroniku, sa izraženom primenom računara koja je naglašenija u odnosu na današnju praksu, pošto sada primenu računara u laboratorijama više ne ograničava njihova dostupnost, već obrazovanje i navike korisnika. Posebna pažnja je poklonjena tome da sav softver koji se koristi na vežbama bude slobodan, dostupan u kasnijem radu bez ikakvih ograničenja i vezivanja za bilo koje vlasnike licencnih prava, njihove zastupnike i interese. U tom cilju je razvijen i niz programa koji su dostpuni pod GPLv3 licencom. Na predavanjima se skreće pažnja na ograničenja koja nameće vlasnički softver i zatvoreni formati podataka.

Primena računara je bitno uticala na oblast električnih merenja, koja je nekada zahtevala značajnu upornost i naporan rad, kao i spremnost na izvršavanje nezanimljivih poslova. Oslobađanjem od ovakvih zadataka, razumevanje fizičkih procesa i sposobnost primene računara postaju prioritet. Takav pristup je u udžbeniku potenciran, a naglasak je stavljen na ilustrovanje koncepata iz drugih predmeta, poput Osnova elektrotehnike i Teorije električnih kola, i povezivanje stečenih znanja. Takođe, niz metoda koji su prikazani na laboratorijskim vežbama je potekao iz rešavanja praktičnih problema, stranih akademskom okruženju koje podrazumeva klimatizovan prostor i kompetentne operatere.

Princip u koncipiranju laboratorijskih vežbi je bio da se obezbedi dovoljno materijala da tokom trajanja vežbi uvek ima nešto novo i zanimljivo da se vidi i uradi, a da se za uspešno savladavanje vežbe zahteva samo osnovni deo postavljenih zadataka. U udžbeniku je uz svaku vežbu iznet i niz "pitanja za razmišljanje" koja imaju za cilj da stimulišu na dalji rad i dublje razumevanje.

ПРАКТИКУМ ИЗ МАТЕМАТИКЕ 2 –

ЗБОРНИК РЕШЕНИХ ТЕСТОВА ОСНОВНОГ ЗНАЊА

✓ **Практикум из математике 2 - Зборник решених тестова основног знања** електронски је уџбеник припремљен за студенткиње и студенте прве године Електротехничког факултета који прати градиво два наставна предмета Математика 2 и Практикум из математике 2. Настао је као допунска и пратећа литература за студенте који желе да провере или допуне своје основно знање из одговарајућих области.

¡ Зборник је груписан у две целине: први део се састоји од решених тестова који су били саставни део испита Математика 2 и сви садрже по десет задатака, док се у другом делу налазе колоквијуми из предмета Практикум из Математике 2 са по петнаест задатака. Сви тестови су решени, а у случају неких задатака дато је више начина за њихово решавање. Сама решења изложена су поступно и уз доста детаља. Решењима већине задатака претходи кратко теоријско излагање, које је посебно истакнуто и уоквирено, па се тестови не морају читати у изложеном редоследу. Овакав вид распореда питања и одговора требало би да инспирише студенте да самостално решавају понуђене задатке, али и да непрекидно консултују другу, потпунију и обимнију литературу.

♣ У тестовима су заступљени задаци из следећих математичких дисциплина: интегрални рачун, диференцијалне једначине, нумерички и степени редови, Булове алгебре, комбинаторика и графови, те елементи линеарне алгебре и аналитичке геометрије.

◊ У креирању овог електронског уџбеника, изузев аутора, учествовали су, на посредан начин, и чланови Катедре за примењену математику који су у прошлости држали предавања и вежбе, и организовали и реализовали многобројне испите из Математике 2.

аутори *Ивана Јововић, Тамара Коледин и Братислав Ричанин*

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