Cognitive Biases in Architecture Design Decisions

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Agenda

- Introduction
- Research Questions
- Deep dive into the topic
- Research Implications
- Next Steps

Introduction

- Architecture design decisions forms the basis for development of software systems
  - Examples: What kind of Software Architecture Style to use?, Which technologies to use?
- Decision-making process not formalized
  - Influenced by previous experience, ease of use, intuition etc.
  - *naturalistic* and *biased*
  - Example: Decision to use a technology for all use cases - Anchor Bias
- Results in sub-optimal solutions

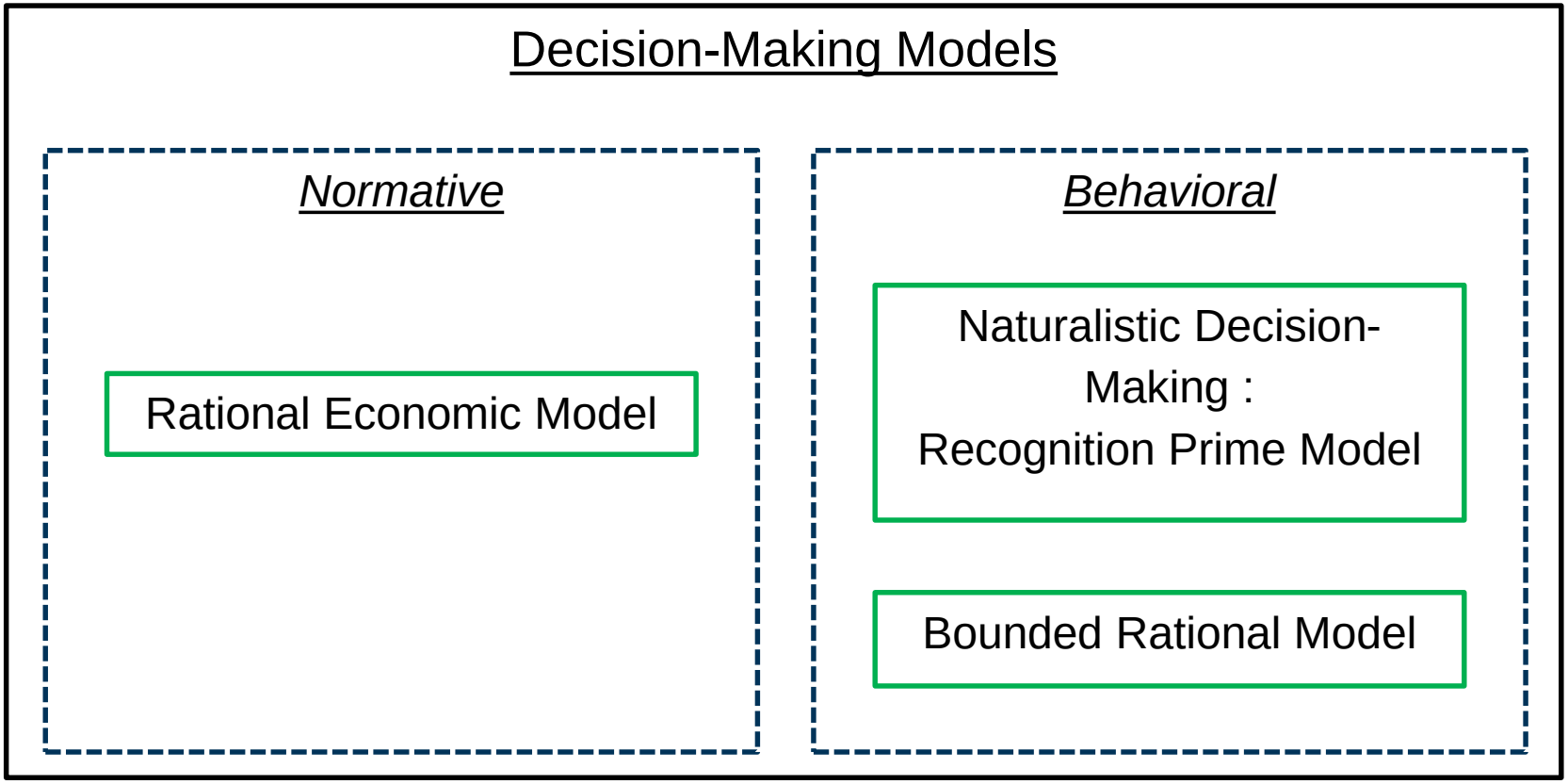
Goal : Formalize decision-making process and identify different cognitive biases associated with each stage to reduce their impact and result in better decisions

