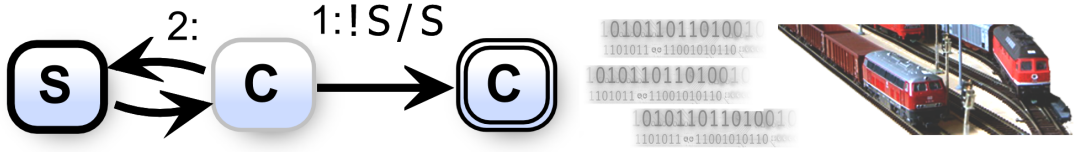
SCCharts: The Railway Project Report



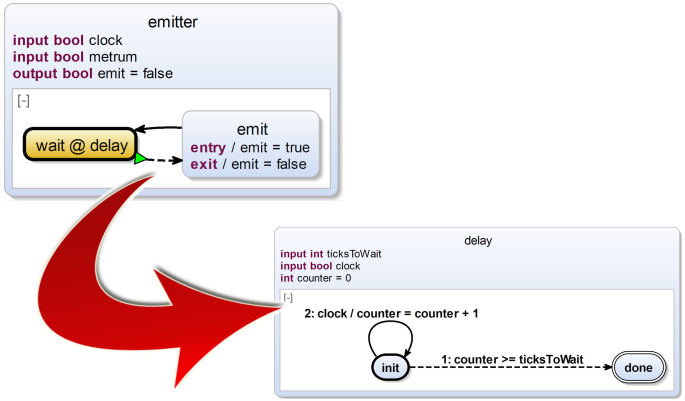
Steven Smyth

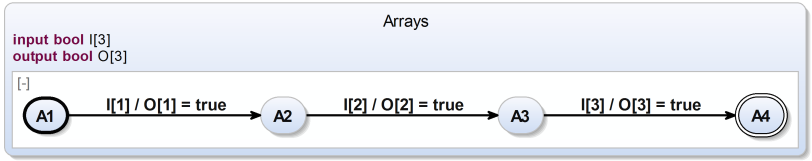
Real-Time Systems and Embedded Systems Group
Department of Computer Science
Kiel University, Germany

Oberseminar, SoSem 14
27.08.2014

Overview

SCCharts Extensions - Roadmap





Category	Feature	OSem	Rail	Status
Core	Referenced SCCharts	✓		
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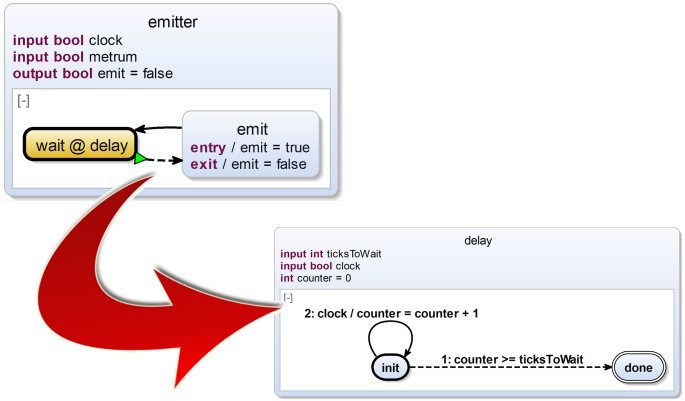
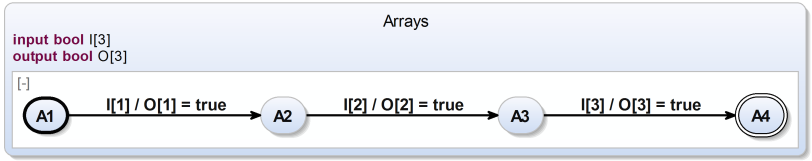
Declaration	Arrays	✓		
	Const	✓		
	Extern			
	Structs	~		
Hostcode	Function calls	✓		

SCCharts Extensions - Roadmap





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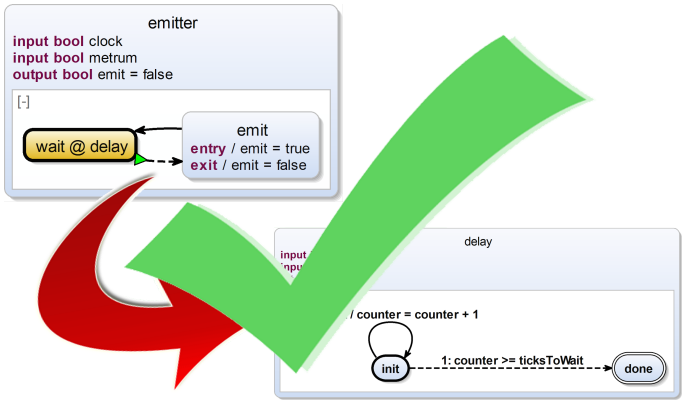

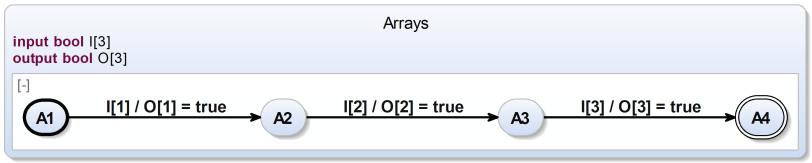

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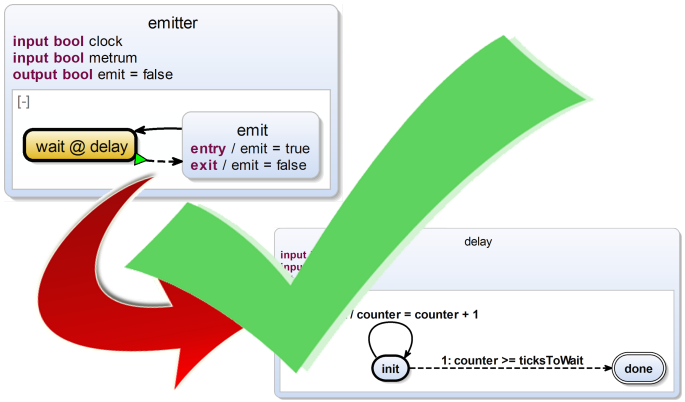

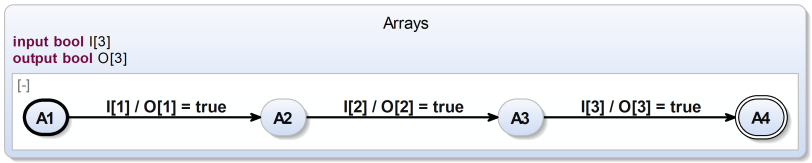

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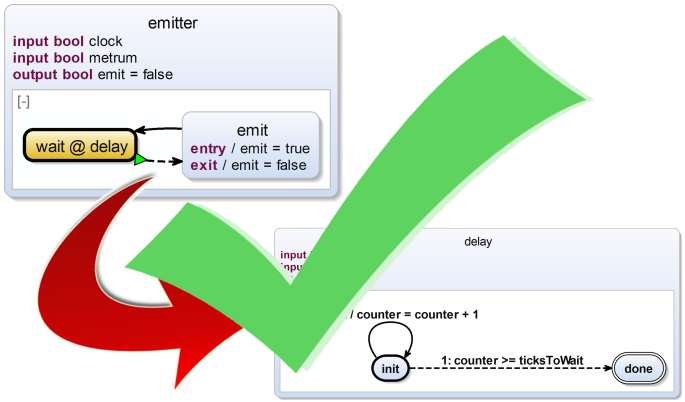

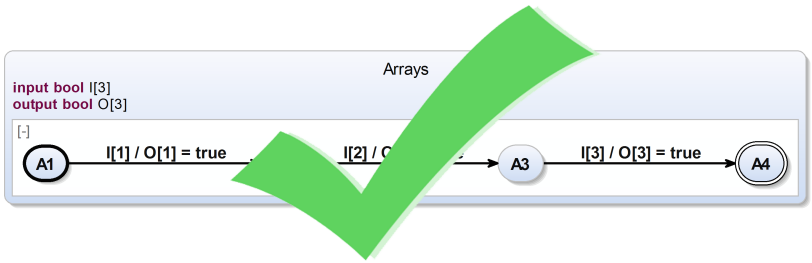

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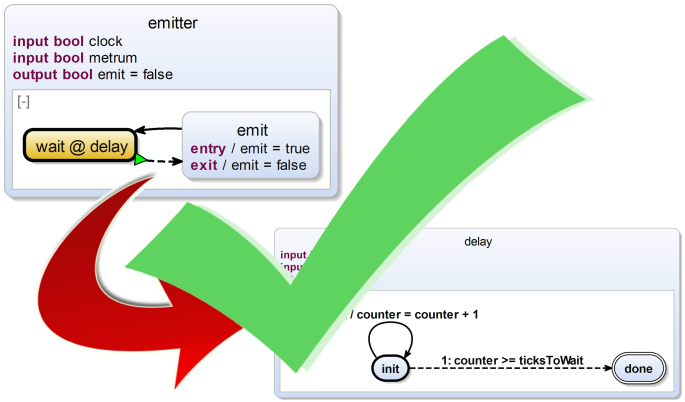

