JOHANNES KEPLER
UNIVERSITY LINZ

Master Thesis Presentation

Migrating Mathematical Programs to Web Interface Frameworks

Hsuan-Ming Chen

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Advisor: Professor Wolfgang Schreiner
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Introduction

- The RISCAL software
- Developed in Java
- Challenge: Users have to locally install Java, the Standard Widget Toolkit (SWT) libraries, and additional packages to run RISCAL.
- Solution: Software as a Service (SaaS)

RISCAL

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RISC Algorithm Language (RISCAL)

File: /home/parallels/Desktop/RISCAL-2.0/spec/gcd.txt

```
1  // ---------------------------------------------------------------------
2  // Computing the greatest common divisor by the Euclidean Algorithm
3  // ---------------------------------------------------------------------
4
5  val N: ℕ;
6  type nat = ℕ[N];
7
8  pred divides(m:nat,n:nat) ⇔ ∃p:nat. m·p = n;
9
10 fun gcd(m:nat,n:nat): nat
11   requires m ≠ 0 ∨ n ≠ 0;
12 = choose result:nat with
13     divides(result,m) ∧ divides(result,n) ∧
14     ¬∃r:nat. divides(r,m) ∧ divides(r,n) ∧ r > result;
15
16 val g:nat = gcd(N,N-1);
17
18 theorem gcd0(m:nat) ⇔ m≠0 ⇒ gcd(m,0) = m;
19 theorem gcd1(m:nat,n:nat) ⇔ m ≠ 0 ∨ n ≠ 0 ⇒ gcd(m,n) = gcd(n,m);
20 theorem gcd2(m:nat,n:nat) ⇔ 1 ≤ n ∧ n ≤ m ⇒ gcd(m,n) = gcd(m%n,n);
21
22 proc gcdp(m:nat,n:nat): nat
23   requires m≠0 ∨ n≠0;
24   ensures result = gcd(m,n);
25 {
26   var a:nat := m;
27   var b:nat := n;
28   while a > 0 ∧ b > 0 do
29     invariant a ≠ 0 ∨ b ≠ 0;
30     invariant gcd(a,b) = gcd(old_a,old_b);
31     decreases a+b;
32   {
33     if a > b then
34       a := a%b;
35     else
36       b := b%a;
37   }
38   return if a = 0 then b else a;
39 }
40
41 fun gcdf(m:nat,n:nat): nat
42   requires m≠0 ∨ n≠0;
43   ensures result = gcd(m,n);
44   decreases m+n;
45 = if m = 0 then n
46   else if n = 0 then m
47   else if m > n then gcdf(m%n, n)
     else gcdf(m, n%m);
```

Analysis

Translation: ☑ Nondeterminism Default Value: 0 Other Values:

Execution: ☑ Silent Inputs: Per Mille: Branches:

Parallelism: ☐ Multi-Threaded Threads: ☐ Distributed Servers:

Operation: gcdp(ℤ,ℤ)

```
RISC Algorithm Language 2.0 (June 18, 2018)
http://www.risc.jku.at/research/formal/software/RISCAL
(C) 2016-, Research Institute for Symbolic Computation (RISC)
This is free software distributed under the terms of the GNU GPL.
Execute "RISCAL -h" to see the available command line options.
---------------------------------------------------------------------
Reading file /home/parallels/Desktop/RISCAL-2.0/spec/gcd.txt
Using N=20.
Computing the value of g...
Type checking and translation completed.
Executing gcdp(ℤ,ℤ) with all 441 inputs.
96 inputs (95 checked, 1 inadmissible, 0 ignored)...
363 inputs (362 checked, 1 inadmissible, 0 ignored)...
Execution completed for ALL inputs (4735 ms, 440 checked, 1 inadmissible).
```

State of the Art

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- Successful mathematical software systems
  - e.g. Mathematica, MATLAB, RStudio, Maple, Geogebra
- Possible web interface frameworks
  - Remote Application Platform (RAP)
  - Java Server Pages (JSP)
  - OpenXava
  - Google Web Toolkit (GWT)

