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Software Functional Sizing Automation from Requirements Written as Triplets

By

Bruel Gérançon, Sylvie Trudel, Roger Kkambou, Serge Robert

Department of Computer Science

Université du Québec à Montréal (UQAM)Montréal, Canada

e-mail: gerancon.bruel@uqam.ca

Bruel Gérançon

Bruel Gérançon, born and raised in Haiti, received a master degree in MIS from the University of Quebec at Montreal (UQAM) in 2011.

He is currently a PhD student in cognitive computing at UQAM.

His research interest lies on the software development process, functional size measurement, and automatic natural language processing (NLP).

Aims and Contribution

In our paper we aimed at:

- Developing a new technique for writing software requirements to facilitate the process of automating software functional sizing
- Developing a tool to automatically measure the software functional size

Contribution:

- We developed the Triplet approach for writing software requirements
- We developed a tool to generate Triplets from Use cases or User Stories and to calculate the Functional Size

Introduction

The measure in software engineering:

- Estimation of the costs and effort of software projects (Abran 2015)
- Monitoring of the software development process as well as budget, and scope

Estimation methods and approaches

Estimation methods and approaches:

- Boehm (1981) proposed the COnstructive COst MOdel (COCOMO).
- Boehm (2000) proposed COCOMO II, using function points as an input

Software functional size

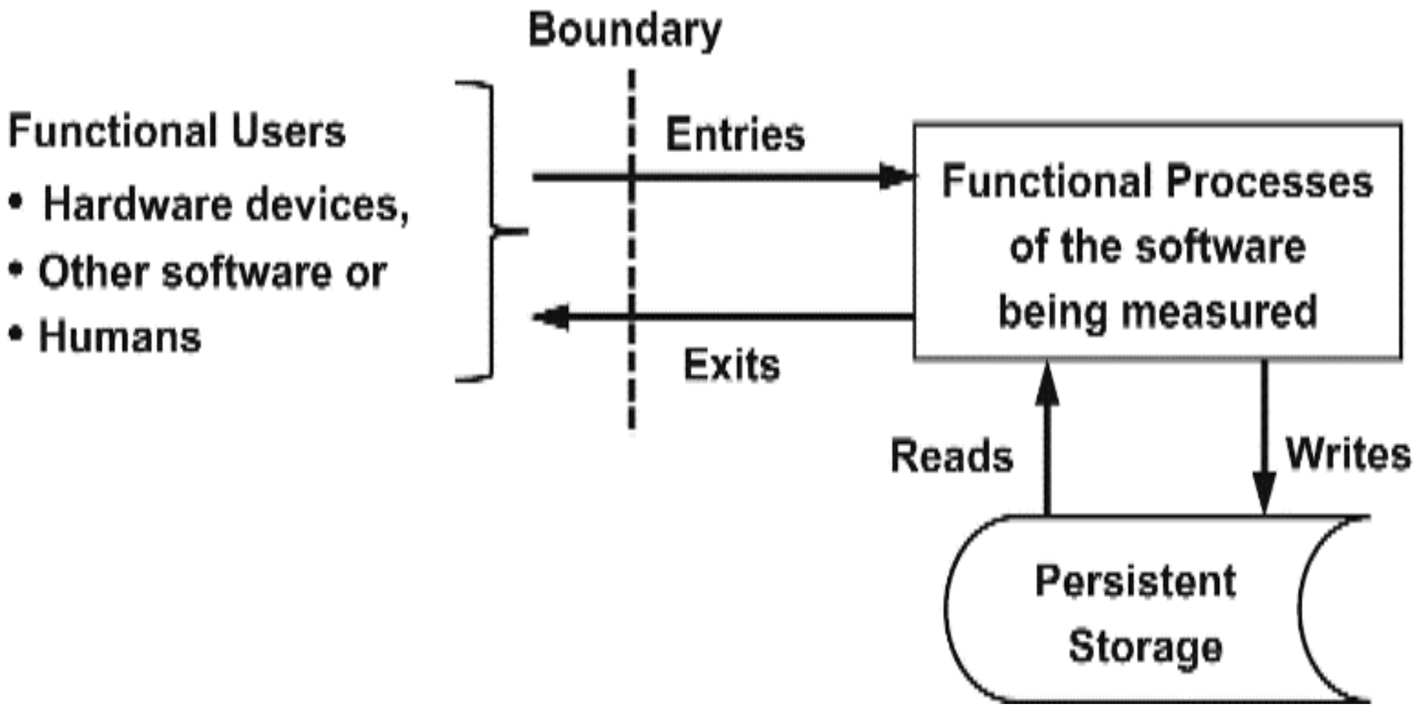
- Measure of software functional size: a key factor to estimate the effort and cost of developing software products (Abran 2015)
- Methods proposed and approved by ISO: COSMIC, IFPUG, NESMA, Mark II and FISMA