Research Questions

1. **What are the different decision-making processes in the context of architecture design decisions?**
2. Which cognitive biases exert their influence at the different stages of decision-making process?

Decision-Making Models

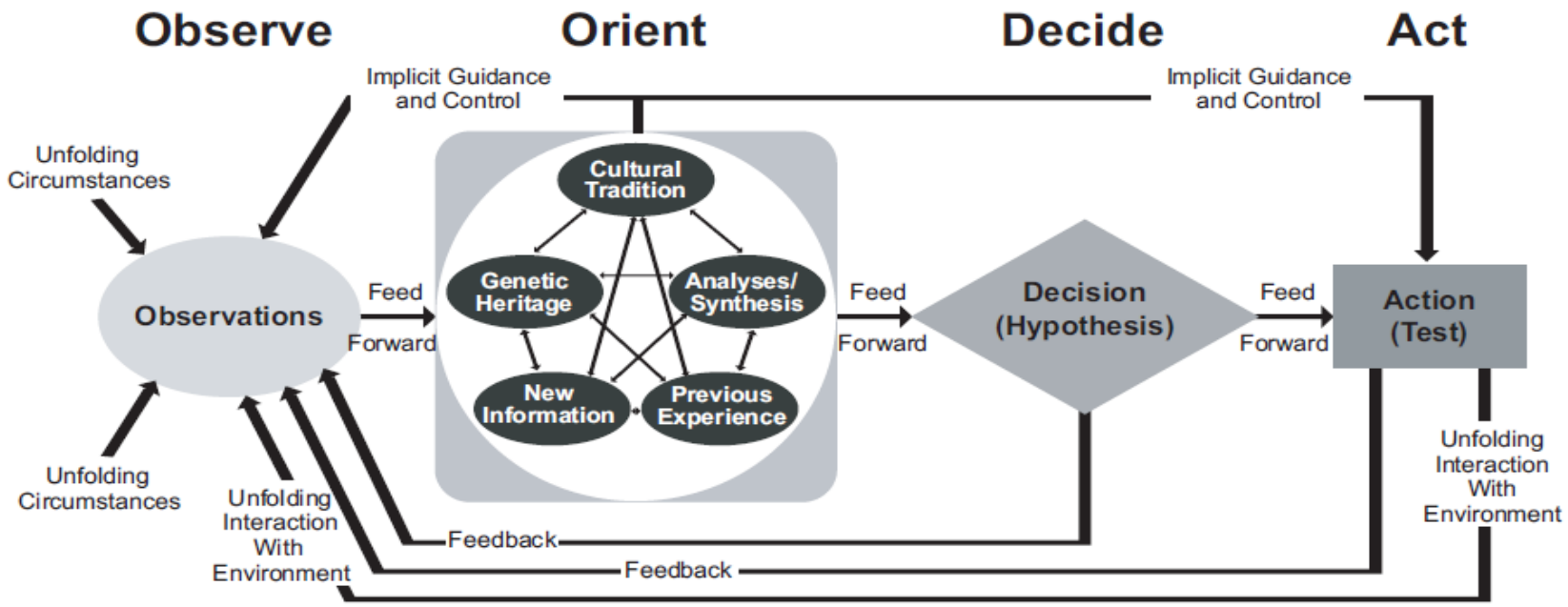
- Several models of decision-making
- Focus on models relevant in the context of architecture design decisions