State of the Art
- Successful Example

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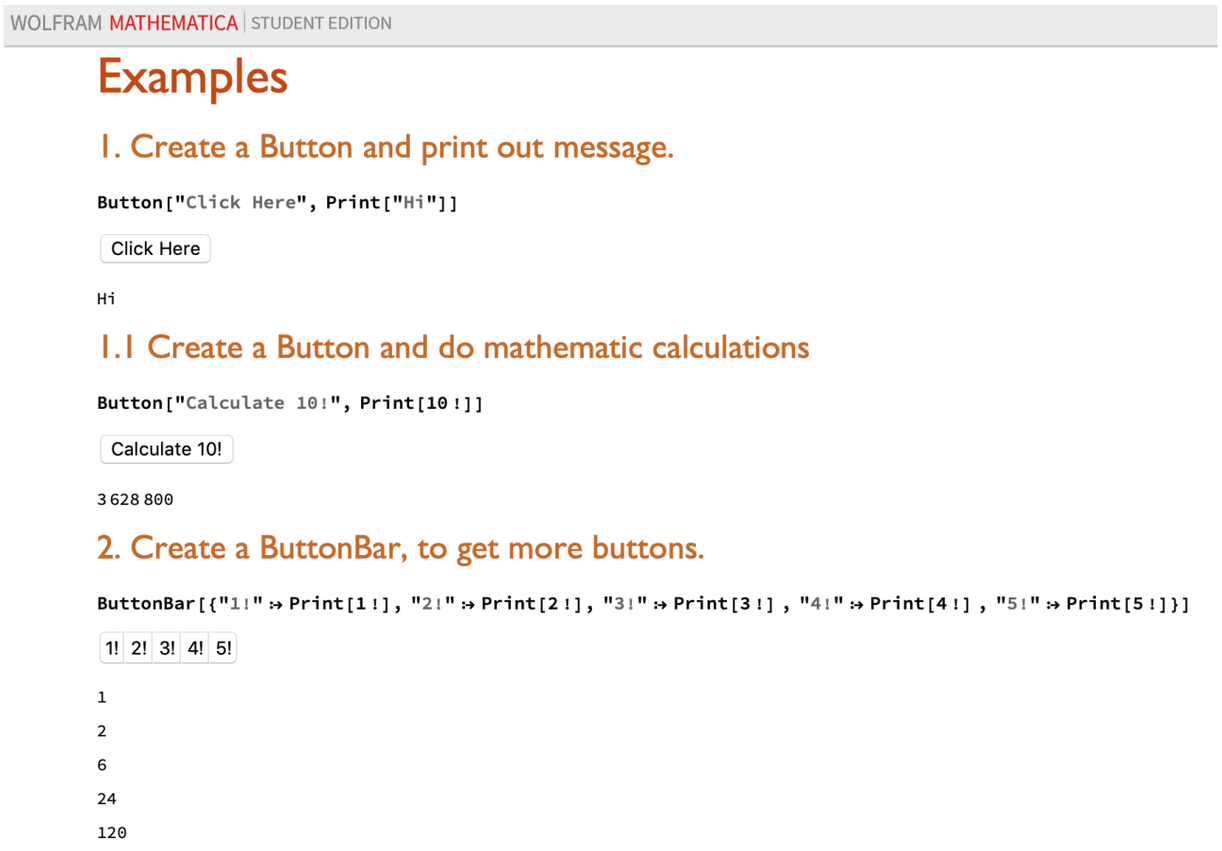
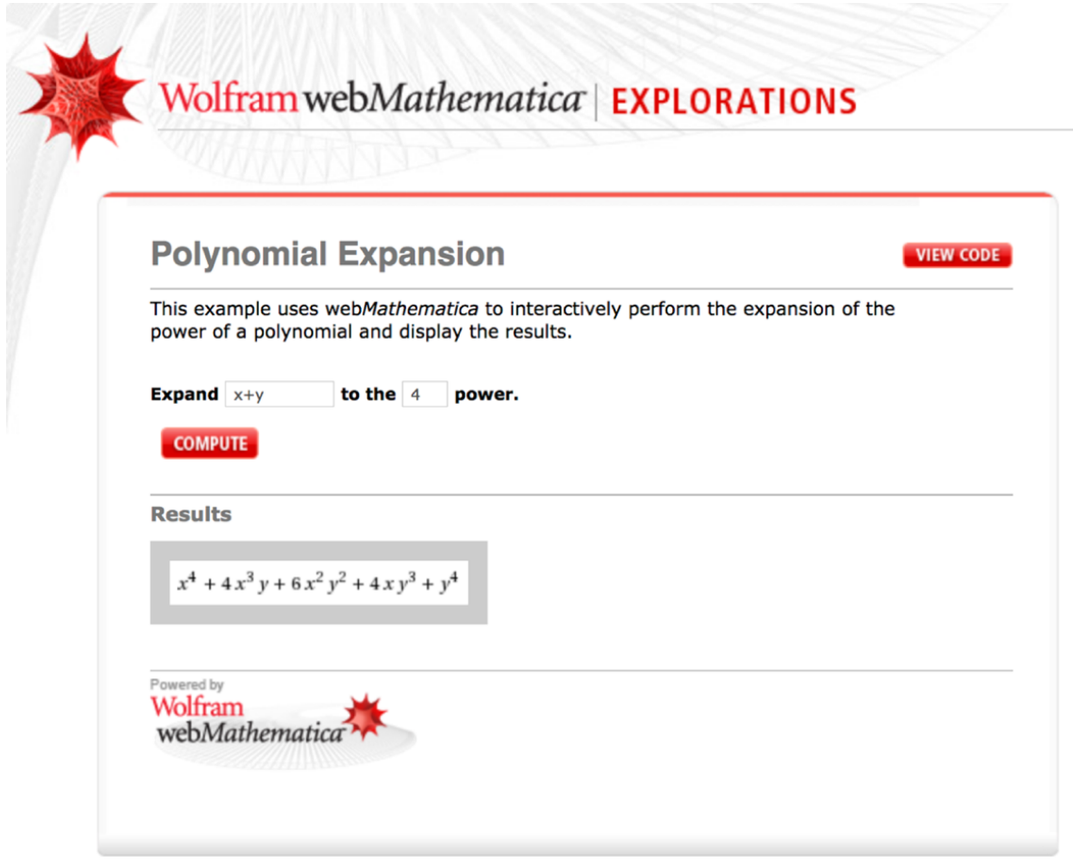


