

Validation of the iStar2ca guidelines: variables, hypotheses, instrumentation and statistical results

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Abstract

This technical report presents the variables, hypotheses, instrumentation and statistical results corresponding to a controlled experiment performed for the evaluation of the *iStar2ca* guidelines.

1 Introduction

We have performed a comparative experiment to assess the performance and perceptions of students applying the *iStar2ca* guidelines V1.0 [1]. The *iStar2ca* guidelines facilitate obtaining a Communication Analysis (CA) model having as input a given *i** model. The comparative experiment was performed in the context of a master course of information system engineering (ISI) in the Universitat Politècnica de València, Spain. The experiment compares practitioner's performance (completeness, efficiency and validity of CA models), and usability perceptions (usefulness, ease of use and intention to use) when the subjects apply their own criteria vs the *iStar2ca* guidelines. This experiment has been designed according to Wholin et al. [2], and it is reported according to Jedlitschka & Pfahl [3] and Juristo & Moreno [4]. This technical report is structured as follows: section 2 describes the variables definition that were analysed during the comparative experiment. Section 3 reports on the hypotheses and section 4 describes the instrumentation used during the experiment. Finally, section 5 summarises the statistical results of the data collected during the experimental tasks.

2 Variables definition

Independent variable

The variable that is not influenced by other variables is the strategy to obtain the resulting CA models from *i** models. We distinguish two treatments for this variable by adding a “_C” to indicate that the variable refers to the treatment when the subjects apply their own criteria; or we add a “_G” to indicate that the variable refers to the treatment when the subjects apply the *iStar2ca* guidelines.

- **CA derivation strategy.** The strategy to obtain CA models from *i** models in top-down scenarios. There are two treatments for this variable:
 - CA_derivation_strategy_C. When the subjects apply their own criteria in order to obtain CA models from *i** models.
 - CA_derivation_strategy_G: When the subjects apply the *iStar2ca* guidelines as defined in [1] (The *iStar2ca* guidelines V1.0).

Dependent variables

The dependent variables are influenced by the independent variable defined above. The dependent variables will present different results according to the treatment of the independent variable. For each dependent variable, we provide a short description and a concise term to refer it in the following subsections. At the end of each term we will add a “_C” to indicate that the variable refers to the treatment when the subjects apply their own criteria; or we will add a “_G” to indicate that the variable refers to the treatment when the subjects apply the *iStar2ca* guidelines.

- **CA model completeness:** CA Model completeness is defined as the percentage of CA model elements in the resulting CA model in comparison with a CA reference model. The term for this variable is CA_model_completeness.
- **CA model validity:** CA model validity is defined as the percentage of validity errors in the resulting CA model in comparison with a CA reference model after the application of a derivation strategy. The term for this variable is CA_model_validity
- **Subject efficiency:** The efficiency is the degree of success during the application of a derivation strategy of CA models according to the time consumed (CA model completeness divided by time consumed). The term for this variable is Subjects_efficiency.
- **Perceived usefulness:** This variable will be measured using a 5-point Likert scale format to obtain users' perception. The term for this variable is PU.
- **Perceived ease of use:** This variable will be measured using a 5-point Likert scale format to obtain users' perception. The term for this variable is PEOU.
- **Intention to use:** This variable will be measured using a 5-point Likert scale format to obtain users' perception. The term for this variable is ITU.

3 Hypotheses

We define null hypotheses that correspond with impact absence from the independent variables to the dependent variables (represented by a 0 in the subscript); also we define alternative hypotheses that suppose the existence of such impact (represented by a 1 in the subscript).

A summary is presented below; afterward we provide all details about each hypothesis.

Null Hypothesis	Statement: The CA derivation strategy from i^* models does not influence...	Formalization
<u>H1₀</u>	... the completeness of the resulting CA models	CA_model_completeness_C = CA_model_completeness_G
<u>H2₀</u>	... the validity of the resulting CA models according to incorrect elements	CA_model_validity_C = CA_model_validity_G
<u>H3₀</u>	...the efficiency of the subjects	Subjects_efficiency_C = Subjects_efficiency_G
<u>H4₀</u>	...the perceived usefulness	PU_C = PU_G
<u>H5₀</u>	...the perceived ease of use	ITU_C = ITU_G
<u>H6₀</u>	... the perceived intention to use	ITU_C = ITU_G

