When Rationality Meets Intuition: A Research Agenda for Software Design Decision Making

Replication Package

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Overview

This document describes the replication package of the paper titled *"When Rationality Meets Intuition: A Research Agenda for Software Design Decision Making"*.

This study has been designed, developed, and reported by the following investigators:

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The replication package comprises multiple files that are structured and accessible in both .xlsx and .csv formats. Their descriptions and links can be found below.

1. Protocol
2. Databases and results - Document *Databases* - Table with queried databases and results
3. Codification Framework - Document *Codification Framework* - Describes the parameters of coding, their descriptions and possible values.
4. Primary Studies - Document *PrimaryStudies* - Complete table of the 26 primary studies included in the research.
5. Data Extract - Documents *PrimaryStudiesDataCoded* and *PrimaryStudies-DataNonCoded* - Extracted data for all primary studies.
6. Rationale - Documents *Rationale* < *parametername* > - Full rationale and classification tables for each parameter.

Abstract: Context. As society's reliance on software systems escalates over time, so too does the cost of failure of these systems. Meanwhile, the complexity of software systems, as well as their design, is also ever-increasing, influenced by the proliferation of new tools and technologies to address societal needs. The traditional response to this complexity in software engineering and software architecture has been to apply rational approaches to software design, through methods and tools for capturing design rationale and software architecture knowledge management. However, research from other fields demonstrates that intuition may also hold benefits for making complex design decisions. All humans, including software designers, make use of both intuition and rationality in varying combinations.
Objective. The aim of this article is to provide a comprehensive overview of what is known and unknown from existing research regarding the use and performance consequences of using intuition and rationality in software design decision- making.
Methods. To this end, a systematic literature review has been conducted, with an initial sample of 3909 unique publications.
Results. We propose (1) an overview of existing research, based on the literature concerning intuition and rationality use in software design decision-making; and (2) a research agenda with fourteen future research questions, that should encourage researchers to fill identified research gaps. The research agenda and corresponding research questions were developed by means of a narrative synthesis, by reflecting on the research gaps based on findings concerning the use of intuition and rationality in decision-making from other domains. Conclusions. This research agenda emphasizes what should be investigated to be able to develop support for the application of the two cognitive processes in software design decision-making.

Keywords: software design, decision-making, intuition, rationality, systematic literature review, research agenda

Codification Framework

This document describes the parameters of the codification framework related to the literature study. It first gives descriptions of parameters found in all Replication Package documents, after which all possible values of each parameter are listed.

Primary Studies Metadata

The Primary studies are described in Document *"PrimaryStudies"*. Their parameters are described in Table 1.

Table 1: Parameters for primary studies.

Parameter Name	Type	Description
Study Code	*Int*	Unique study identifier given to each primary study identification
Link	*String*	Link to main publication page of the study
Title	*String*	Title of the study
Author	*String*	List of all authors of the study
Year	*String*	Year of publication of the study
Venue	*String*	Venue in which the study was published
Study keywords	*String*	Keywords of the study as published on main publication page
Rationale for Field	*String*	Describes the focus of the study in relation to the field

Data Extraction Parameters

Extracted parameter data from the literature study for all primary studies is described in Table 2 and Table 3. Extra tables are provided in Section giving each parameters' full set of the possible coding values. The data extracted from the primary studies can be found in Documents *"PrimaryStudies-DataCoded"* and *"PrimaryStudiesDataNonCoded"*. The full rationale per parameter can be found in accompanying Documents *"Rationale < parametername >"*.

Table 2: Parameters for Intuition and Rationality Clusters.

Parameter Name	Type	Description
Attributes of Intuition and Rationality	*Set*, see Tables 5 and 6	Conceptualizations of Intuition and Rationality
Intuition Cluster	*Set*, see Table 4 or 5	Attributes of intuition addressed in the study
Rationality Cluster	*Set*, see Table 4 or 6	Attributes of rationality addressed in the study
Element Classification	*Set*, see Table 4	Final classification of the study

Table 3: Parameters for Decision types, Performance category, Level of Analysis, Antecedents and Contextual Factors

Parameter Name	Type	Description
Decision Types	*Set*, see Table 7	Identification of stages of software design
Performance Category	*Set*, see Table 8	Types of design decision making performance outcomes
Level of Analysis	*Set*, see Table 9	Individual or team focus of the study
Antecedents	*Set*, see Table 10	Factors inducing the use of intuition and rationality
Contextual Factors	*Set*, see Table 11	Factors for when the use of either approach is beneficial or detrimental

Parameter Values

Possible parameter values for Intuition and Rationality Clusters and Classification in Table 2 are presented in Table 4.