Desktop Version



Web Version

Evaluation

- Installation & Portability
- Support & Popularity
- Aesthetics & Usability
- Mobility & Browser Support
- Performance
- Development Process

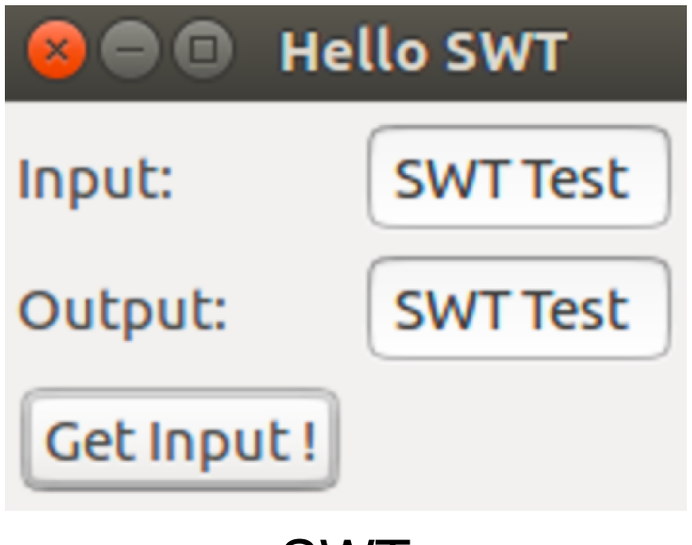
- Client-Side Features
  - Rich Text Editor Panel
  - Input & Output Panel
  - Menus
  - File Selection Dialog
  - Selection Boxes
  - Pop Up Panels and Windows
  - Tree-structured Panels
  - Built-in Browsing

(Marks are in the range 1-4 where 4 means the best and 1 means the worst.)