Hypothesis 1: Completeness

Null hypothesis, H1₀. The CA derivation strategy from i^* models does not influence the completeness of the resulting CA models.

$$CA_model_completeness_C = CA_model_completeness_G$$

Alternative hypothesis, H1₁. The CA derivation strategy from i^* models that apply the *iStar2ca* guidelines influence with a greater value the completeness of the resulting CA models than the CA derivation strategy that apply the criteria of the subjects.

$$CA_model_completeness_G > CA_model_completeness_C$$

Hypothesis 3: Validity

Null hypothesis, H2₀. The CA derivation strategy from i^* models does not influence the validity of the resulting CA models according to incorrect elements.

$$CA_model_Validity_C = CA_model_Validity_G$$

Alternative hypothesis, H2₁ The CA derivation strategy from *i** models that apply the *iStar2ca* guidelines influence with a greater value the validity of the resulting CA models than the CA derivation strategy that apply the criteria of the subjects.

$$CA_model_Validity_G > CA_model_Validity_C$$

Hypothesis 3: Efficiency

Null hypothesis, H3₀. The CA derivation strategy from *i** models does not influence the efficiency of the subjects.

$$Subjects_efficiency_C = Subjects_efficiency_G$$

Alternative hypothesis, H3₁. The CA derivation strategy from *i** models that apply the *iStar2ca* guidelines influence with a greater value the efficiency of the subjects than the CA derivation strategy that apply the criteria of the subjects.

$$Subjects_efficiency_G > Subjects_efficiency_C$$

Hypothesis 4: Usefulness

Null hypothesis, H4₀. The CA derivation strategy from *i** models does not influence the perceived usefulness of the subjects.

$$PU_C = PU_G$$

Alternative hypothesis, H4₁. The CA derivation strategy from *i** models case A that apply the *iStar2ca* guidelines influence with a greater value the perceived usefulness of the subjects than the CA derivation strategy that apply the criteria of the subjects.

$$PU_G > PU_C$$

Hypothesis 5: Ease of use

Null hypothesis, H5₀. The CA derivation strategy from *i** models does not influence the perceived ease of use.

$$PEOU_C = PEOU_G$$

Alternative hypothesis, H5₁. The CA derivation strategy from *i** models that apply the *iStar2ca* guidelines influence with a greater value the perceived ease of use of the subjects than the CA derivation strategy that apply the criteria of the subjects.

$$PEOU_G > PEOU_C$$

Hypothesis 6: Intention to use

Null hypothesis, H6₀. The CA derivation strategy from *i** models does not influence the perceived intention to use.

$$ITU_C = ITU_G$$

Alternative hypothesis, H6₁. The CA derivation strategy from *i** models that apply the *iStar2ca* guidelines influence with a greater value the perceived intention to use of the subjects than the CA derivation strategy that apply the criteria of the subjects.

$$ITU_G > ITU_C$$

4 Instrumentation (see the webpage: http://hci.dsic.upv.es/istar2ca_exp/)

Table 1. Instruments of the experiment

Code	Instruments' description	URL of the instrument
11	Scorecard to keep track of the experiment execution : a Microsoft Excel file	http://hci.dsic.upv.es/istar2ca_exp/instruments/l1-Scorecard/ISI_2014_scorecardv0.

