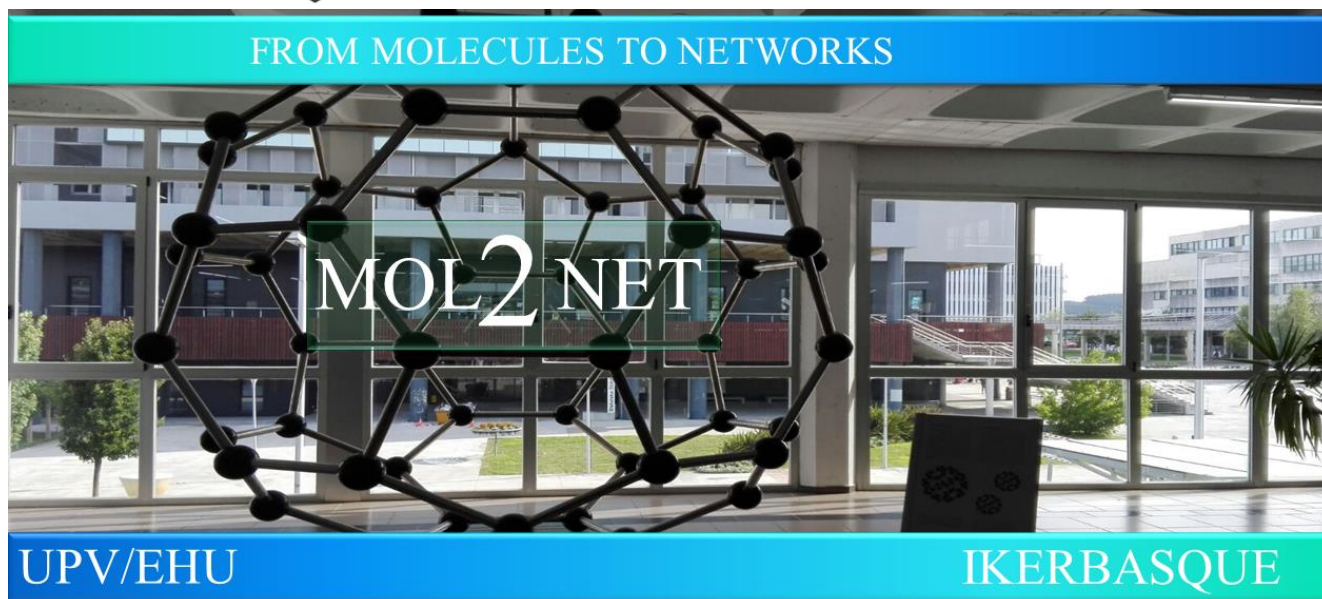w

MDPI
sciforum

MOL2NET'21, Conference on Molecular, Biomedical & Computational Sciences and Engineering, 7th ed.

Software Resources for Developing Multicriteria Applications: A Review, Part 3: operating systems supported

Figueroa-Perez J. Francisco[1], Leyva-Lopez Juan C.[2], Ramirez-Noriega Alan D.[1] and Perez-Contreras Edgar O.[1]

[1]*Facultad de Ingeniería Mochis, Universidad Autónoma de Sinaloa, Fuente de Poseidón y Angel Flores s/n,, Los Mochis, 81223, Sinaloa, México. ´*
[2]*Unidad Culiacán, Universidad Autónoma de Occidente, Blvd. Lola Beltrán y Blvd. Rolando Arjona s/n, Culiacán, 80120, Sinaloa, México.*

Abstract.

In the last years, some Software Resources for Developing Multicriteria Applications (SRDMA) have been developed. The purpose of this review is to determine the state of the art on SRDMA to obtain a catalog of what has been developed which include libraries, frameworks, webservices and others. For this, it was performed a web search of research published in the last 10 years.

We have published this review in three different parts and presented them on three different congresses of Mol2Net series according to the topic. The publications and software found were classified into 3 different categories. Part 1: types of software resources developed (NIECXSM), Part 2: multicriteria methods implemented (USEDAT-08) and operating systems supported (CATCHTOHIT-03).

To analyze them we carry out a Contextual and a Formal Concept Analysis. Findings suggest that the most supported operating systems were Windows, Linux and Mac. Thus, we consider that future research should contemplate the support

of operating systems for mobile devices, which are widely used today.