Evaluation

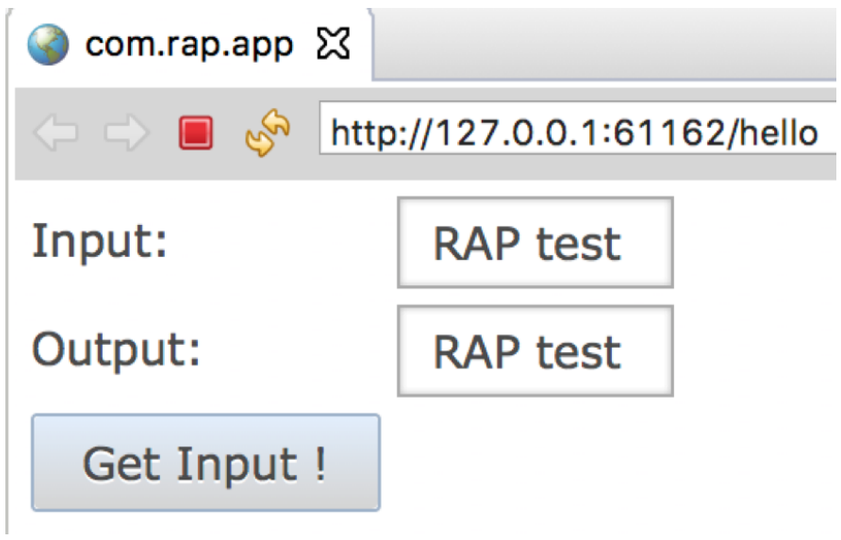
Marks for	Installation & Portability	Support & Popularity	Aesthetics & Usability	Mobility & Browser Support	Performance
RAP	3	3	4	3	3
JSP	4	4	2	4	4
OpenXava	1	1	-	-	-
GWT	2	2	3	2	2