		05.xlsx
12	Material with the motivation of the course and objectives: slides and textual material.	http://hci.dsic.upv.es/istar2ca_experiment/instruments/I2-Motivation/Motivation_ISI_course_2013-2014.pdf
13	Demographic questionnaire and results	http://hci.dsic.upv.es/istar2ca_experiment/instruments/I3-Demographic_quest/DemographicQuestionnaire_ISE2014.pdf http://hci.dsic.upv.es/istar2ca_experiment/instruments/I3-Demographic_quest/Results_report-16-08-2014-final.xls
14	Material for <i>i*</i> training (learning objective: understand <i>i*</i> models): slides, additional textual material	http://hci.dsic.upv.es/istar2ca_experiment/instruments/I4-iStarTraining/iStarTraining-ISIcourse_2014.pdf
15	Cheat sheet with the <i>i*</i> primitives (learning objective: quick access to the <i>i*</i> primitives for ease use during the training activities and the experimental task)	http://hci.dsic.upv.es/istar2ca_experiment/instruments/I5-iStar_cheat_sheet/iStarcheatsheet_v1.1.pdf
16	Training cases to practice <i>i*</i> model understanding Case1: SuperStationery Co. + questionnaire Case2: HealthCare + questionnaire Case2 is rated to provide feedback to the subjects.	http://hci.dsic.upv.es/istar2ca_experiment/instruments/I6-iStar_case_training/TrainingCase1-SuperStationery-ANSWERS.pdf http://hci.dsic.upv.es/istar2ca_experiment/instruments/I6-iStar_case_training/TrainingCase1-SuperStationery-without_answers.pdf http://hci.dsic.upv.es/istar2ca_experiment/instruments/I6-iStar_case_training/TrainingCase2-HealthCare-ANSWERS.pdf http://hci.dsic.upv.es/istar2ca_experiment/instruments/I6-iStar_case_training/TrainingCase2-HealthCare-without_answers.pdf
17	Material for CA training (learning objective: understand, create and assess the quality of CA models): slides, additional textual material	http://hci.dsic.upv.es/istar2ca_experiment/instruments/I7-CA_training/CA-2.pdf http://hci.dsic.upv.es/istar2ca_experiment/instruments/I7-CA_training/CA-1.pdf
18	Textual material to specify CA models. Stationery material	Write an email to us to request this instrument
19	Cheat sheet with CA primitives (learning objective: quick access to the CA primitives for	http://hci.dsic.upv.es/istar2ca_experiment/instruments/I9-

	ease use during the training activities and the experimental task)	CA cheat sheet/CAcheatsheet.pdf
I10	Case to specify an information system with CA: slides, additional textual material Case: Projects office	http://hci.dsic.upv.es/istar2ca_exp/instruments/I10-CA_case_training/CE02-ENProjectsOfficeREQUIRTextual(LTE)v2.1short.pdf http://hci.dsic.upv.es/istar2ca_exp/instruments/I10-CA_case_training/ComprensibilidadCA-ProjectsOffice.pdf http://hci.dsic.upv.es/istar2ca_exp/instruments/I10-CA_case_training/ProjectsOfficeCED(simple).pdf
I11	SuperStationery case to practice derivation of CA applying criteria: slides, additional textual material	http://hci.dsic.upv.es/istar2ca_exp/instruments/I11-SuperStationery_case/SuperStationery-CaseDescription(twopages).pdf
I12	Experimental task applying <u>criteria</u> - task instructions	Write an email to us to request this instrument
I13	Form to register subjects time and performance during experimental task	http://hci.dsic.upv.es/istar2ca_exp/instruments/I13-Form_to_register_subjects_performance/1_Form-Subjectperformance_Criteria.pdf http://hci.dsic.upv.es/istar2ca_exp/instruments/I13-Form_to_register_subjects_performance/2_Form-Subjectperformance-Guidelines.pdf
I14	A1 case for <u>experimental task applying criteria</u> : textual material	http://hci.dsic.upv.es/istar2ca_exp/instruments/I14-iStar_case_A1_for_exp_task-Criteria/Explanation-Elections-v4.1.pdf
I15	B1 case for <u>experimental task applying criteria</u> : textual material	http://hci.dsic.upv.es/istar2ca_exp/instruments/I15-iStar_case_B1_for_exp_task-Criteria/Explanation-Academy-v2.pdf
I16	MEM questionnaire to measure Perceived usefulness, Perceived ease of use and Intention to use	http://hci.dsic.upv.es/istar2ca_exp/instruments/I16-MEM_quest/1_MEMquestionnaire-ISI2014-ExperimentalTask-Criteria.pdf http://hci.dsic.upv.es/istar2ca_exp/instruments/I16-MEM_quest/2_MEMquestionnaire-ISI2014-ExperimentalTask-Criteria.pdf