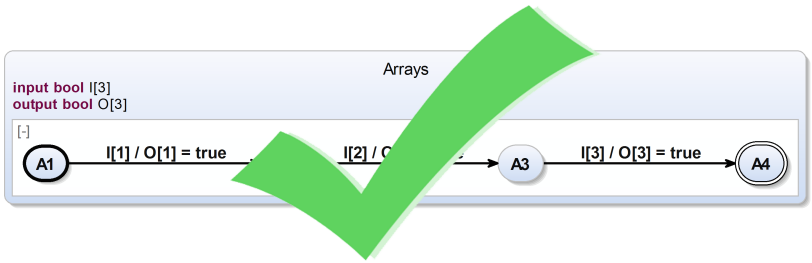

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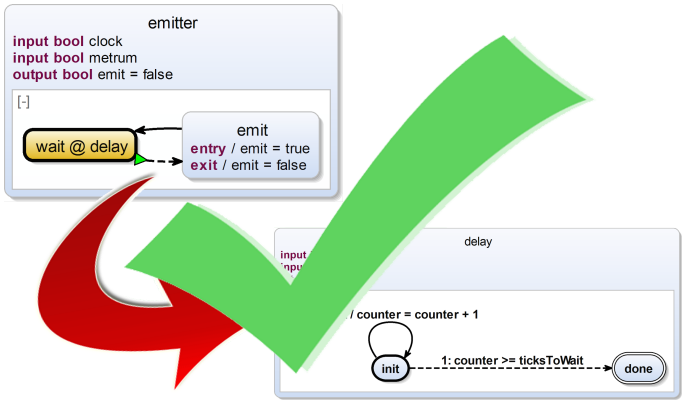

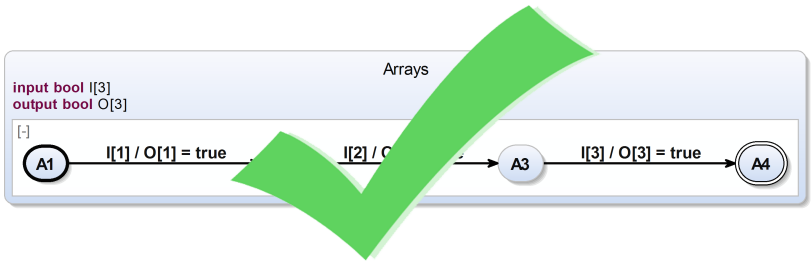

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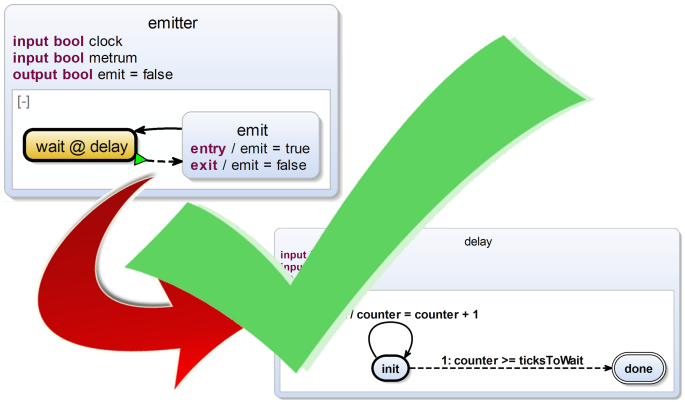

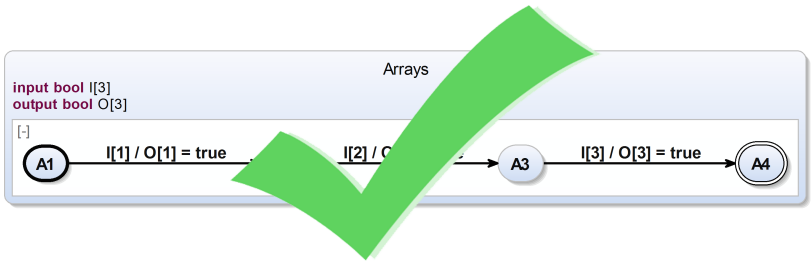

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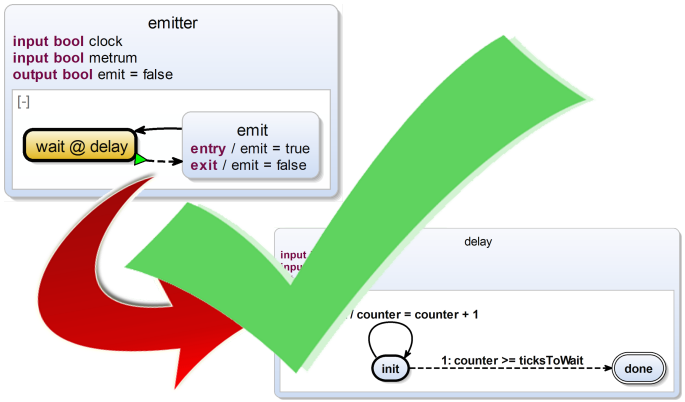

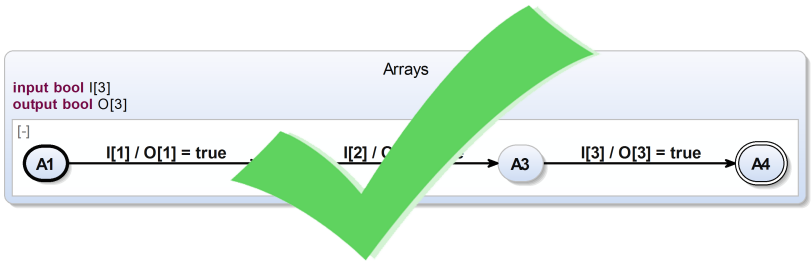

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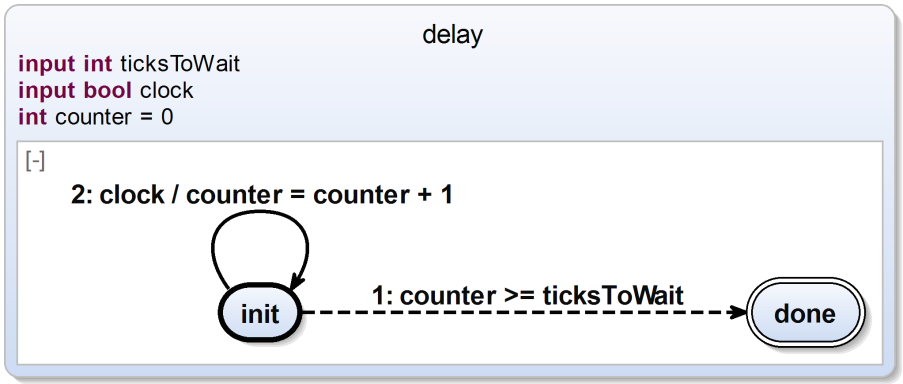
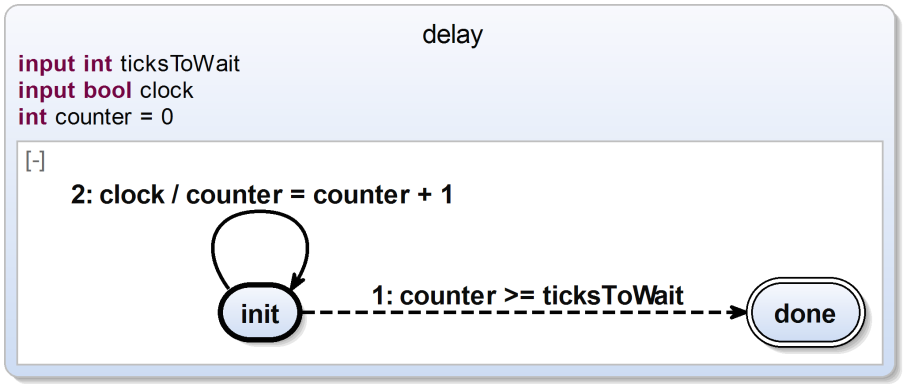
Hostcode	Function calls	✗		✓

SCCharts Extensions - Referenced SCCharts




```
1  scchart delay {
2    input int ticksToWait;
3    input bool clock;
4    int counter = 0;
5
6    initial state init
7    --> done immediate with
8      counter >= ticksToWait
9    --> init with
10     clock / counter = counter + 1;
11
12   final state done;
13 }
```