Evaluation
- Development Process

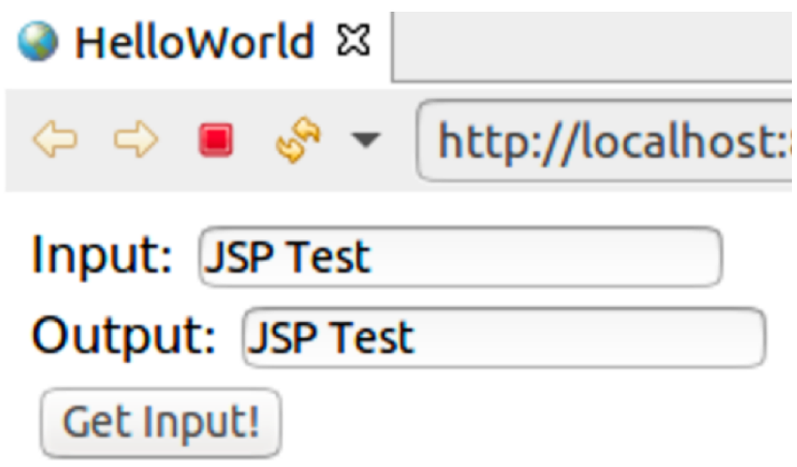


SWT

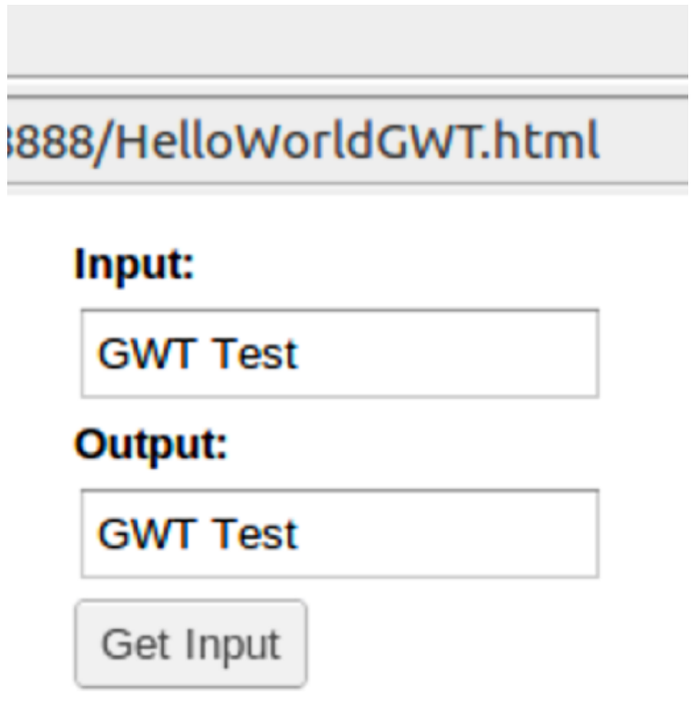
	Marks
RAP	4
JSP	3
GWT	2



RAP



JSP



GWT

Evaluation
- Client-Side Features

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Marks for	Rich Text Editor Panel	Input & Output Panel	Menus	File Selection Dialog	Selection Boxes	Pop Up Panel & Windows	Tree-Structured Panel	Built-in Browsing
RAP	3	4	4	1	4	4	4	4
JSP	4	4	2	1	4	4	2	1
GWT	4	4	4	1	4	4	4	1

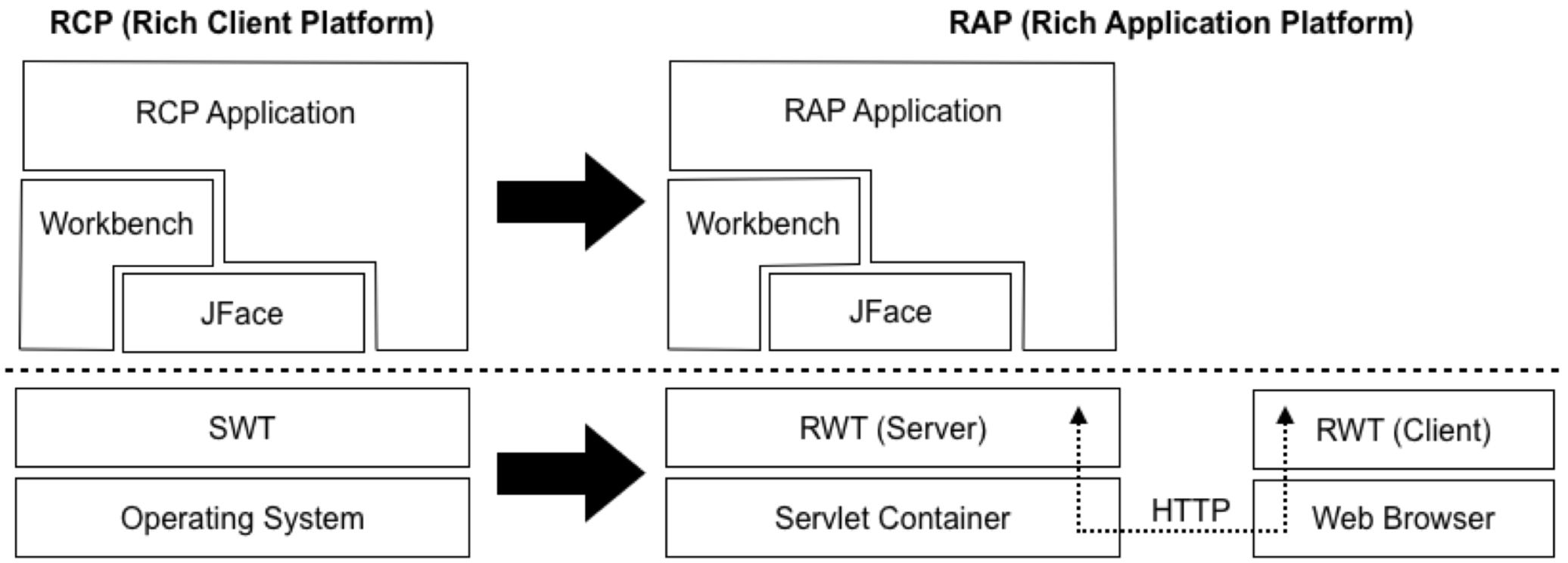
Evaluation
- Summary

- RAP is selected as the best candidate.