		re-ISI2014-ExperimentalTask-Guidelines.pdf
I17	Material for <i>iStar2ca guidelines</i> training: slides, SuperStationery case, pizzeria case and textual material	http://hci.dsic.upv.es/istar2ca_exp/instruments/I17-iStar2ca_guidelines_training/GuidelinesSummaryandPizzeriacase-referencesolution.pdf http://hci.dsic.upv.es/istar2ca_exp/instruments/I17-iStar2ca_guidelines_training/iStar2CAguidelines(x2pages).pdf http://hci.dsic.upv.es/istar2ca_exp/instruments/I17-iStar2ca_guidelines_training/Pizzeria_casedescription.pdf http://hci.dsic.upv.es/istar2ca_exp/instruments/I17-iStar2ca_guidelines_training/Pizzeria_formwithsolution.pdf
I18	Cheat sheet with the <i>iStar2ca</i> guidelines (learning objective: quick access to the <i>iStar2ca</i> guidelines for ease use during the training activities and the experimental task)	http://hci.dsic.upv.es/istar2ca_exp/instruments/I18-iStar2ca_guidelines_cheat_sheet/Guidelinescheatsheet.pdf
I19	Experimental task applying the <i>iStar2ca guidelines</i> - task instructions	Write an email to us to request this instrument
I20	A2 case for <u>experimental task applying the <i>iStar2ca</i> guidelines</u> : textual material	http://hci.dsic.upv.es/istar2ca_exp/instruments/I20-iStar_case_A2_for_exp_task-iStar2ca_Guidelines/Literary_competition.pdf
I21	B2 case for <u>experimental task applying the <i>iStar2ca</i> guidelines</u> : textual material	http://hci.dsic.upv.es/istar2ca_exp/instruments/I21-iStar_case_B2_for_exp_task-iStar2ca_Guidelines/Explanation-Expeditions_v2.pdf
I22	Template to evaluate the resulting CA models models vs the reference solutions	http://hci.dsic.upv.es/istar2ca_exp/instruments/I22-Form-modelComparison/Correction-A1-Case-Elections_for_department_board.pdf http://hci.dsic.upv.es/istar2ca_exp/instruments/I22-Form-modelComparison/Correction-A2-Case-Literary_competition.pdf http://hci.dsic.upv.es/istar2ca_exp/instruments/I22-Form-modelComparison/Correction-B1-Case-

		National language academy.pdf http://hci.dsic.upv.es/istar2ca_exp/instruments/I22-Form-modelComparison/Correction-B2-Case-Expedition_(International_mountaineering_federation).pdf
I23	Slides with the summary of the sessions and overview of the results	http://hci.dsic.upv.es/istar2ca_exp/instruments/I23-Summary/1_Summary_ISI_class_2014_model_assesment.pdf
I24	Recording machine to record the focus group session	Write an email to us to request this instrument
I25	Method and instrument to measure CA model completeness. Excel sheet with the reference models and formulas for comparison	http://hci.dsic.upv.es/istar2ca_exp/instruments/I25-Measurement-ResultingCAModels/TemplateModelEvaluation-CED-Reference solution.xlsx
I26	Preliminary system of codes to make qualitative analysis of the focus group	http://hci.dsic.upv.es/istar2ca_exp/instruments/I26-FocusGroup/Focusgroup_data_ClassificationduringtheFG.xlsx http://hci.dsic.upv.es/istar2ca_exp/instruments/I26-FocusGroup/FocusGroup.pdf

5 Statistical results

5.1.1 Completeness

For the sake of brevity, the variables have been shorten and they are specified as the following:

CA_model_completeness_C = Elements_C

CA_model_completeness_G = Elements_G

Table 2. Descriptive statistics for Elements_C and Elements_G measures

Variable	Mean	N	Std. Deviation	Std. Error Mean
Elements_C	,5897	19	,21027	,04824
Elements_G	,7965	19	,15471	,03549