OODA Loop
Observe, Orient, Decide and Act

- Decision cycle proposed by military strategist, John Boyd
  - forms the basis for the thesis

Figure 1: *OODA Loop*



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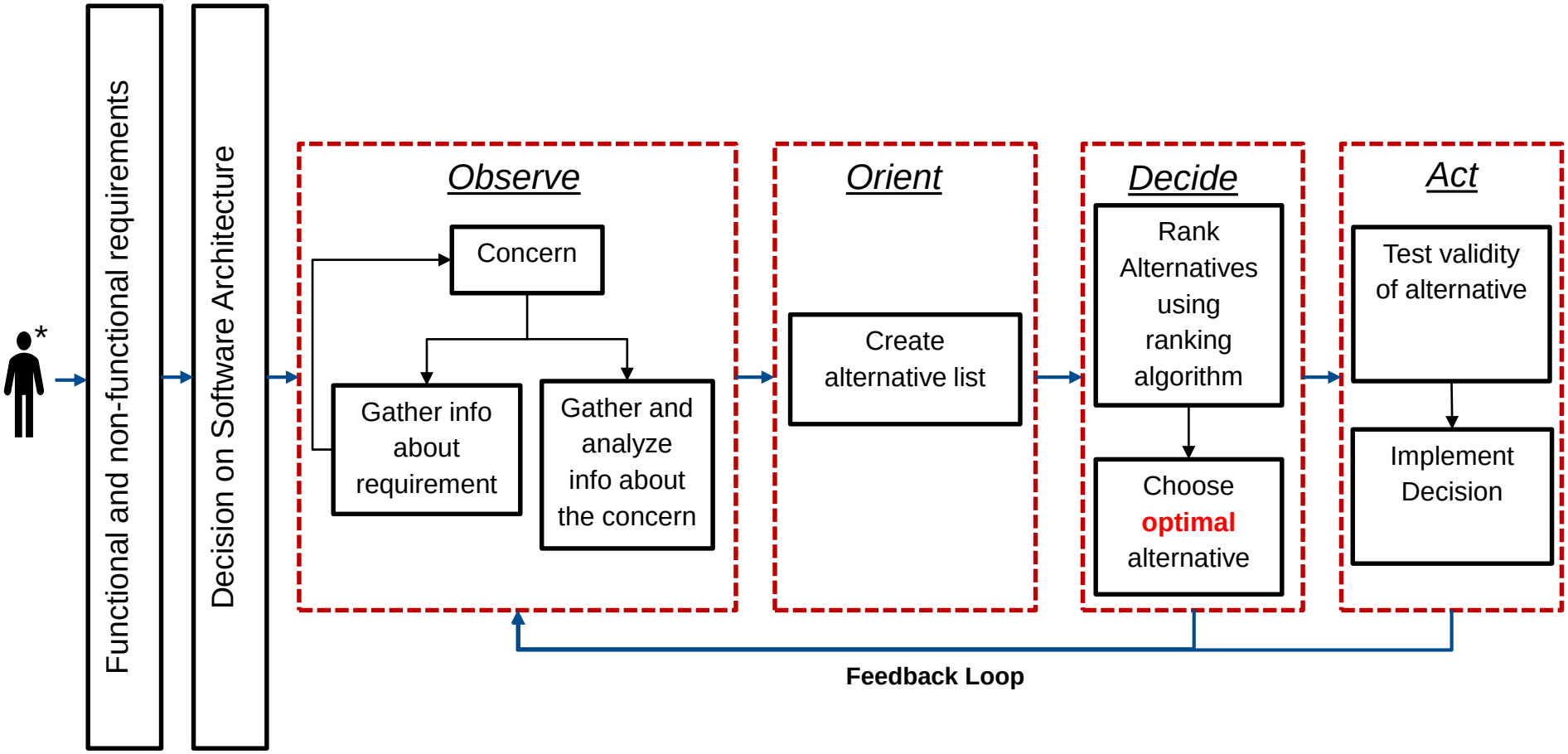
Normative Model
Rational Economic Model **