The COSMIC Method

- COSMIC: The only functional sizing method of 2nd generation
- Developed with the aim of overcoming some limitations of the other methods
- Applicable to information systems, real-time/embedded systems, mobile apps, cloud apps, etc.
- Can be measured early in the life cycle, and can be approximated earlier

The COSMIC Method

The four types of data movement:



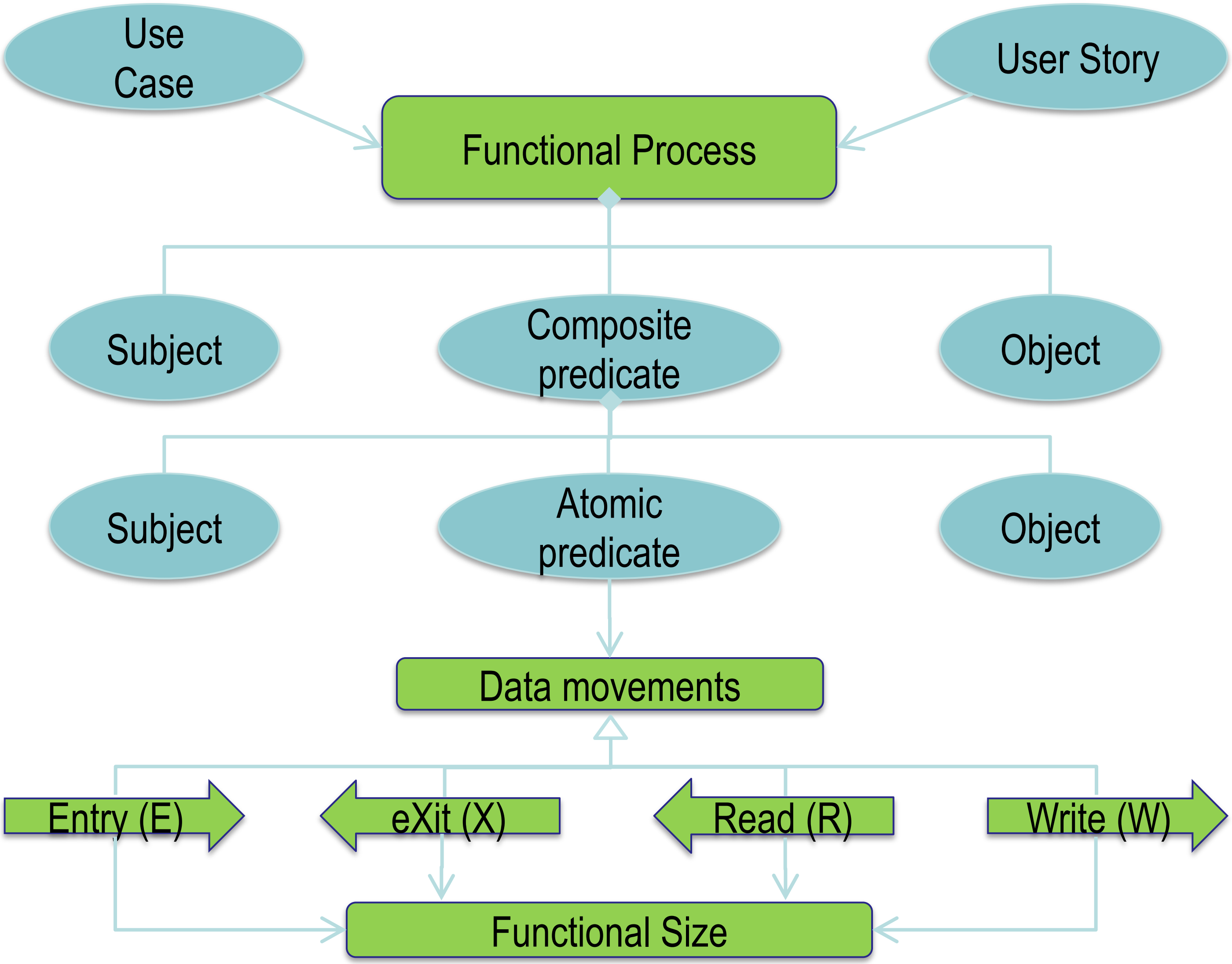
Problematic

- Functional size of software: measured from software requirements
- Automation of software functional size: depends necessarily on the software requirements writing technique (Use Case, User Stories)
- Problem with automated sizing: requirements unungerstood by machines

Software requirements writing technique proposed

- Software requirements writing technique proposed: **“Triplet Approach”**

Model of Triplet (Triple Store)



Tool developed

Tool developed for generating triplets:

- First module: used to automatically generate triplets from Use Cases, User Stories or functional requirements written in natural language.
- Second module: used to obtain the functional size of the software being measured

First module of our tool

- It targets the structure (subject, predicate, object).
- *We assumed that the writing of software requirements is done with dyadic predicates, that is, predicates with two arguments f (x, y*
- The predicate: expressed by a verb (a data movement).
- The “x” variable: subject of the action
- the “y” variable: object of the action
- Association of the function “f” with “x” and “y” variables.
- Using of a descriptive logic to represent the sentences to be splitted into first order predicate formulas.
- Construction and application of our own rules and algorithms to generate the triplets from the Use Cases or User Stories written in natural language.

Second module of our tool

- Quantifies the number of atomic predicates (verbs) of each triplet.
- A set of rules is applied to make each predicate correspond to a type of data movement (Entry, Exit, Read, or Write).

Example

- Example of a Use case scenario
  - The system verifies the information, saves the data, or returns an error message”.
- We transform each of these actions into a series of predicates of the form: ∃ object, ∃ subject such as predicate (object, subject).
- Use Cases described in formal logic by variables to represent subjects, predicates, and objects as follows:

  - Subject:
    - {x} = The system
  - Predicates:
    - {f1} = verifies
    - {f2} = saves
    - {f3} = returns
  - Objects:
    - {y1} = information
    - {y2} = data
    - {y3} = error message

- We obtain the following logical formula:
  - $\exists\ x\ [f1(x, y1) \wedge f2\ (x, y2) \wedge f3\ (x, y3)]$