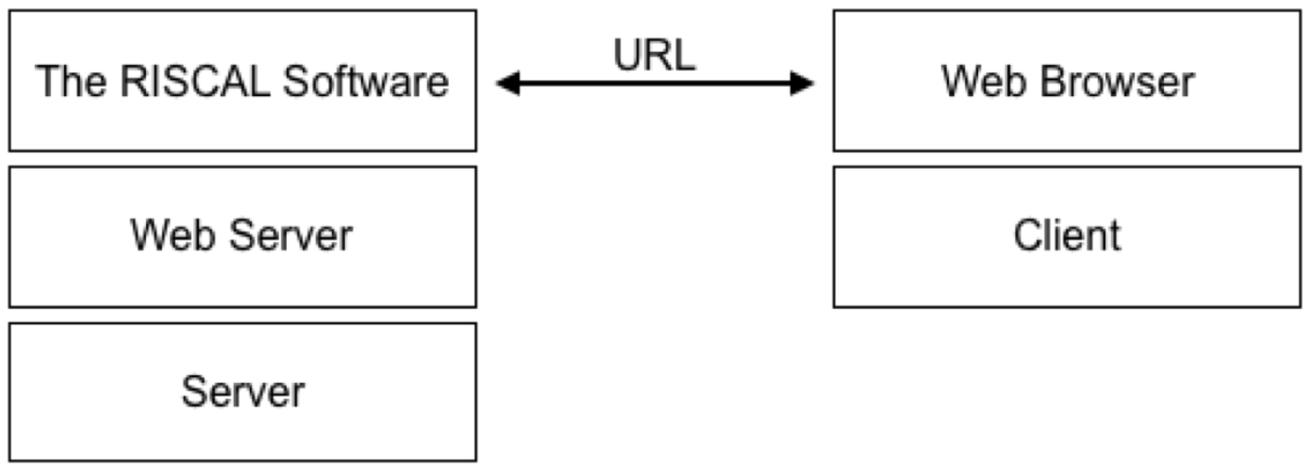
- RAP performs better in client-side features.

Marks for	Installation & Portability	Support & Popularity	Aesthetics & Usability	Mobility & Browser Support	Performance	Development Process	Client-Side Features	Summary
RAP	3	3	4	3	3	4	3.5	23.5
JSP	4	4	2	4	4	3	2.75	23.75
GWT	2	2	3	2	2	2	3.25	16.25