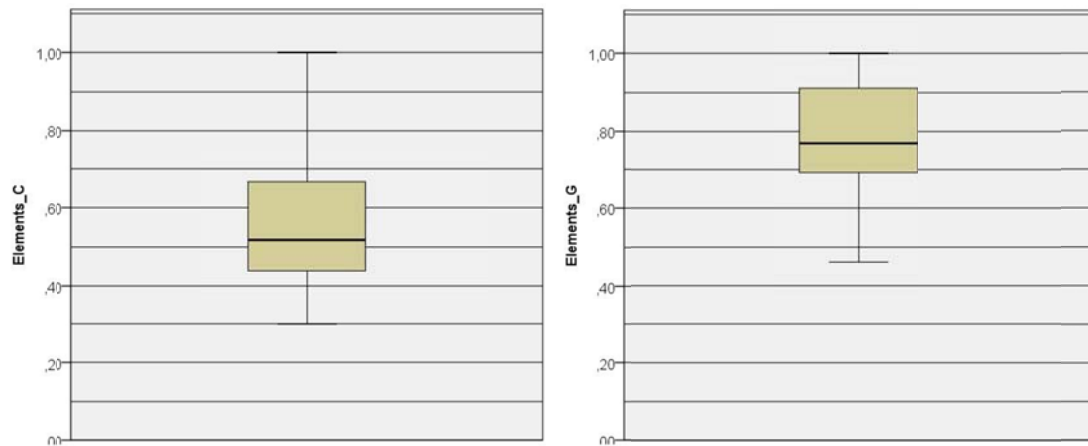


Figure 1 Box plot for CA model completeness measures

Table 3. Paired-Samples T Test for Elements_C and Elements_G measures

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Elements_C - Elements_G	-,20682	,22087	,05067	-,31328	-,10037	-4,082	18	,001

5.1.2 Validity

For the sake of brevity, the variables have been shortened and they are specified as the following:

CA_model_validity_C = Invalidity_C

CA_model_validity_G = Invalidity_G

Table 4. Descriptive statistics for the Invalidity_C and Invalidity_G measures

Variable	Mean	N	Std. Deviation	Std. Error Mean
Invalidity_C	,0402	19	,04091	,00939
Invalidity_G	,0340	19	,02854	,00655

Table 5. Paired Samples T test for Invalidity_C and Invalidity_G measures

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Invalidity_C - Invalidity_G	,00615	,04775	,01095	-,01686	,02916	,561	18	,582

5.1.3 Subjects efficiency

For the sake of brevity, the variables have been shortened and they are specified as the following:

Subjects_efficiency_C = Minutes_C

Subjects_efficiency_G = Minutes_G

Table 6. Descriptive statistics for the Minutes_C and Minutes_G measures

	Mean	N	Std. Deviation	Std. Error Mean
Minutes_C	66,9474	19	14,13614	3,24305
Minutes_G	77,4211	19	18,23707	4,18387

Table 7. Paired-Samples T Test for the Minutes_C and Minutes_G measures

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Minutes_C - Minutes_G	-10,47368	19,83927	4,55144	20,03590	-,91146	2,301	18	,034

5.1.4 Subjects perceptions

Table 8. Descriptive statistics for the PEOU_C, PU_C, ITU_C, PEOU_G, PU_G, ITU_G measures

	Mean	N	Std. Deviation	Std. Error Mean
PEOU_C	3,6018	19	,82727	,18979
PEOU_G	3,7719	19	,66484	,15252
PU_C	3,5526	19	,76185	,17478
PU_G	3,8064	19	,58938	,13521
ITU_C	3,3158	19	1,05686	,24246
ITU_G	3,6316	19	,87943	,20175

Table 9. Paired-Samples T test for the PEOU_C, PU_C, ITU_C, PEOU_G, PU_G, ITU_G measures

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
PEOU_C - PEOU_G	-,17018	1,04921	,24071	-,67588	,33553	-,707	18	,489
PU_C - PU_G	-,25376	,74270	,17039	-,61173	,10421	-1,489	18	,154
ITU_C - ITU_G	-,31579	1,32508	,30400	-,95446	,32288	-1,039	18	,313