SCCharts Extensions - Referenced SCCharts

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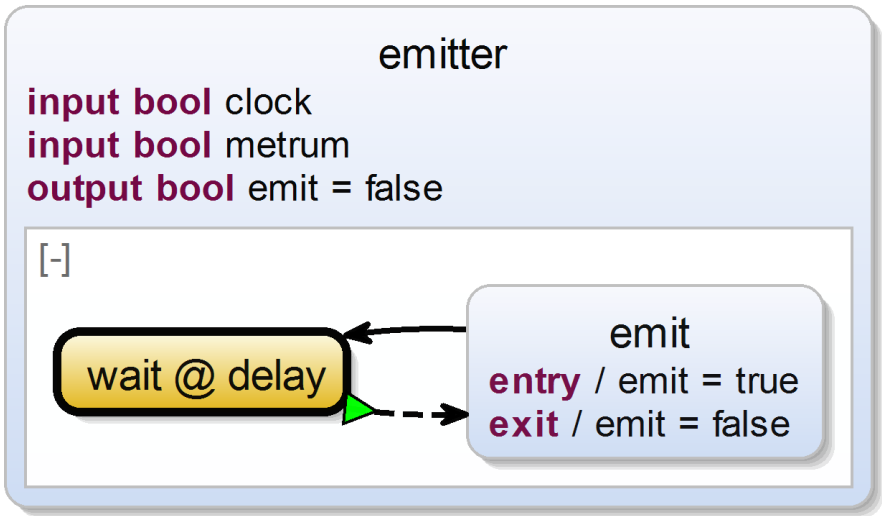
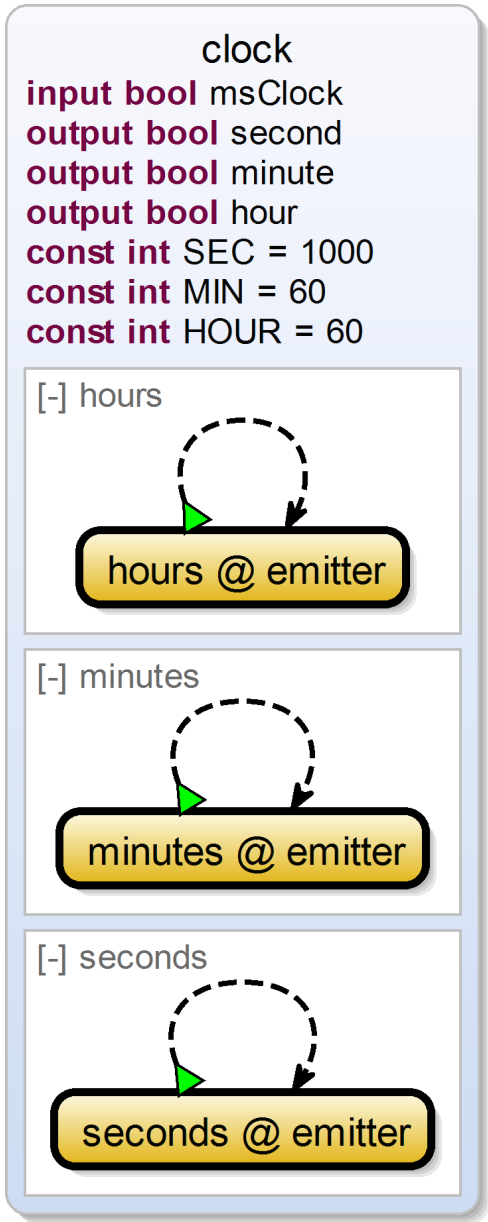


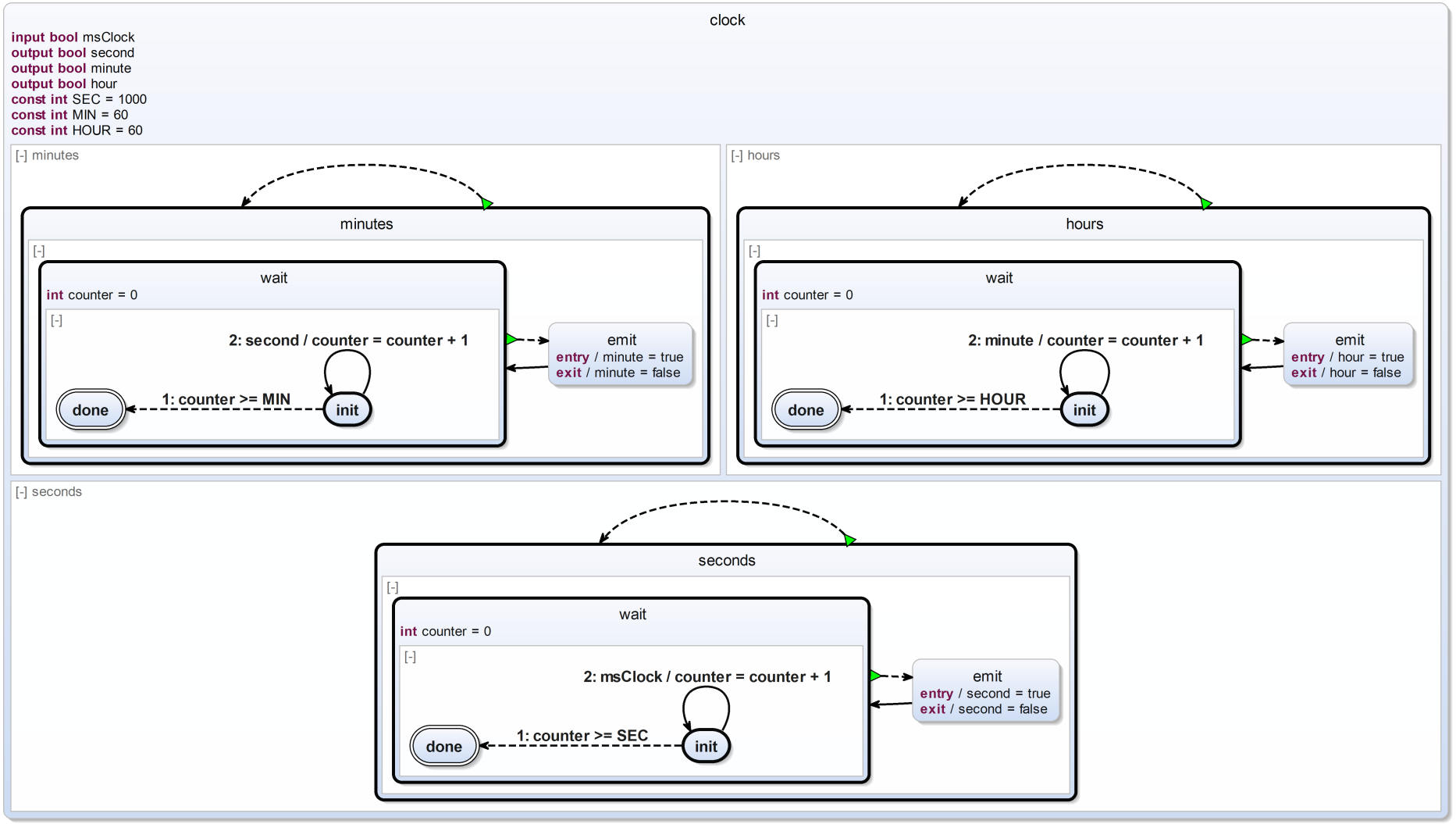

```
1  scchart emitter {
2    input bool clock;
3    input bool metrum;
4    output bool emit = false;
5
6    initial state wait
7    references delay
8    bind clock to clock,
9         ticksToWait to metrum
10   >-> emit;
11
12   state emit {
13     entry / emit = true;
14     exit / emit = false;
15   }
16   --> wait;
17 }
```

SCCharts Extensions - Referenced SCCharts



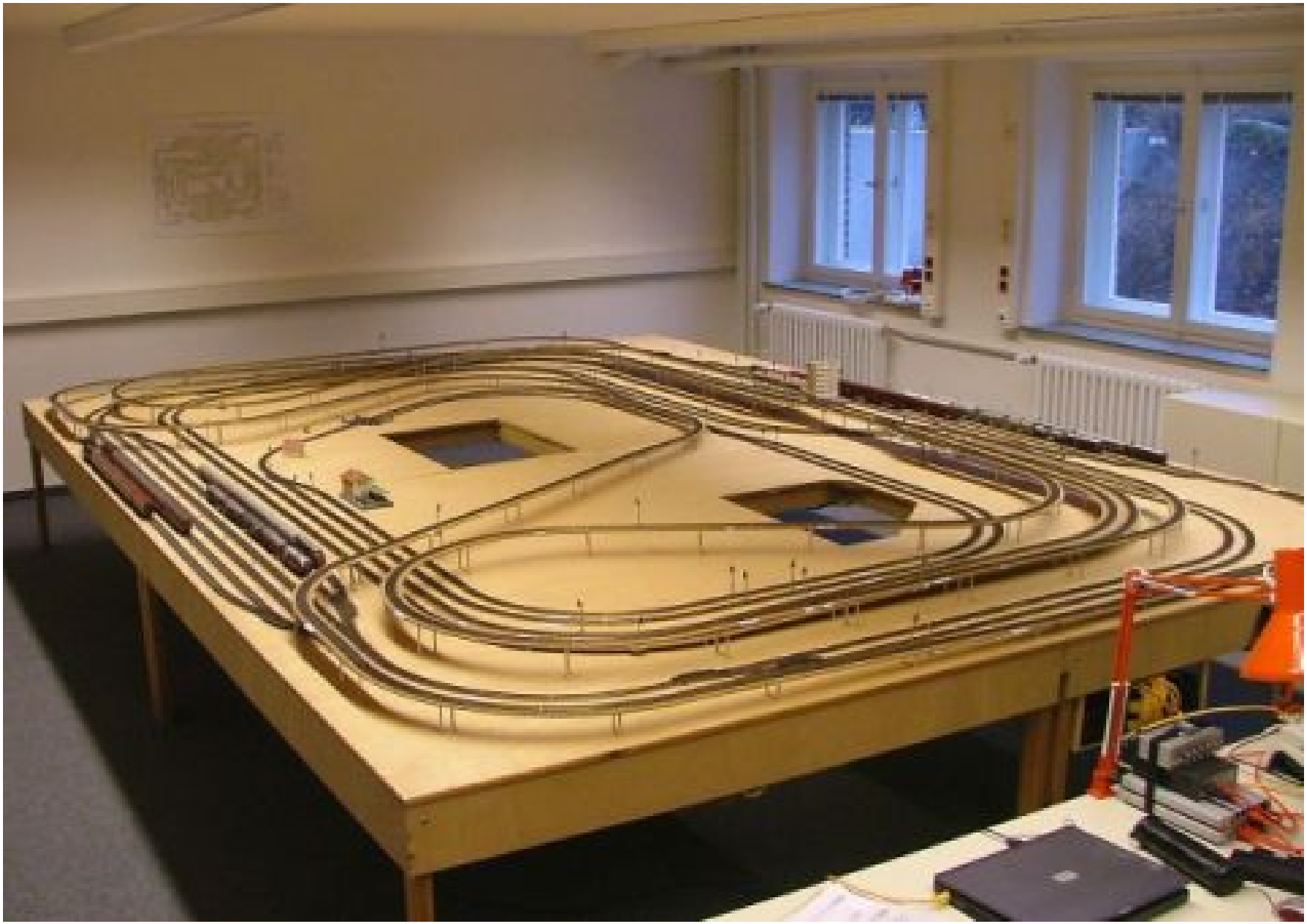

```
1  scchart clock {
2    input bool msClock;
3    output bool second, minute, hour;
4    const int SEC = 1000, MIN = 60,
5              HOUR = 60;
6
7    region seconds:
8
9    initial state seconds
10   references emitter
11   bind clock to msClock,
12        metrum to SEC,
13        emit to second
14   >-> seconds;
15
16   region minutes:
17
18   initial state minutes
19   references emitter
20   bind clock to second,
21        metrum to MIN,
22        emit to minute
23   >-> minutes;
24
25   region hours:
26
27   initial state hours
28   references emitter
29   bind clock to minute,
30        metrum to HOUR,
31        emit to hour
32   >-> hours;
33 }
```