Introduction

Multicriteria Decision Making (MCDM) is one of the most popular decision-making tools utilized in various fields and involves the analysis of various available choices in a situation (Ozsahin et al., 2021). There are a lot of methods available for solving MCDM problems, many of them implemented by computer systems.

A software resource is a cohesive collection of artifacts that solve a specific problem in the software development lifecycle. It may be any work-products or software related activities (Zhao et al., 2010) .

The goal of this work is to perform a literature review of researches dealing with Software Resources for Developing Multicriteria Applications (SRDMA) based on the guidelines proposed by (B. A. Kitchenham et al., 2015). It focused specifically on resources associated with application programming like libraries, frameworks, webservices, and so on. The review provides an inventory of resources developed between 2012 to 2022 (until April 2022) in the context of SRDMA.

Materials and Methods

To carry out this review, the structured method was implemented following the guidelines provided by (B. A. Kitchenham et al., 2015) in five phases: research questions, search process, study selection, data extraction and data synthesis.

Research questions

Research questions guide the review process (B. Kitchenham & Charters, 2007) . Its establishment will allow us to guide the investigation and to learn more about the topics that interest us about the SRDMA developed in recent years. Derived from the objective of this study, three research questions were formulated:

1. RQ-1: What types of software resources have been developed to help build multicriteria applications? Identify the types of resources developed for this purpose such as libraries, web services, frameworks and so on

2. RQ-2: What operating systems support the software resources developed to help build multicriteria applications? To know which operating systems are supported by developed software resources such as Windows, Linux, Android and so on.

Search process

The search process was carried out using a web search restricted to journals, books, book chapters or conference proceedings that were peer reviewed. Also we searched in websites of research organizations and trusted companies that offer this type of software resources. The search was made using the following string: "multicriteria" ("mcdm" OR "madm" OR "modm") AND "software resource" ("software library" OR "software framework" OR "software webservice" OR "software sdk" OR "software api" OR "software toolkit").

The sources for data collection included Google Scholar, ScienceDirect, Springer, ACM Digital Library, IEEE and Software resources available on the Web (Decision Deck Consortium, 2022; Gunther et al., 2015; Hämäläinen, 2013; Universidade Federal Fluminense, 2014) .

Study selection

Inclusion and exclusion criteria were defined according to the research questions. It was used to evaluate the retrieved data, analyze and interpret the literature to carry out the selection of primary studies and the software.

- Inclusion criteria: IC1: Published or released between 2012 and 2022; IC2: Analyze, discuss or presents any software development resource for devel oping multicriteria applications; IC3: Answer at least one research question.
- Exclusion Criteria: EC1: Earlier version of more recent work; EC2: Duplicate studies or software; EC3: Does not focus on software resources for developing multicriteria applications.

Data extraction

The procedure for data extraction of each study consisted of extracting the data general information of each study and information that helps answer the research questions.

Data synthesis

To analyze the software resources features it was employed a basic contextual analysis and a Formal Concept Analysis (FCA) (Wille, 2005) which is used for the analysis of data structured into units with formal abstractions of concepts, allowing meaningful comprehensible interpretation.

Conduction

After bringing together the results of the automated search only relevant works containing search string were considered. This yielded to a total of 189 relevant papers or software. By applying the inclusion and exclusion criteria, at the end of search process it was reduced to a final set of 63 papers or software.

Results and Discussion

Contextual and FCA results are presented below.

Contextual Results

RQ-1: What types of software resources have been developed to help build multicriteria applications?

Figure 1 show types of software resources that have been developed to help build multicriteria applications. Here we see that frameworks dominate, followed in second place but far behind by algorithms and applications.
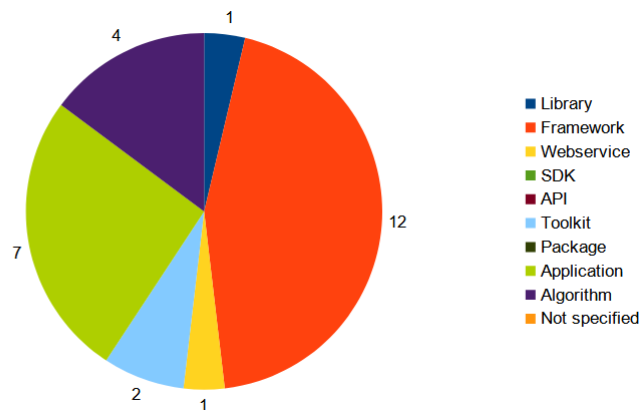

Figure 1: Types of software resources

RQ-2: What operating systems support the software resources developed to help build multicriteria applications?