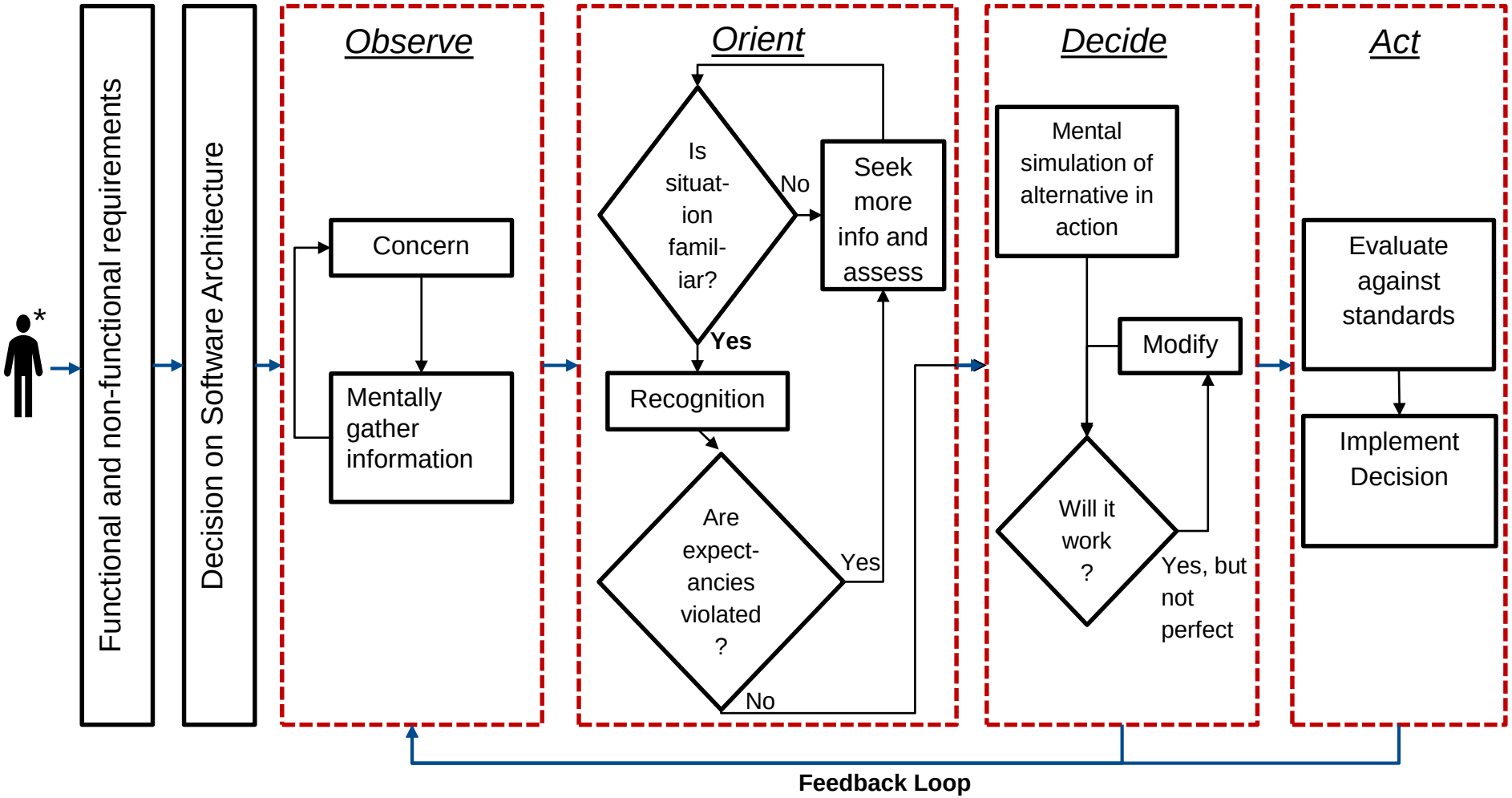


** Software Architect*

*** Adapted from Buchanan and Huczynski (2004); Drucker (2001); Miller