SCCharts Extensions - Referenced SCCharts



Overview

Project Overview

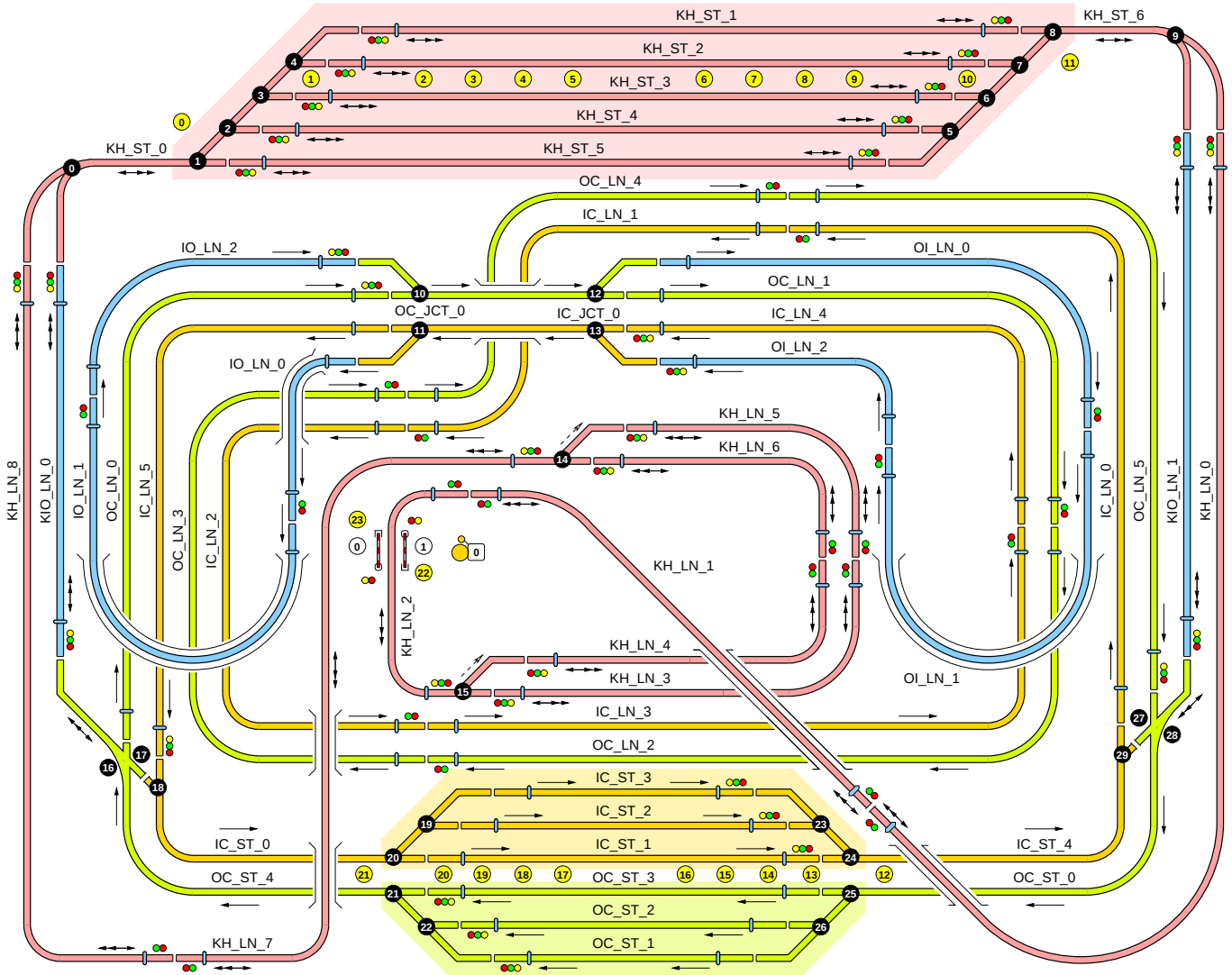


Project Overview

Project Overview

Model Railway Track Layout

Realtime and Embedded Systems Group



Symbols

Track segments

- Inner Circle
- Outer Circle
- Kicking Horse Pass
- Interconnections

Track specialties

- Bridge
- Point or crossing
- Railroad crossing

Directions

- Unidirectional block
- Bidirectional block with forward direction
- Preferred direction

Electronics

- Block isolation
- Reed contact
- Block signal
- Lighting
- Point operating unit

Stephan Höhrmann, January 2006
http://www.informatik.uni-kiel.de/~railway/

Project Overview - Controller Size

Approximatly...

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Approximatly...

- 135.000 states

Project Overview - Controller Size

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- 135.000 states
- 17.000 regions

Project Overview - Controller Size

Approximatly...

- 135.000 states
- 17.000 regions
- 152.000 transitions

Project Overview - Controller Size

Approximatly...

- 135.000 states
- 17.000 regions
- 152.000 transitions
- 127.000 SCG nodes

Project Overview - Controller Size

Approximatly...

- 135.000 states
- 17.000 regions
- 152.000 transitions

- 127.000 SCG nodes
- 256.000 dependencies
  - in 50.000 nodes

Project Overview - Controller Size

Approximatly...

- 135.000 states
- 17.000 regions
- 152.000 transitions

- 127.000 SCG nodes
- 256.000 dependencies
  - in 50.000 nodes
- 88.000 scheduling blocks

Project Overview - Controller Size

Approximatly...

- 135.000 states
- 17.000 regions
- 152.000 transitions

- 127.000 SCG nodes
- 256.000 dependencies
  - in 50.000 nodes
- 88.000 scheduling blocks
- 1.400.000 lines of generated C code
  - still 650.000 lines after beautifier

Project Overview - Controller Size

Approximatly...

- 135.000 states
- 17.000 regions
- 152.000 transitions

- 127.000 SCG nodes
- 256.000 dependencies
  - in 50.000 nodes
- 88.000 scheduling blocks
- 1.400.000 lines of generated C code
  - still 650.000 lines after beautifier
- 3.000 lines of own C code

Project Overview - Controller Size

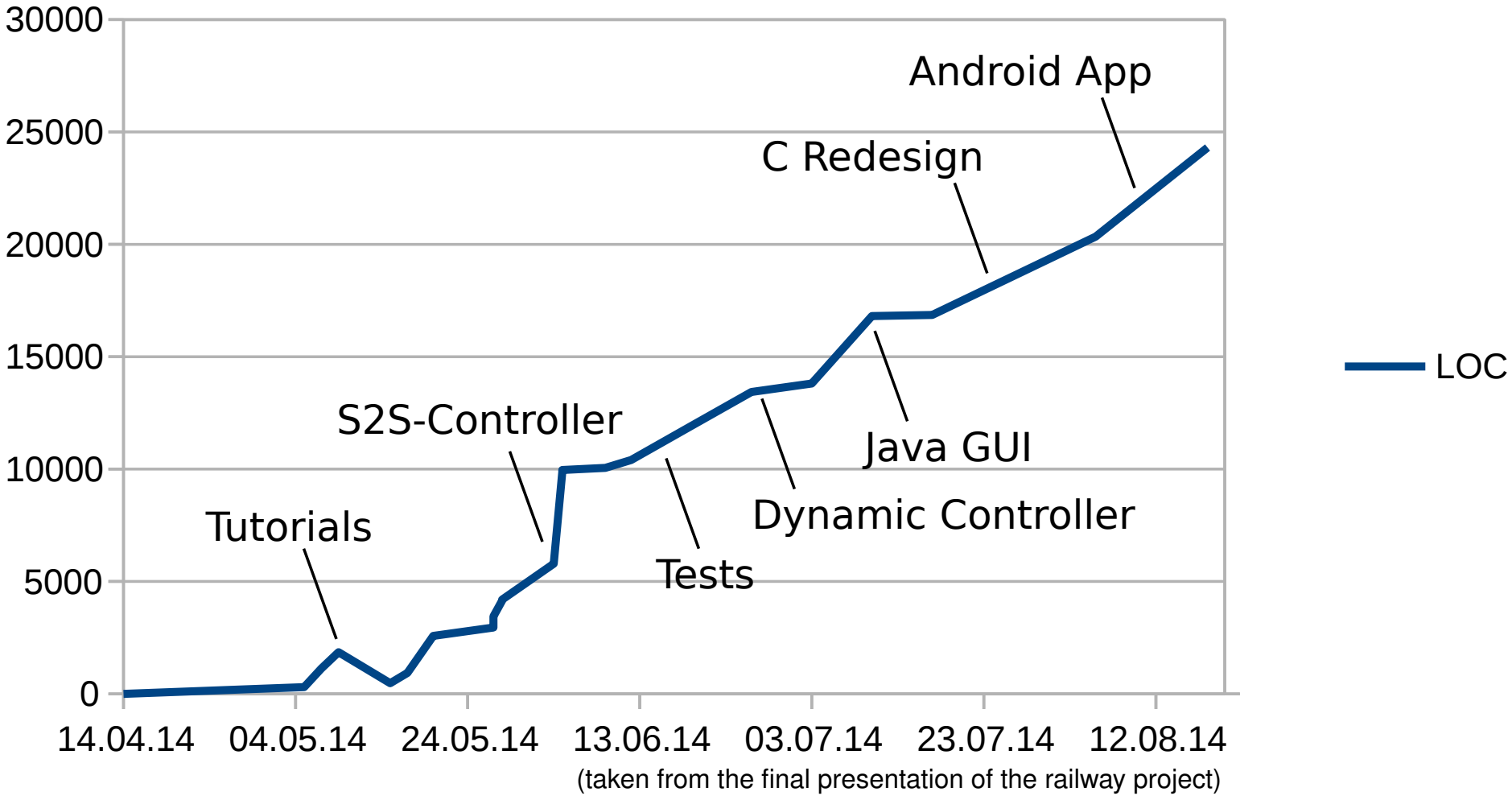
Approximatly...