Figure 2 show what operating systems are supported by software resources. From the software that specify any supported operating systems, they are spread more or less evenly across Windows, Linux, and Mac. Very few have web or mobile support.
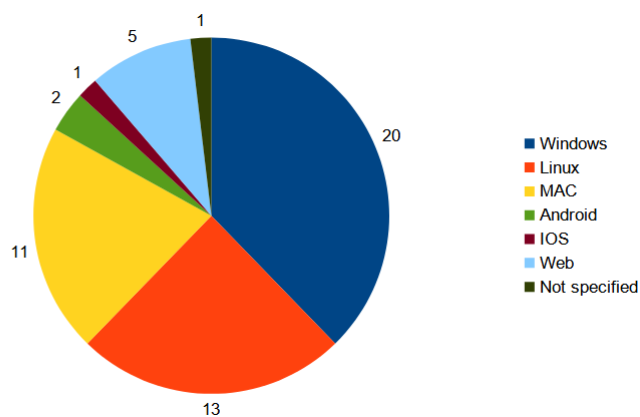

Figure 2: Operating systems are supported

Formal Concept Analysis Results

To analyze in greater depth the papers we use Formal Concept Analysis (FCA) (Wille, 2005) which allows to group the papers into a lattice along with the different features that are addressed to visualize the commonality of particular SRDMA attributes and the level to which papers address the same or different SRDMA attributes. The analysis was done with the software Lattice Miner Platform 2.0 from the University of Quebec (Laboratoire LARIM, 2017).

In previous sections it showed that the most type of software resource developed were frameworks, applications and algorithms. So, these elements are used as a base in FCA analysis to identify relationships that are not easily noticeable at first glance.

Lattice 1: Type of software resource and operating systems.

Lattice in figure 13 shows the relationship between the most developed types of software resource and the most used operating systems. Here we can see that the few investigations that report this information indicate that 5 frameworks work on Windows and 4 on Linux+Windows+Mac.