Hickson and Wilson (2002).*

Behavioral Model

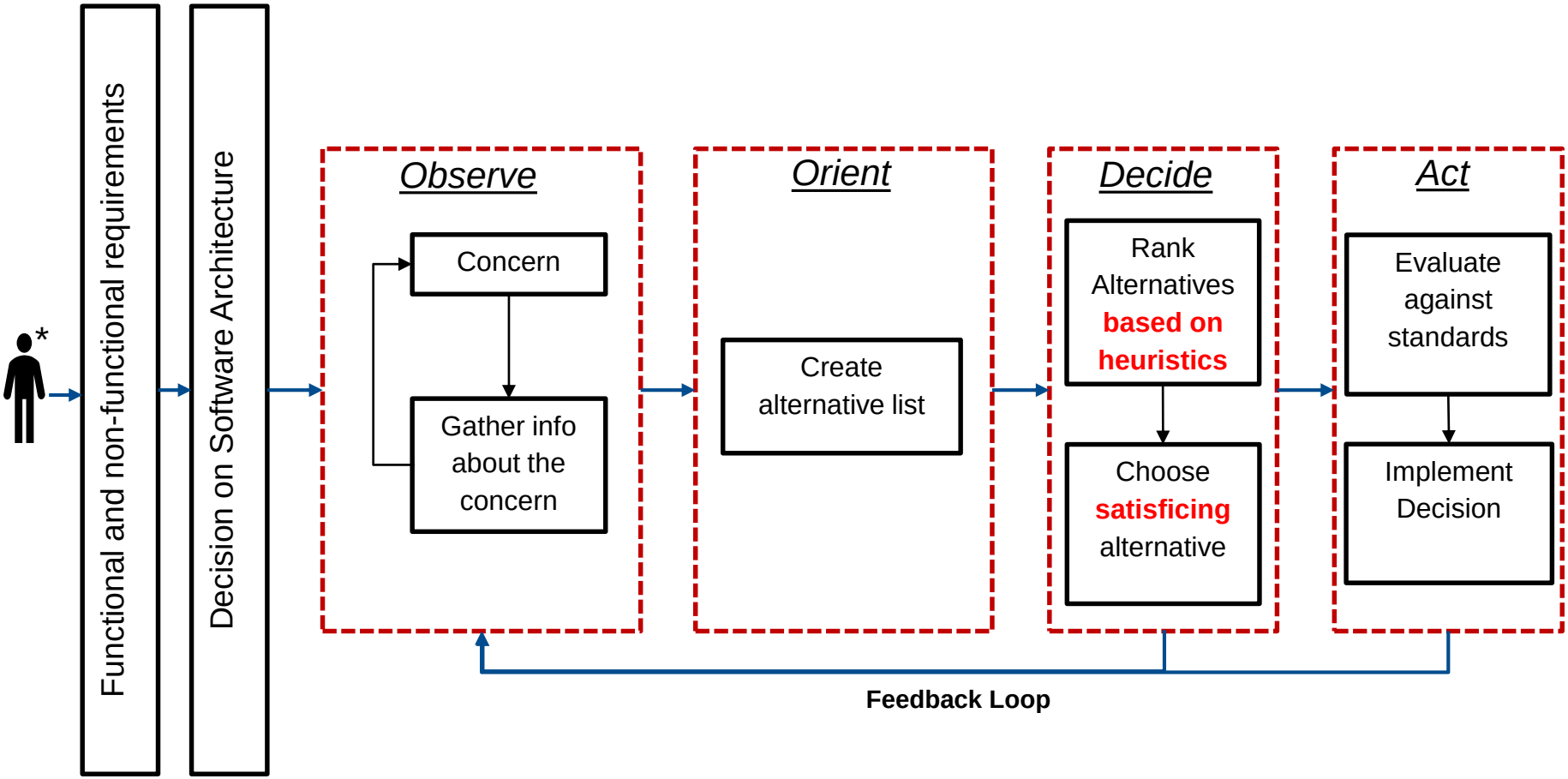
Naturalistic Decision Making – Recognition Prime Model