- 135.000 states
- 17.000 regions
- 152.000 transitions

- 127.000 SCG nodes
- 256.000 dependencies
  - in 50.000 nodes
- 88.000 scheduling blocks
- 1.400.000 lines of generated C code
  - still 650.000 lines after beautifier
- 3.000 lines of own C code

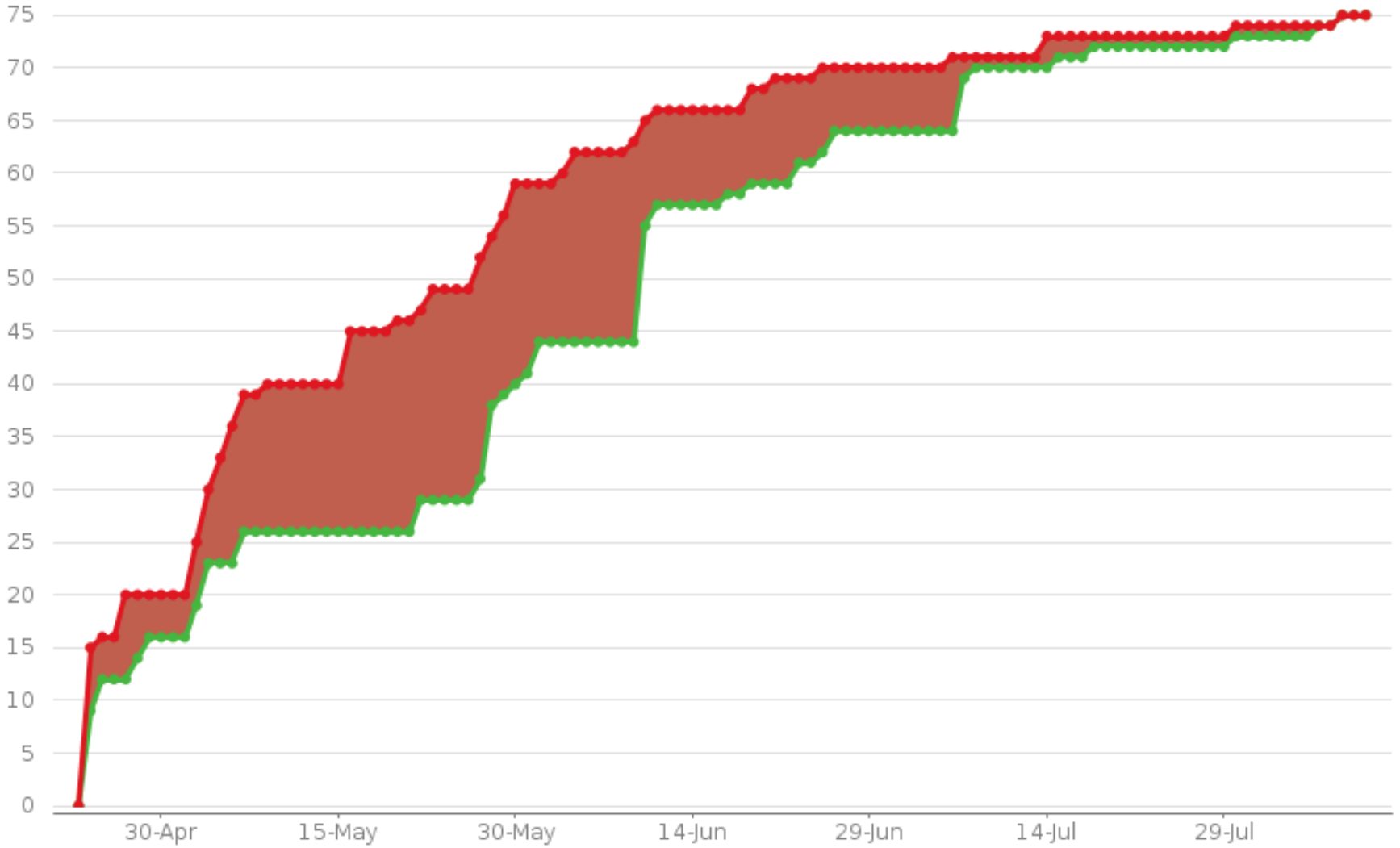
As comparison: The Wrist Watch has ~400 states.

Project Overview - Controller Size



(taken from the final presentation of the railway project)