Regarding the algorithms, 3 do it in Linux and 2 in Linux+Windows+Mac. As for the applications, 4 work on windows and 2 on Linux+Windows+Mac.
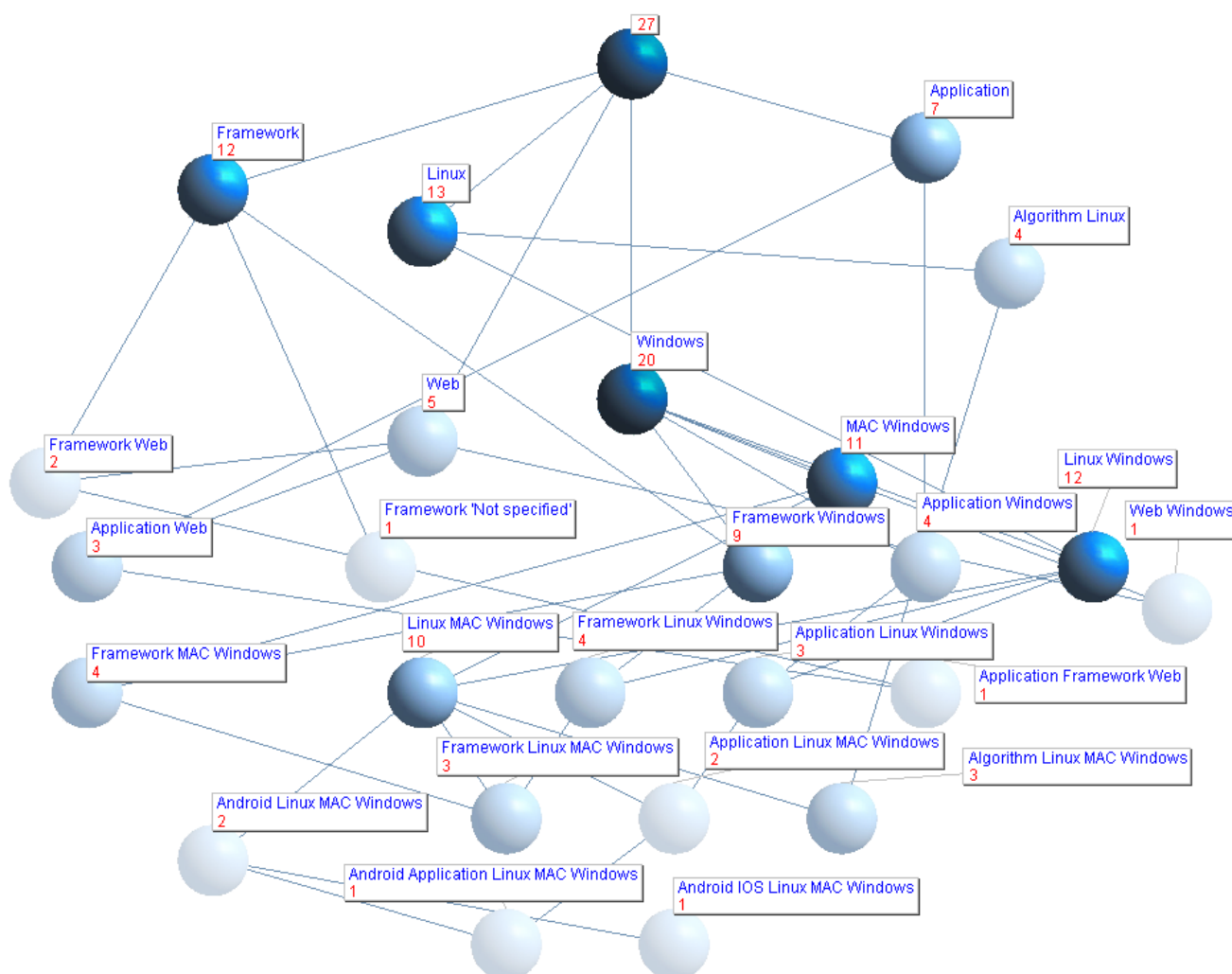

Figure 3: Type of software resource and operating systems

Conclusions

The objective of this review was to assess the state of art in the SRDMA area. It was found that Windows with 20, Linux with 13 and Mac with 11 are the more used. There is a poor support for mobile operating systems. This provides indications that this field of research presents areas of opportunity in which it needs to gain more maturity. We suggest further research should explore the support of operating systems for mobile devices, which are widely used today.

References

Decision Deck Consortium. (2022). *Decision Deck Project*. http://www.decision-deck.org/project/

Gunther, C., Tammer, C., Hillmann, M., & Winkler, B. (2015). *Project FLO Development of tools for solving (vector, set) optimization problems*. https://project-flo.de/

Hämäläinen, R. P. (2013). *DECISIONARIUM*. http://decisionarium.tkk.fi/

Kitchenham, B. A., Budgen, D., & Brereton, P. (2015). Evidence-Based Software Engineering and Systematic Reviews. *Evidence-Based Software Engineering and Systematic Reviews*.

Kitchenham, B., & Charters, S. (2007). *Guidelines for performing systematic literature reviews in software engineering*. -

Laboratoire LARIM. (2017). *Lattice Miner 2.0*. https://github.com/LarimUQO/lattice-miner

Ozsahin, I., Ozsahin, D. U., & Uzun, B. (2021). *Applications of Multi-Criteria Decision-Making Theories in Healthcare and Biomedical Engineering*. Academic Press.

Universidade Federal Fluminense. (2014). *MCDALab/MEM: Multiplex Electionis Methodus*. https://github.com/MCDALab/MEM

Wille, R. (2005). Formal concept analysis as mathematical theory of concepts and concept hierarchies. *Formal concept analysis*, *3626*, 1-33.

Zhao, J., Xie, B., Wang, Y., Xu, Y., & others. (2010). TSRR: A software resource repository for trustworthiness resource management and reuse.