Perceived usefulness

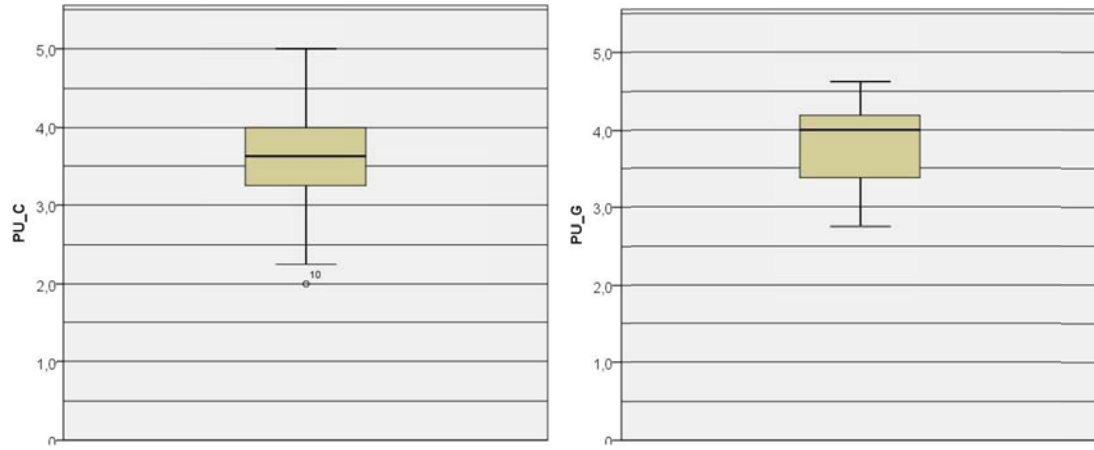


Figure 2 Box plot for the PU_C and PU_G measures

Perceived ease of use

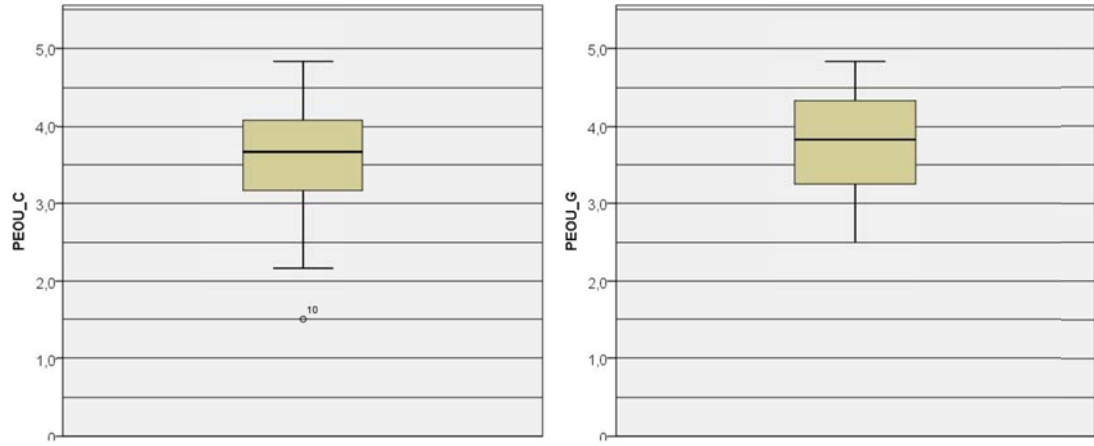


Figure 3 Box plot for the PEOU_C and PEOU_G measures

Perceived intention to use

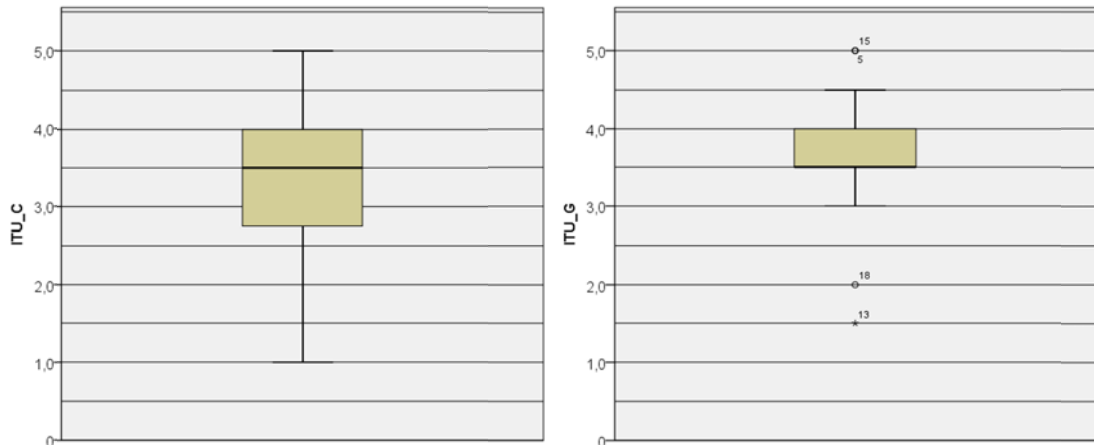


Figure 4 Box plot for the ITU_C and ITU_G measures

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