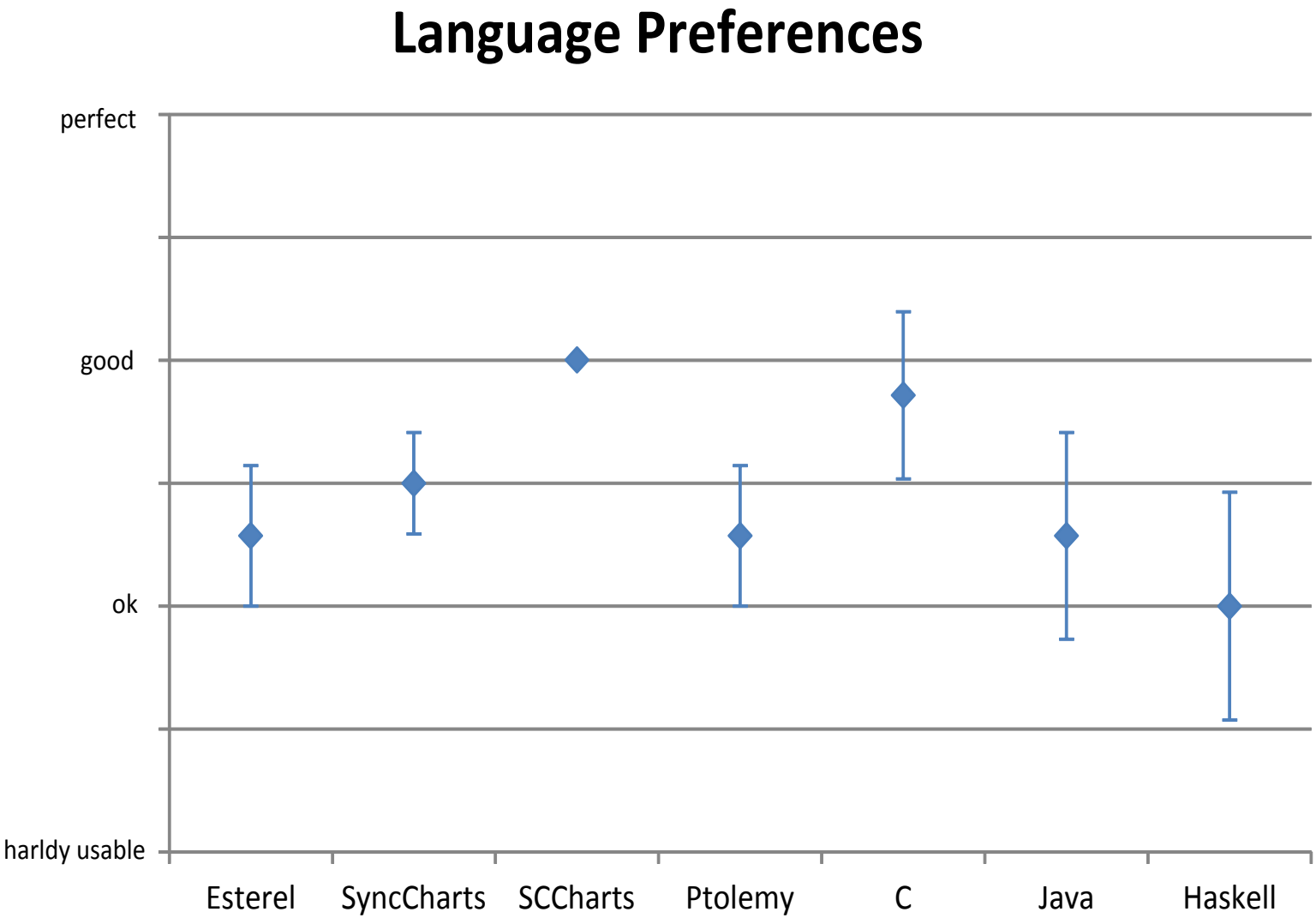
Project Overview - Joint Work



Overview

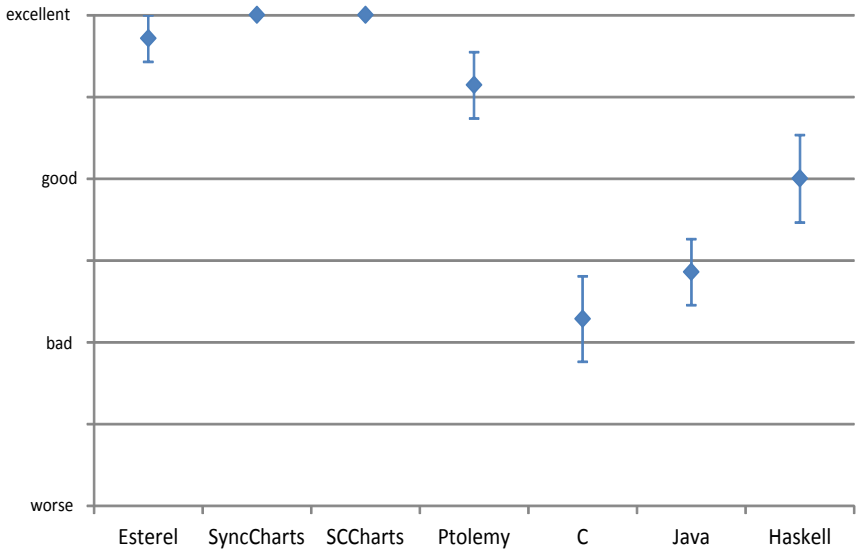
Language Evaluation

To which extent would you like to use the following modeling/programming languages for this project?

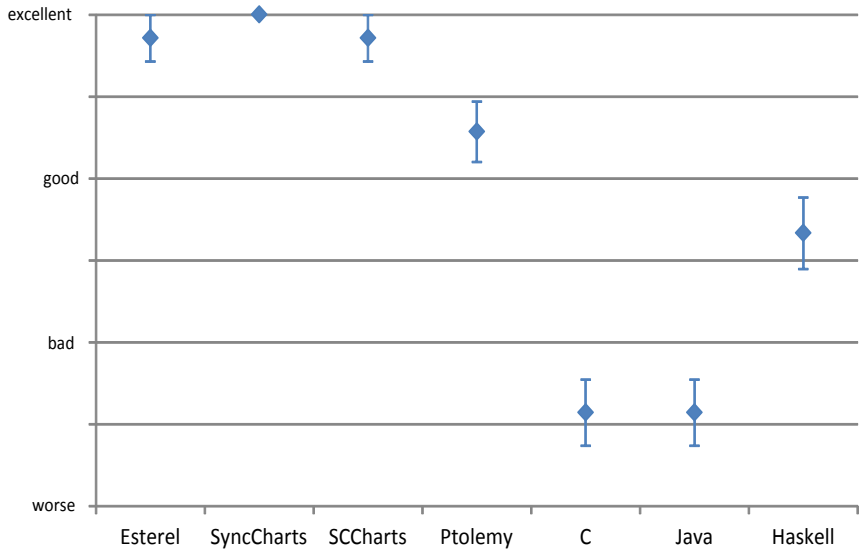


Language Evaluation

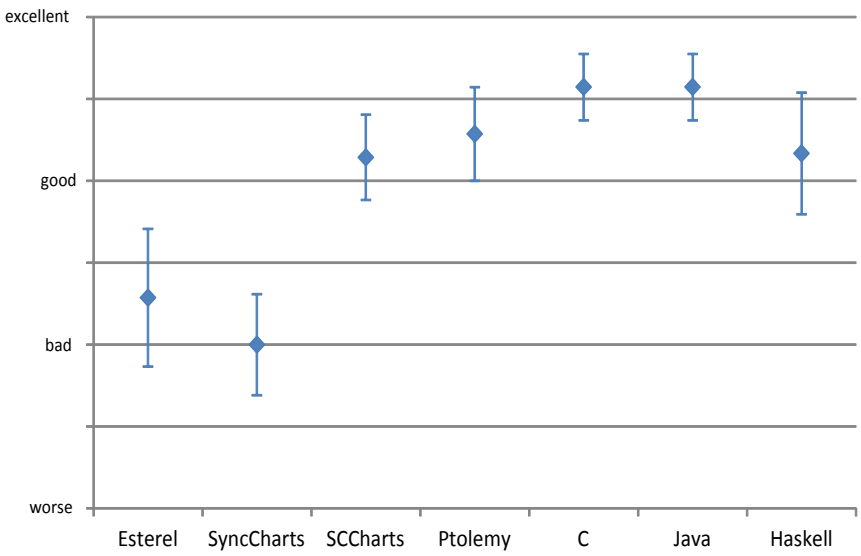
General determinism



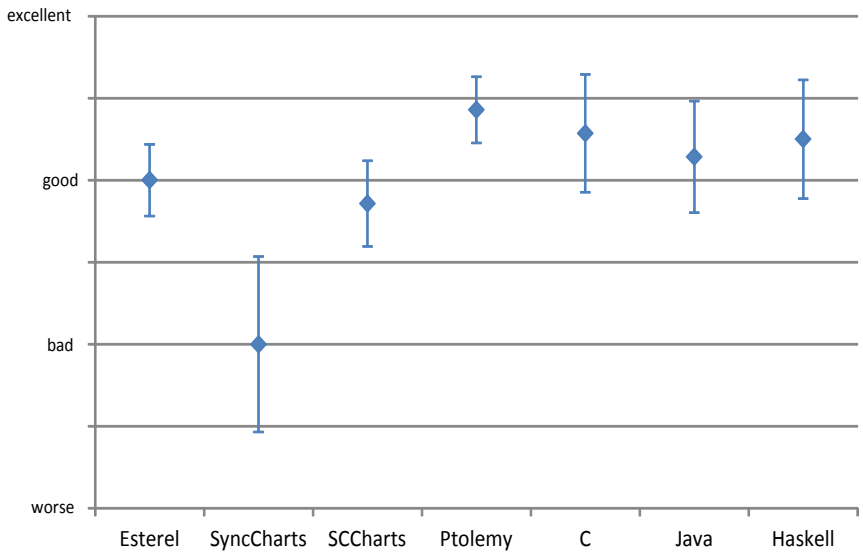
Deterministic concurrency



Sequentiality



Composability



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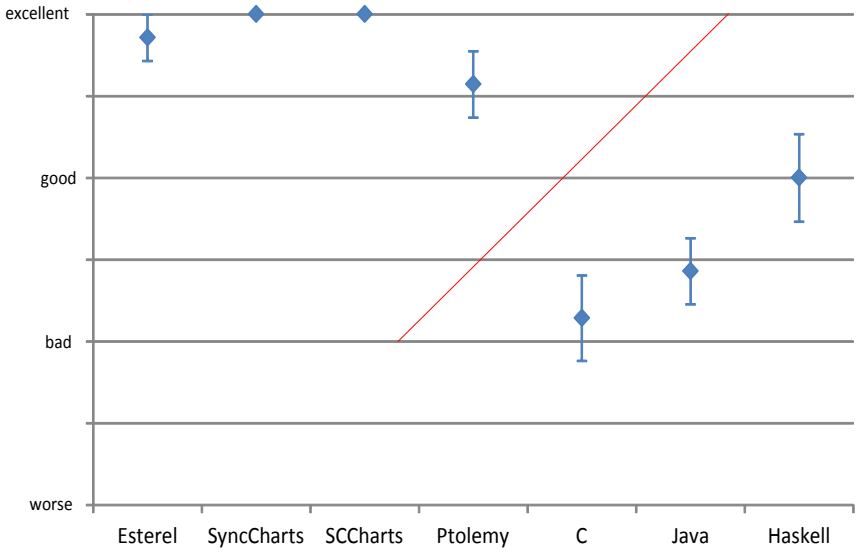

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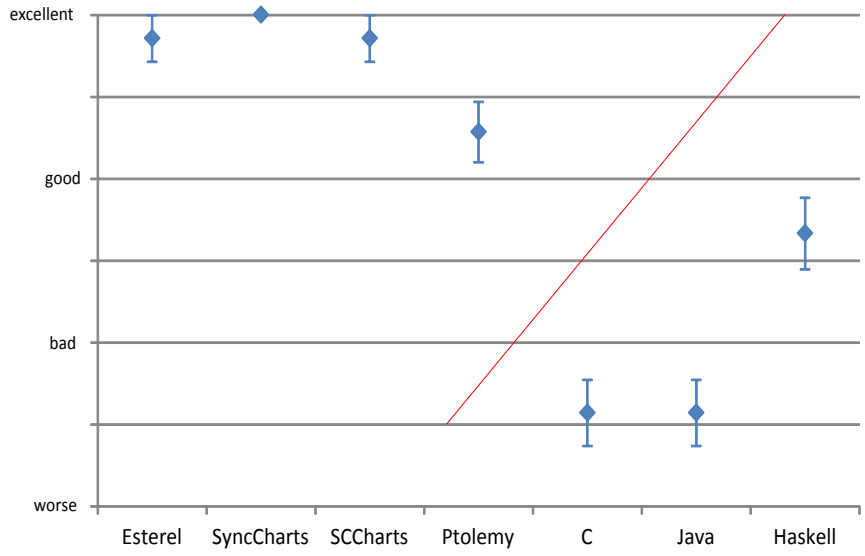