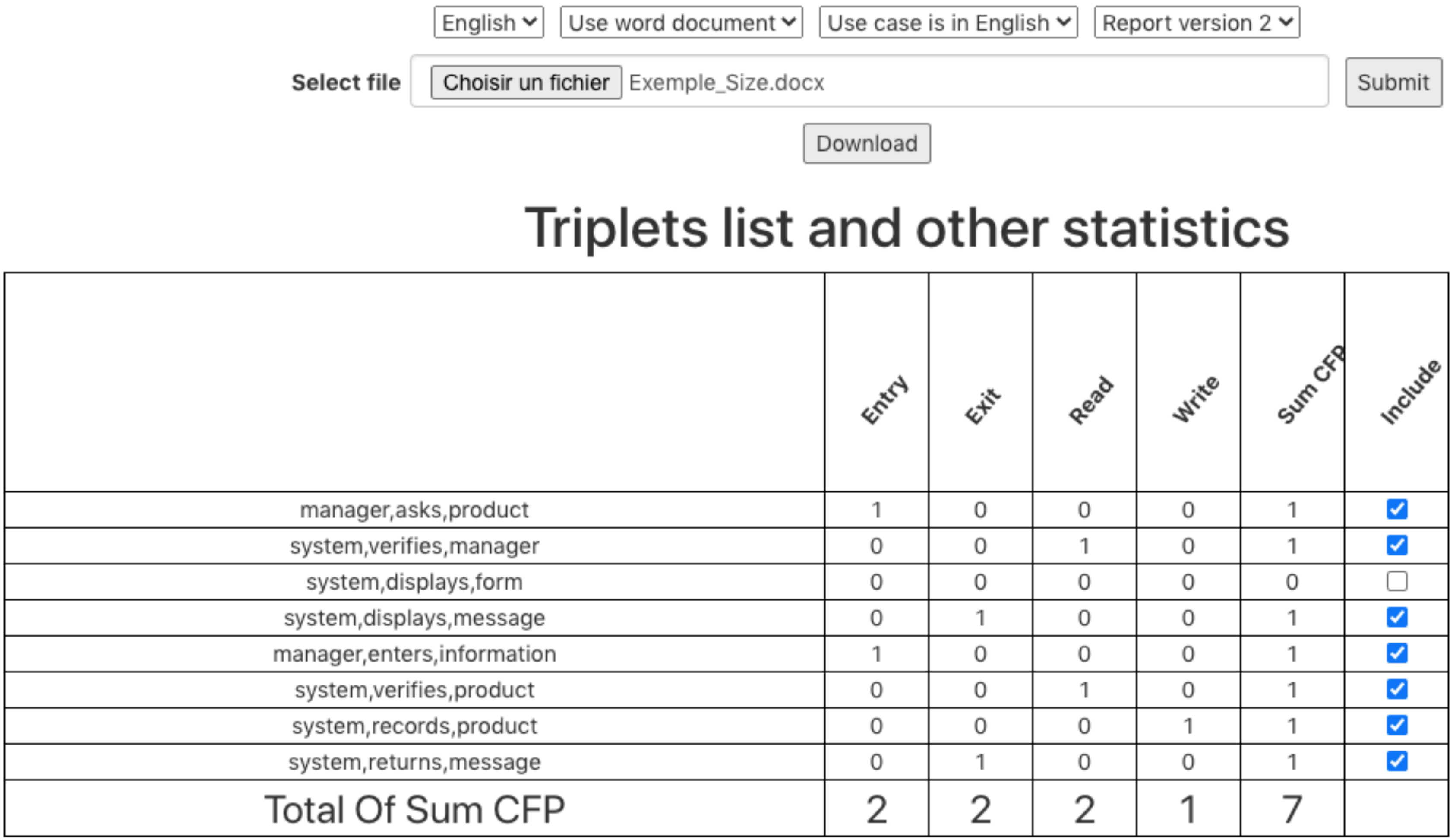
Description of a Use Case and its Manually and Automatically Measured Functional Size

Description: *“The sales manager asks to add a new product. The system verifies the sales manager credentials and displays the new product form or displays a credential error message. The sales manager enters the new product information and asks the system to save the new product. The system verifies the data, records the product, and returns a confirmation message for the addition of the new product or an error message if the product already exists ”*

Manually Measured Functional Size

Functional Process Elements	Data Groups	E	X	R	W	Sum of CFP
Asks to add a new product	Credentials	1				1
Verifies the sales manager credentials	Credentials			1		1
Displays a credential error message	Error message		1			1
Displays the new product form	[New product form]					-
Enters the new product information	New Product	1				1
Verifies the data	Data			1		1
Records the product	Product				1	1
Returns a confirmation message	Confirmation message		1			1
Returns an error message	Error message					-
Total:		2	2	2	1	7

