OSAKA UNIVERSITY

ICSE 2015
Firenze, Italy
May 16-24

Towards Automatic Constraints Elicitation in Pair-wise Testing Based on a Linguistic Approach: Elicitation Support Using Coupling Strength

Hiroyuki Nakagawa, Tatsuhiro Tsuchiya

RET 2015, May 18th, 2015, Firenze, Italy

Background: Pair-wise testing

- Pair-wise testing: Provides small set of test cases
  - Covers every pair of parameter values
- Constraints: define combinations that never happen
  - Determine the test space as well as parameters
- Constraints elicitation is a daunting task [Blue13]
  - Requires Manual capturing and precise definition

→ Try to realize automatic constraints elicitation

A test model

Parameter	Values
OS	Win, Mac, Linux
Browser	IE, Safari, Chrome
Plugin	Media, Quick

Constraints:

OS = "Mac" → Browser = "Safari" \|\| "Chrome"

A test suite for pair-wise testing

OS	Browser	Plugin
Win	Safari	Media
Win	Chrome	Quick
Win	IE	Media
Mac	Chrome	Media
~~Mac~~	~~IE~~	~~Quick~~
Mac	Safari	Quick
Linux	IE	Media
Linux	Safari	Quick
Linux	Chrome	Media

[Blue 13] D. Blue, I. Segall, R. Tzoref-Brill, A. Zlotnick,, "Interaction-based test-suite minimization", in ICSE 2013.

Approach: Measure coupling strength

- Our goal: identify which combinations of parameters contain constraints
  - Assumption: most constraints are caused by strong relationships between parameters

- Define a metric *Coupling strength* : σ (f, g)
  - Measures how strong the relationship between parameters is

- Focus on the distance between parameters in document
  - Requirements document is an appropriate document
  - Relative parameters tend to be located near in the document

$$\sigma(f, g) \propto 1/d(f, g)$$

Distance between parameters

- Def. $$d(f,g) = \frac{\Sigma_{p \in P^F} \ \min_{q \in P^G}(|p-q|) + \Sigma_{q \in P^G} \ \min_{p \in P^F}(|q-p|)}{|P^F| + |P^G|}$$
  - F, G: word groups
    - Members: parameter themselves and their values

Parameter	Values
OS	Win, Mac, Linux
Browser	IE, Safari, Chrome
Plugin	Media, Quick