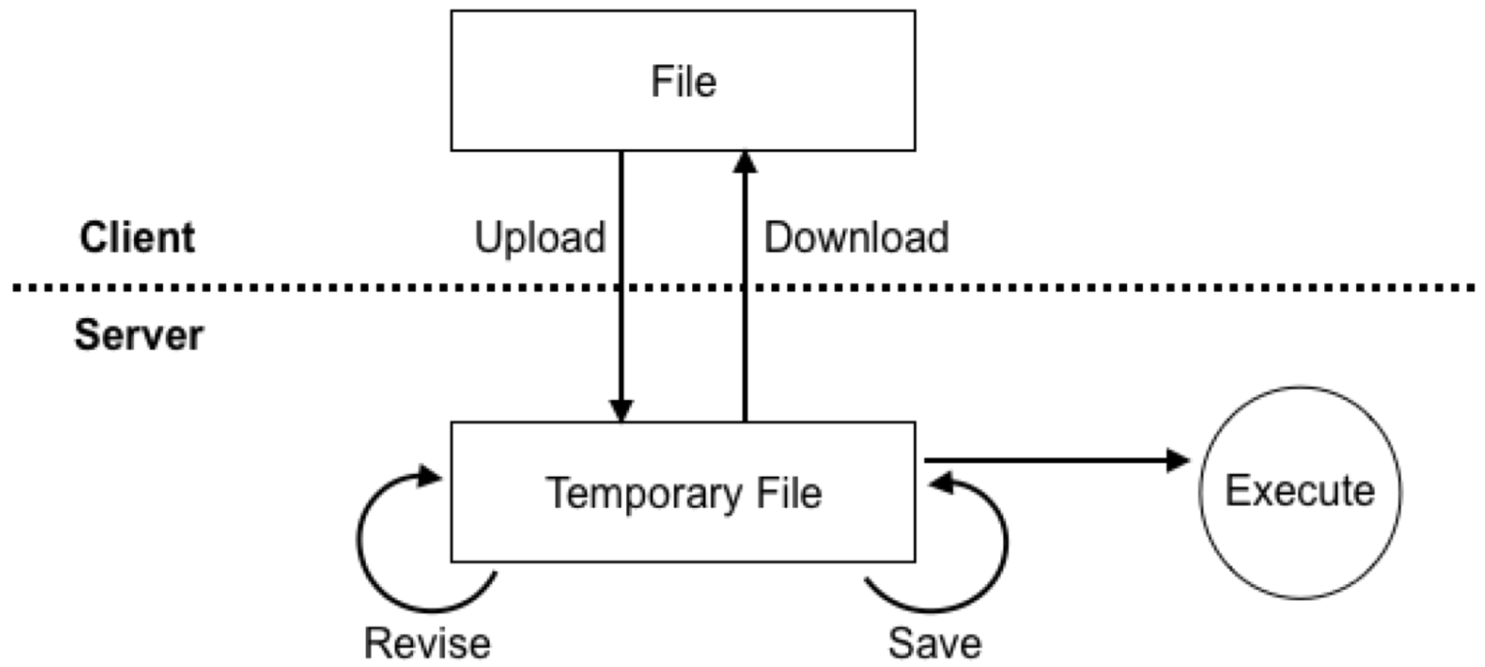
Implementation
- RCP/RAP Architecture



Implementation
- System Architecture



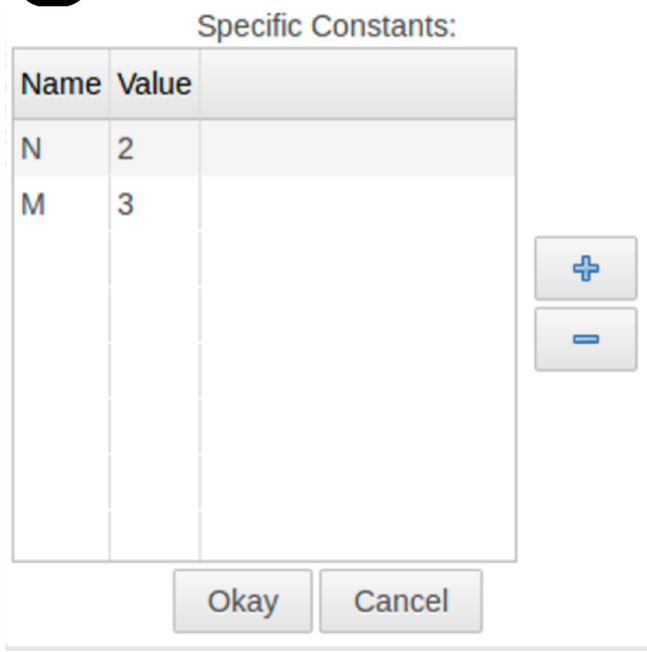
System Architecture



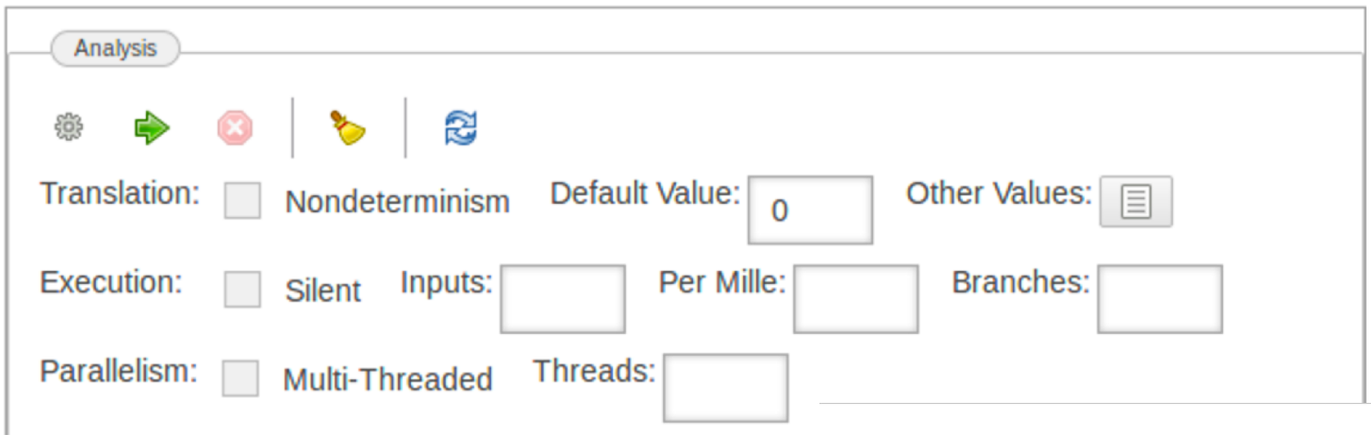
Scenario of File I/O

Implementation
- User Interface Challenges

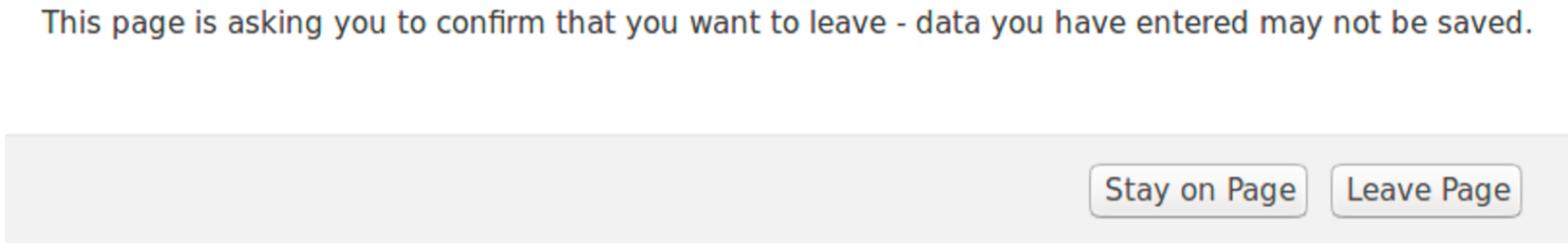
- “Other Value” Dialog (Package error fixed)
- Input Fields (Runtime bugs fixed)
- Exit Confirmation Dialog (Runtime bugs fixed)



Other Value Dialog



Input Fields



Exit Confirmation Dialog

Implementation
- Known Bugs & Unimplemented Features

- Unimplemented Features
    - Error detection (widgets not support)
    - Undo/Redo feature (widgets not support)
- Known Bugs
    - Accelerator (a.k.a keyboard shortcuts)
    - Output panel extrudes the other panels

Implementation
- Deployment on the Server

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- Web server (Tomcat or Jetty) required
- Configuration of a RAP program
    - META-INF/MANIFEST.MF: defines the required plugins, packages to import, runtime classes path, execution environments, and extensions.
    - OSGI-INF/contribution.xml: specifies the provided services and the implementation classes in the servlet.
    - WEB-INF/launch.ini: describes the properties which are loaded to start the framework.
    - WEB-INF/web.xml: indicates the servlet description and the configuration of the parameters.