Table 4: Possible codes for Intuition and Rationality from Evans, 2008

Category	Cluster	Code	Description
Intuition		**INT**	Gut-feeling about a decision option or matching scenarios with past ones
	Consciousness	**I-CON**	Speed and spontaneity of intuition as defining factors
	Evolution	**I-EVO**	Intuition in terms of the personal experience of the software designer
	Functional characteristics	**I-FUNC**	The associative or heuristic nature of intuition
	Individual differences	**I-IND**	
Rationality		**RAT**	Evaluating options using rules and logic
	Consciousness	**R-CON**	Explicit and controlled nature of rationality
	Evolution	**R-EVO**	Rationality in terms of its reliance on language
	Functional characteristics	**R-FUNC**	Rule-based, logical, and sequential nature of rationality is emphasized
	Individual differences	**R-IND**	

Attribute parameter values for Intuition are given in Table 5 and for Rationality in Table 6 on the next pages.

Table 5: Possible attribute values for Intuition parameter from Evans, 2008

Cluster	Attribute	Code	Description
Consciousness		**I-CON**	Speed and spontaneity of intuition as defining factors
	Unconscious (preconscious)	**UNC**	
	Implicit	**IMP**	
	Automatic	**AUT**	
	Low effort	**LEFF**	
	Rapid	**RAP**	
	High capacity	**HICA**	
	Default process	**DFP**	
	Holistic	**HOL**	
Evolution		**I-EVO**	Intuition in terms of the personal experience of the software designer
	Evolutionarily old	**EOL**	
	Evolutionary rationality	**ERA**	
	Shared with animals	**ANI**	
	Non-verbal	**NOV**	
	Modular cognition	**MOD**	
Functional characteristics		**I-FUNC**	The associative or heuristic nature of intuition
	Associative	**ASO**	
	Domain specific	**DOS**	
	Contextualized	**CTX**	
	Pragmatic	**PRA**	
	Parallel	**PAR**	
	Stereotypical	**STE**	
Individual differences		**I-IND**	
	Universal	**UNI**	
	Independent of general intelligence	**IGI**	
	Independent of working memory	**IWM**	

Table 6: Possible attribute values for Rationality parameter from Evans, 2008

Cluster	Attribute	Code	Description
Consciousness		**R-CON**	Explicit and controlled nature of rationality
	Conscious	**CON**	
	Explicit	**EXP**	
	Controlled	**CTR**	
	High effort	**HIEFF**	
	Slow	**SLO**	
	Low capacity	**LOC**	
	Inhibitory	**INH**	
	Analytic	**ANA**	
Evolution		**R-EVO**	Rationality in terms of its reliance on language
	Evolutionarily recent	**EVR**	
	Individual rationality	**IND**	
	Uniquely human	**HUM**	
	linked to language	**LANG**	
	Fluid intelligence	**FLU**	
Functional characteristics		**R-FUNC**	Rule-based, logical, and sequential nature of rationality is emphasized
	Rule based	**RUL**	
	Domain general	**DOM**	
	Abstract	**ABS**	
	Logical	**LOG**	
	Sequential	**SEQ**	
	Egalitarian	**EGA**	
Individual differences		**R-IND**	
	Heritable	**HER**	
	Linked to general intelligence	**LIN**	
	Limited by working memory capacity	**LIM**	

The parameters presented in Table 3 each have their own set of possible values.

Table 7: Possible parameter values for Decision Types

Category	**Name**	**Code**	**Description**
Performance	Design planning	**DP**	Decisions around scoping, and identifying key design issues
	Problem space	**PS**	Decisions linked to analysis of the design problem
	Solution space	**SS**	Decisions linked to the generation, evaluation, and selection of a design solution

Table 8: Possible parameter values for Performance

Category	**Name**	**Code**	**Description**
Performance	Decision outcome	**DO**	Outcome of a particular decision
	Decision making process	**DMP**	Evaluation of decision process itself
	Project outcome	**PO**	Outcome of the project as a whole

Table 9: Possible parameter values for Level of Analysis

Category	**Name**	**Code**	**Description**
Level of Analysis	Individual decision making	**IDM**	The presence of a single decision maker in decision
	Team decision making	TDM	Multiple decision makers involved in decision

Table 10: Possible parameter values for Antecedents from Clarke and O'connor, 2012

Category	Name	Code	Description
Antecedents	**Application**	**A-APP**	Linked to the nature of the application being developed
	Business	**A-BUS**	Business and strategic considerations
	Management	**A-MAN**	Management involved in the software development project
	Operation	**A-OPR**	Considerations and constraints linked to operations
	Organization	**A-ORG**	Organizational issues pertinent to the software development project
	Personnel	**A-PER**	Personnel involved in the software development project
	Requirements	**A-REQ**	Requirements of the software being developed
	Technology	**A-TEC**	Technology used for the development project

Table 11: Possible parameter values for Contextual Factors from Clarke and O'connor, 2012

Category	Name	Code	Description
	Application	**C-APP**	Linked to the nature of the application being developed
	Business	**C-BUS**	Business and strategic considerations
	Management	**C-MAN**	Management involved in the software development project
	Operation	**C-OPR**	Considerations and constraints linked to operations
	Organisation	**C-ORG**	Organizational issues pertinent to the software development project
	Personnel	**C-PER**	Personnel involved in the software development project
	Requirements	**C-REQ**	Requirements of the software being developed
	Technology	**C-TEC**	Technology used for the development project

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