f: OS, g: Browser

F: {OS, Win, Mac, Linux}
G: {Browser, IE, Safari, Chrome}

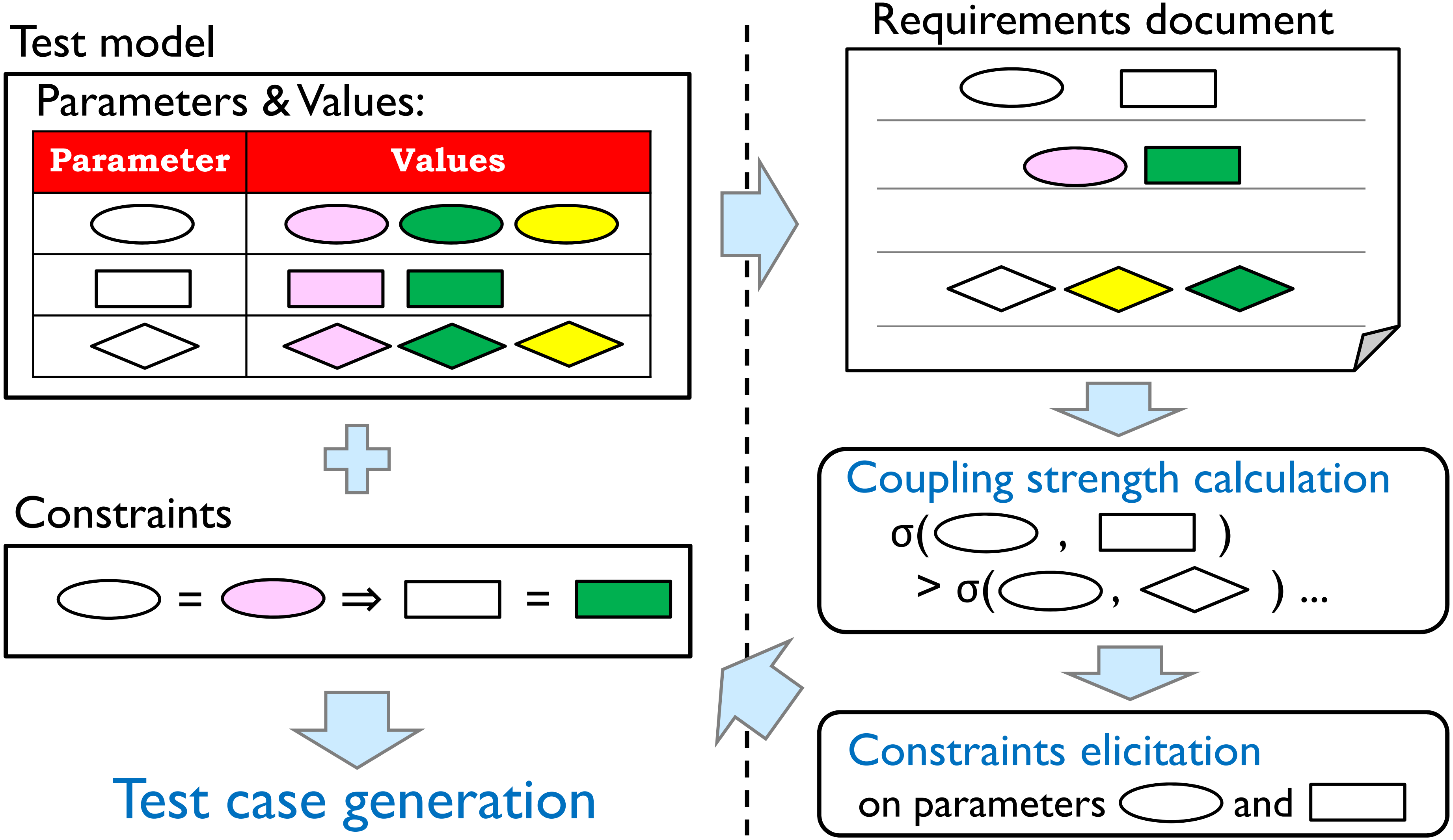
  - P^X (= $<p^X_1, p^X_2, \ldots, p^X_n>$) :
    - Positions of word x (∈ X) in the document

> This application should work with the two most recent versions of the following browsers: Chrome, Safari, and IE. Make sure cookies and JavaScript are turned on for the browser. …

G: {Browser, IE, Safari, Chrome}

P^G = $<14, 15, 16, 18, 29, \ldots>$

Overview


Test model
Parameters & Values:
Parameter
Values
Constraints
= ⇒ =
Test case generation
Requirements document
Coupling strength calculation
σ(,)
> σ(,) …
Constraints elicitation
on parameters and

Case study

- ATM system example [Bjork]

Parameter	Values
Transaction	Withdrawal, Deposit, Transfer, Balance inquiry
Account (A)	Checking, Savings, Money market
Account (B)	Checking, Savings, Money market, Not selected
Amount	$20, $40, $60, $100, $200, None
Card	Valid, Invalid, Unreadable
PIN	Correct, Incorrect, Non-enterable

- Possible constraints
  - (a) Transaction = “Balance inquiry” → Account (B) = “Not selected”
  - (b) Transaction = “Balance inquiry” → Amount = “None”
  - (c) Card = “Invalid” || “Unreadable” → PIN = “Non-enterable”

[Bjork] R. C. Bjork, "ATM simulation links,“ http://www.cs.gordon.edu/courses/cs211/ATMExample/

Experimental results

σ (f, g)		g				
		Transaction	Account	Amount	Card	PIN
f	Transaction	—	0.264	0.275	0.261	0.199
	Account	0.127	—	0.532	0.208	0.132
	Amount	0.146	0.586	—	0.143	0.124
	Card	0.178	0.293	0.183	—	0.346
	PIN	0.164	0.225	0.193	0.418	—

- Extracted combinations
  - (A1) Transaction → Amount, Account, Card ⇒ (a), (b)
  - (A2) Account → Amount
  - (A3) Amount → Account
  - (A4) Card → PIN, Account ⇒ (c)
  - (A5) PIN → Card

Conclusions

- We presented the first step of our approach to supporting constraints elicitation
  - Provides automatic constraint schema extraction
  - Estimates coupling strength from the requirements document
- Preliminary results demonstrate the possibility of our approach
- Future work
  - Elaboration of the elicitation mechanism
    - Extract concrete constraints
  - Other applications of σ (f, g) to the test design
    - E.g.) variable strength interaction testing