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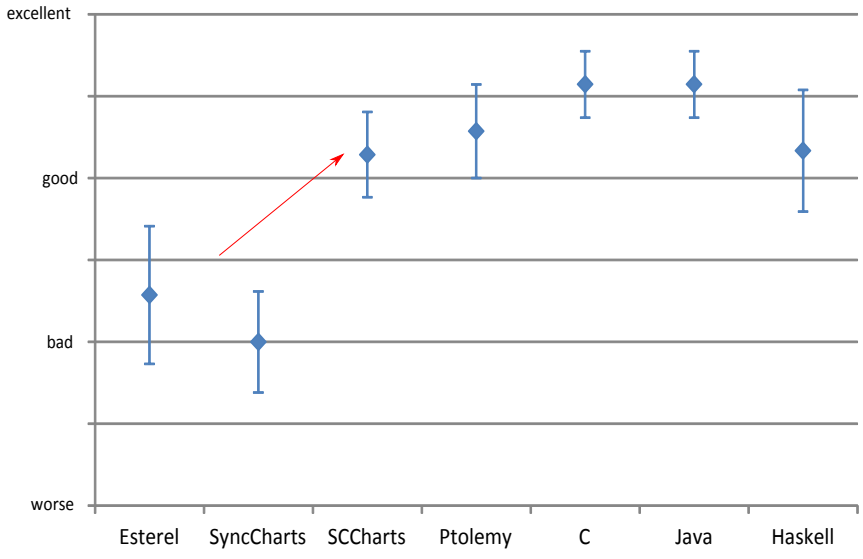

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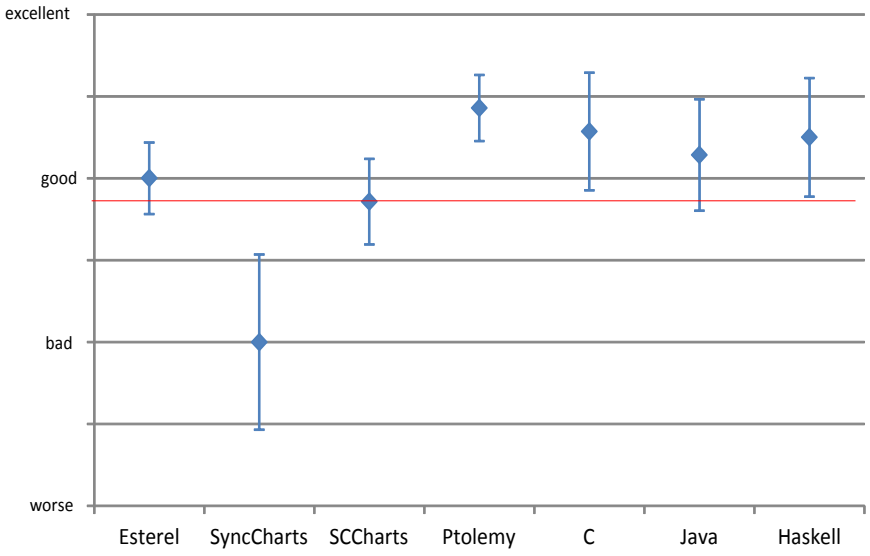
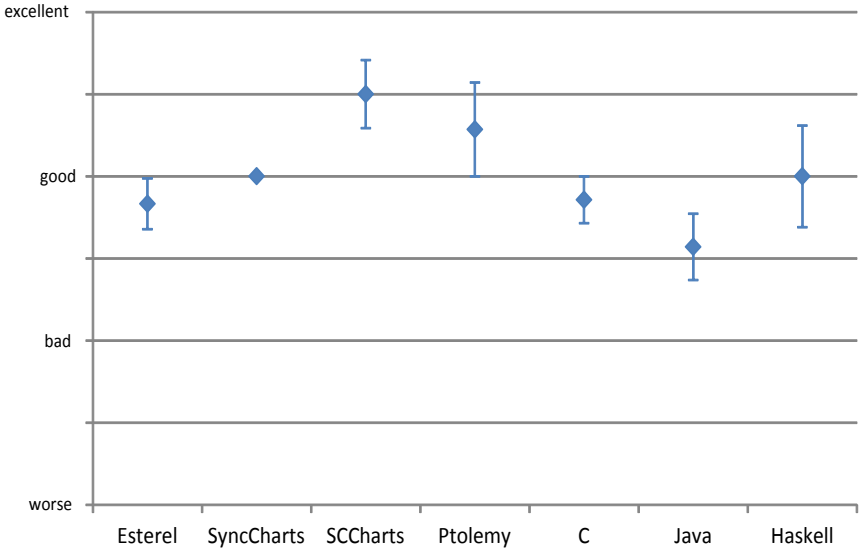
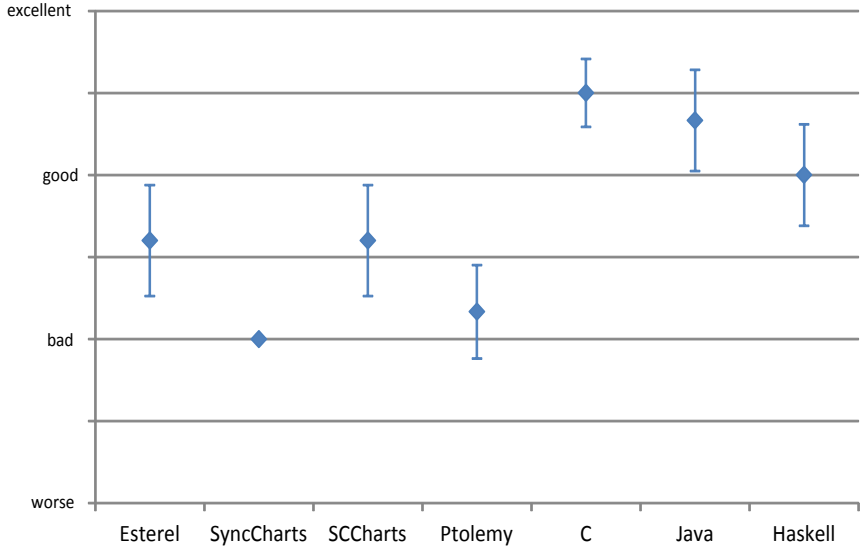