    - build.properties: defines the libraries to be built and the source folders which should be compiled. This file is connected to the MANIFEST.MF file.
- Exported as a WAR file

Demo

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10.211.55.10

/manager RISCAL

Tomcat Web Application Manager

Message:	OK

Manager			
List Applications	HTML Manager Help	Manager Help	Server Status

Applications					
Path	Version	Display Name	Running	Sessions	Commands
/	*None specified*	Welcome to Tomcat	true	0	Start Stop Reload Undeploy Expire sessions with idle ≥ 30 minutes
/docs	*None specified*	Tomcat Documentation	true	0	Start Stop Reload Undeploy Expire sessions with idle ≥ 30 minutes
/examples	*None specified*	Servlet and JSP Examples	true	0	Start Stop Reload Undeploy Expire sessions with idle ≥ 30 minutes
/host-manager	*None specified*	Tomcat Host Manager Application	true	0	Start Stop Reload Undeploy Expire sessions with idle ≥ 30 minutes
/manager	*None specified*	Tomcat Manager Application	true	1	Start Stop Reload Undeploy Expire sessions with idle ≥ 30 minutes
/riscal	*None specified*		true	1	Start Stop Reload Undeploy Expire sessions with idle ≥ 30 minutes

Conclusions

- RISCAL is successfully ported to a web platform
- Define criteria for the evaluation of web frameworks with respect to the requirements of RISCAL
- Evaluate various web interface frameworks according to the criteria
- Demonstrate the challenges while performing developments
- A reference for developers