Automatically Measured Functional Size



English ⌄ | Use word document ⌄ | Use case is in English ⌄ | Report version 2 ⌄

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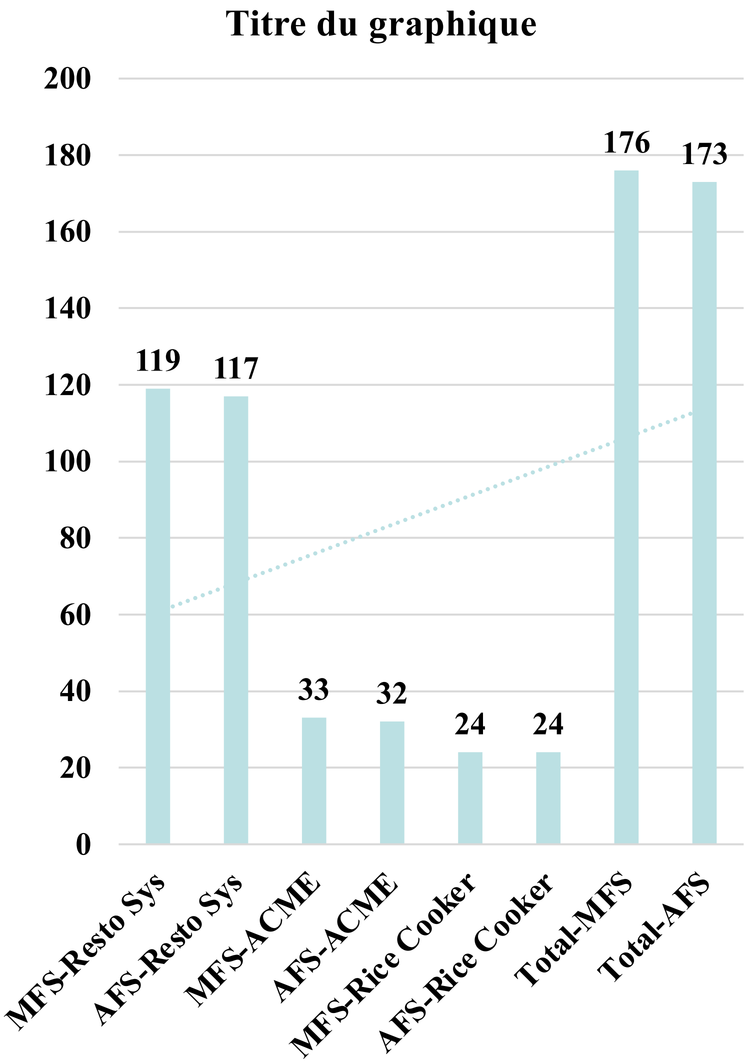
Triplets list and other statistics

	Entry	Exit	Read	Write	Sum CFP	Include
manager,asks,product	1	0	0	0	1	☑
system,verifies,manager	0	0	1	0	1	☑
system,displays,form	0	0	0	0	0	□
system,displays,message	0	1	0	0	1	☑
manager,enters,information	1	0	0	0	1	☑
system,verifies,product	0	0	1	0	1	☑
system,records,product	0	0	0	1	1	☑
system,returns,message	0	1	0	0	1	☑
Total Of Sum CFP	2	2	2	1	7	

Results of our research

Automatic and manual functional sizing comparisons

Project	Manual Functional Sizing	Automatic Functional Sizing	Accuracy
Resto Sys	119	117	98.32%
ACME Car Hire System	33	32	96.97%
Rice Cooker	24	24	100.00%
Total	**176**	**173**	**98.30%**



Evaluation and Validation of Results by COSMIC Experts

- Results of the tool compared with those of human experts
- The manually measured results of these projects: published and available on the COSMIC website
- Automated results: consistent with the manual results validated and published by experts (with an average accuracy of 98.30%)
- The accuracy varies between 96.97% and 100%.

Limitations of our research

- One limitation of the tool: It cannot generate triplets for sentences written in the passive form
- However, the tool detects sentences written with a passive voice and raises the issue as a potential error

Conclusion

- Triplet approach proposed: help to automate the functional size measurement process
- proven, tested, and validated by the development of a tool, as defined by the COSMIC method.
- Approximated results to the human experts: about 98.30%.

Future work

- Integration of a new module to allow to the tool to generate triplets for sentences written in the passive form
- Integration of a machine learning module
- Recognition of the languages (Spanish, creole, Italian, etc.)

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