*Software Architect

** Adapted from : A Recognition Primed Decision (RPD) Model of Rapid Decision Making by Gary Klein (1993)

Behavioral Model
Bounded Rational **



** Software Architect*
***Adapted from Decision-making in practice: The use of cognitive heuristics by senior managers by Mark Crowder (2013)*

Research Questions

1. What are the different decision-making processes in the context of architecture design decisions?
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Cognitive Biases

- What is it?
  - Systematic deviation from rationality in judgement
  - Due to limitations in human cognitive capacity
  - Impacts decisions and judgements
- Cognitive Bias listing and classifications
  - Wikipedia lists **175** biases
  - David Arnott* lists **37** biases related to decision support systems
- Currently, **44** biases identified in the research so far from the context of architectural design decisions on the basis of OODA loop for the observe, orient and decide phase

** Cognitive biases and decision support systems development: a design science approach*

Cognitive Biases Classification

Cognitive Bias Classification for Architecture Design Decisions on basis of OODA Loop			
Biases in Observe Phase	**Biases in Orient Phase**	**Biases in Decide Phase**	**Biases in Act Phase**
Anchoring and Adjustment	Anchoring and Adjustment	Anchoring and Adjustment	Post-purchase rationalization
Completeness	Availability heuristic	Attenuation	
Confirmation	Bandwagon effect	Bandwagon effect	
Framing	Base rate fallacy	Choice-supportive bias	
Information bias	Confirmation bias	Complexity	
Levels-of-processing effect	Distinction bias	Control -- related to choice-supportive bias	
Misinformation effect	Focussing effect (same as Base rate fallacy)	Habit --subclass of anchoring	
Mode	Functional fixedness -- subclass of anchoring	Hard–easy effect -- related to complexity	
Reference	Google effect	Hyperbolic discounting	
Search	Law of the instrument -- subclass of anchoring	IKEA Effect	
Similarity	Levels-of-processing effect	Inconsistency --related to hyperbolic discounting	
	Mere exposure effect -- subclass of anchoring	Law of the instrument -- subclass of anchoring	
	Reference -- subclass of anchor	Mere exposure effect -- anchoring	
	Similarity	Negativity bias	
		Not invented here -- same as IKEA effect	
		Optimism bias -- Negativity bias related to it	
		Planning fallacy -- related to complexity	
		Pro-innovation bias -- related to optimism	
		Pseudocertainty effect	
		Test -- in mental simulation	
		Time-saving bias -- subclass of complexity	
		Triviality / Parkinson's Law of	
		Well travelled road effect -- related to complexity	

Software Architecture Design Pattern Selection
An instance of decision-making

- Systems designed using architectural design patterns
- Biased selection of design process → naturalistic decision-making
- Resulting systems are sub-optimal
- Example :
  - Wide use of MVC pattern in php due to popularity – *Bandwagon effect*
  - Alternatives : Repository, Pipes & Filters etc.

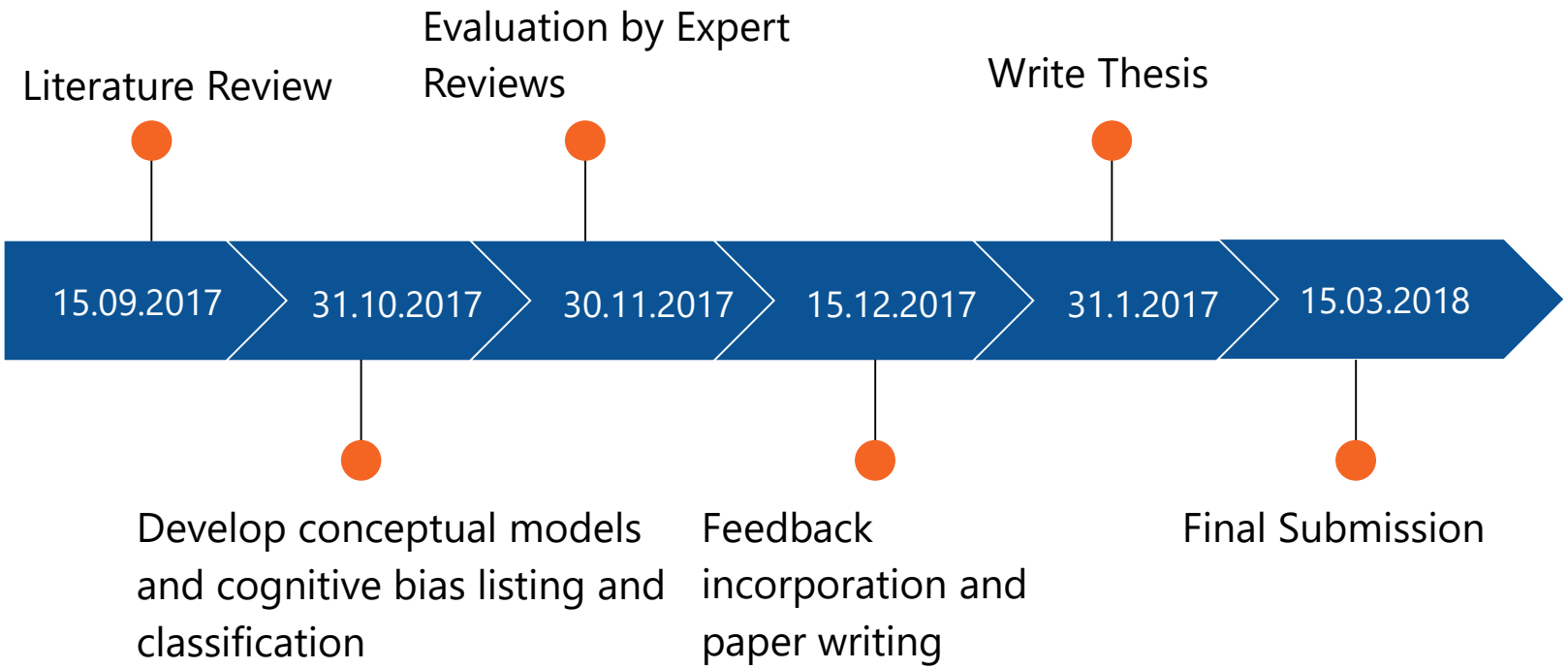
Research implications

- Formalize the decision-making process
- Assist in debiasing
  - Possessing knowledge about the biases helps us avoid it - *Availability heuristic*
  - Find evidence of biases through *confirmation bias*
- Move from *naturalistic decision-making* into *bounded rationality*
- Avoid *observe* and *orient* paralysis

Next Steps

- Evaluation of the cognitive bias classification into the OODA loop
  - First, through extractor and checker roles (Systematic Literature Review)
  - Second, by expert evaluation
- Presentation of the process diagrams and respective cognitive biases by reducing *publication bias* as much as possible

Timeline


Literature Review
Evaluation by Expert Reviews
Write Thesis
15.09.2017
31.10.2017
30.11.2017
15.12.2017
31.1.2017
15.03.2018
Develop conceptual models and cognitive bias listing and classification
Feedback incorporation and paper writing
Final Submission

Thank you