Language Evaluation

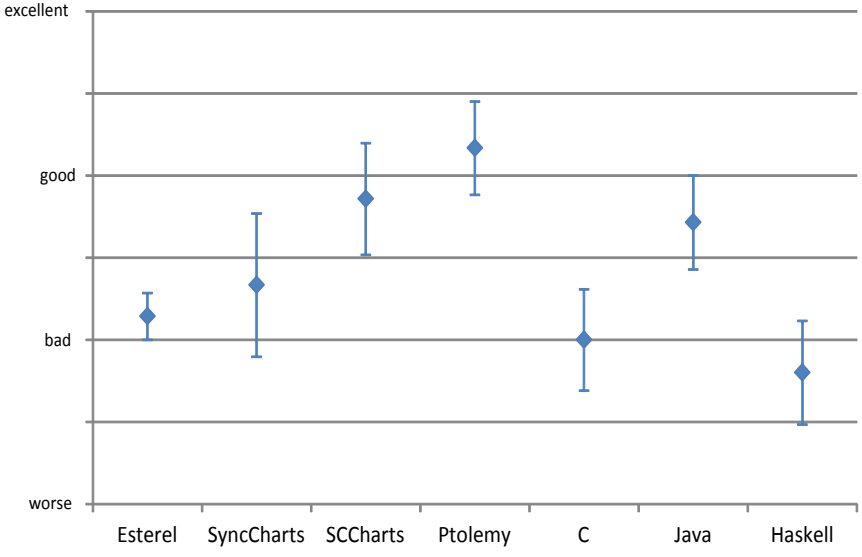
Solving abstract problems



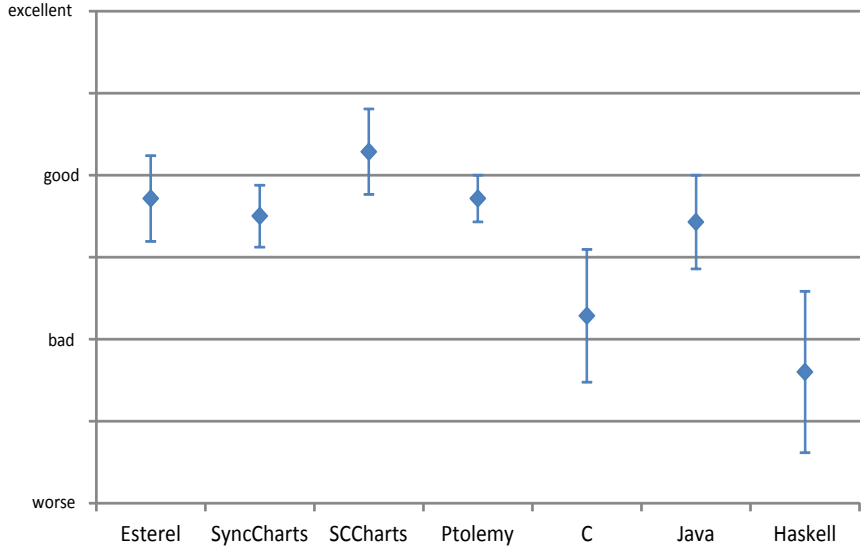
Solving low-level problems



Understandability



Simplicity



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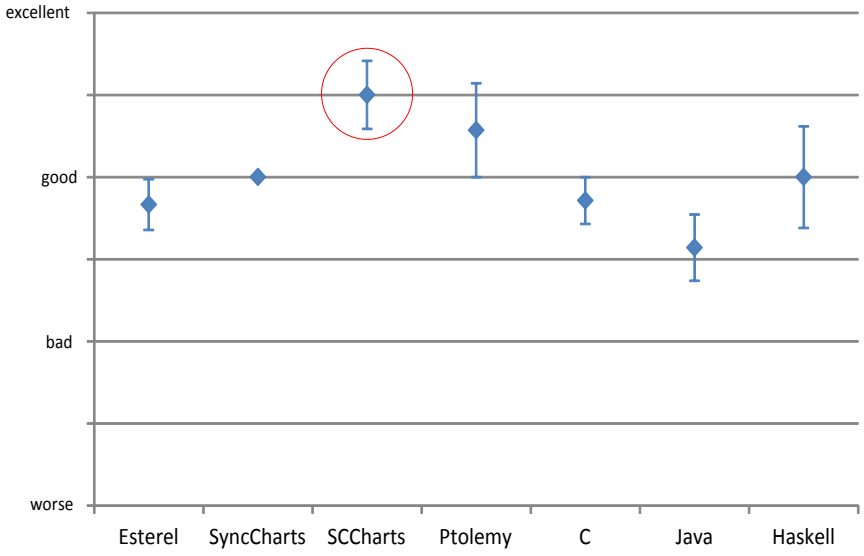

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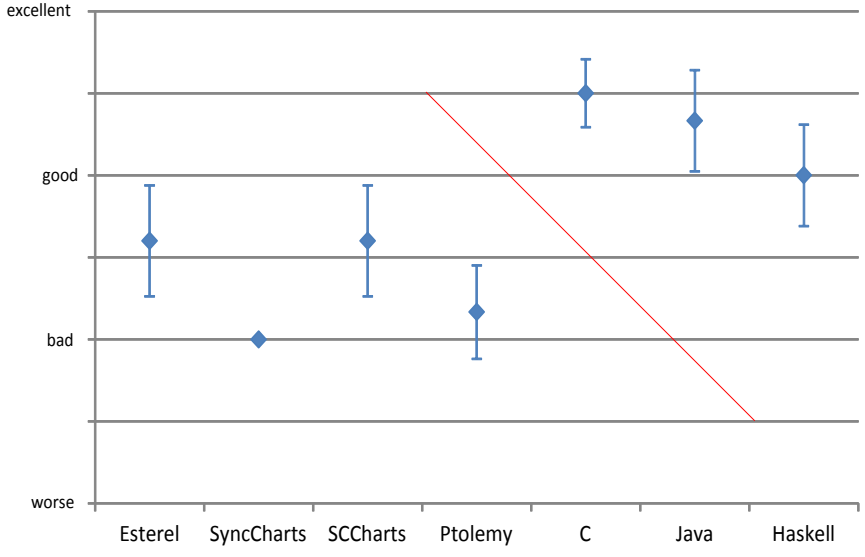
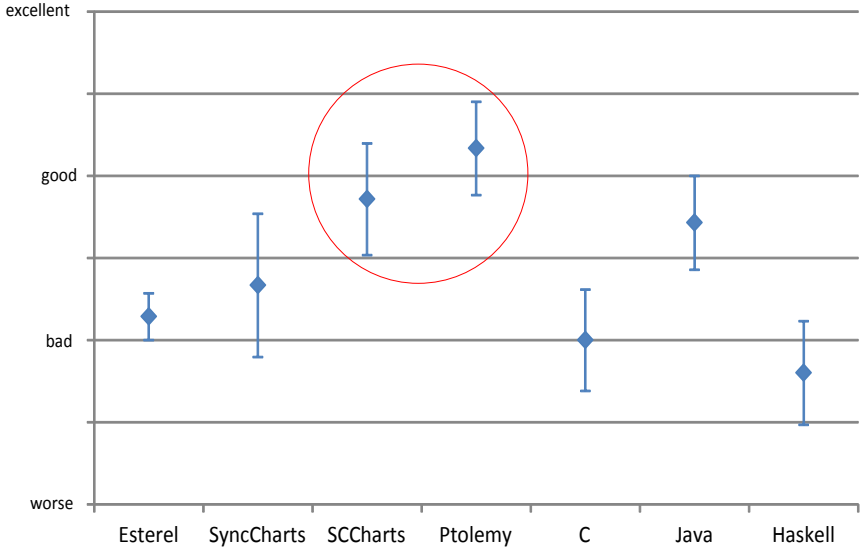
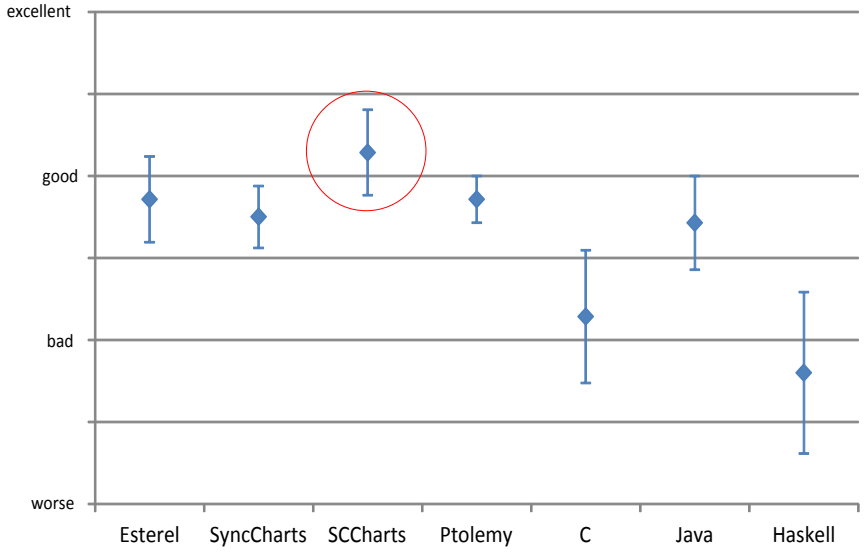


Understandability

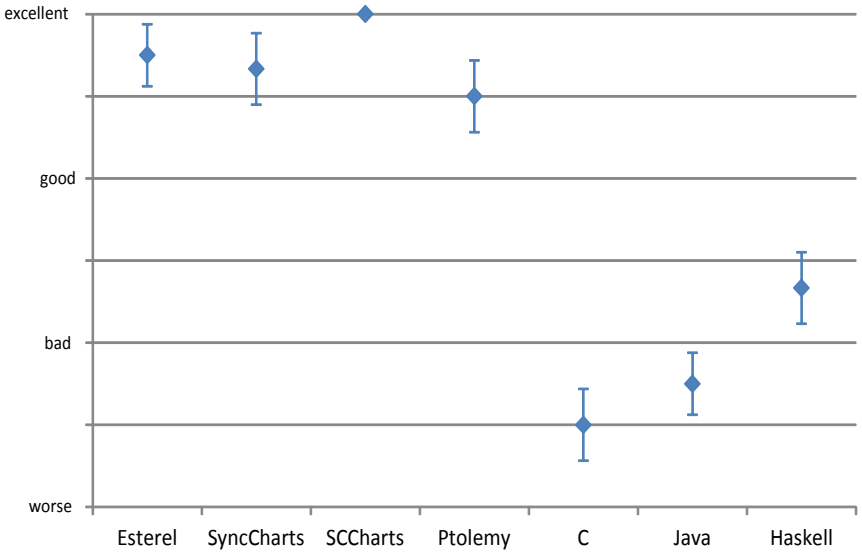


Simplicity

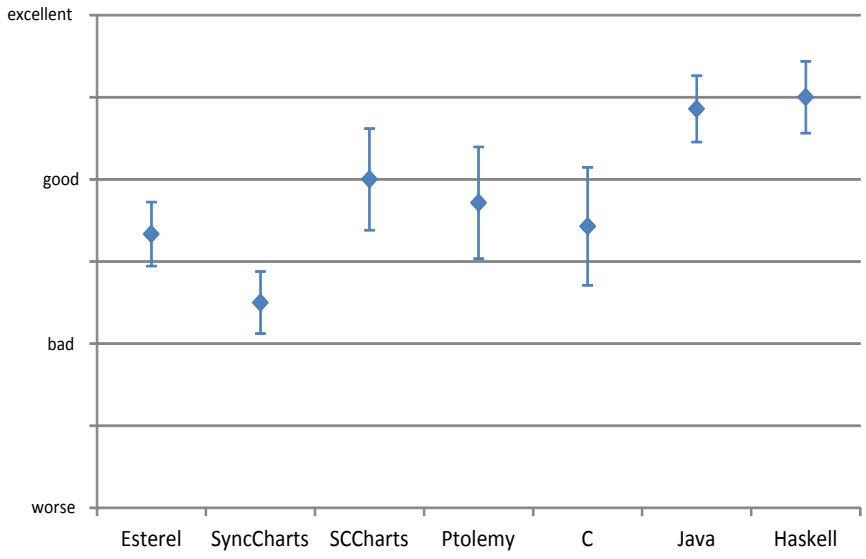


Language Evaluation

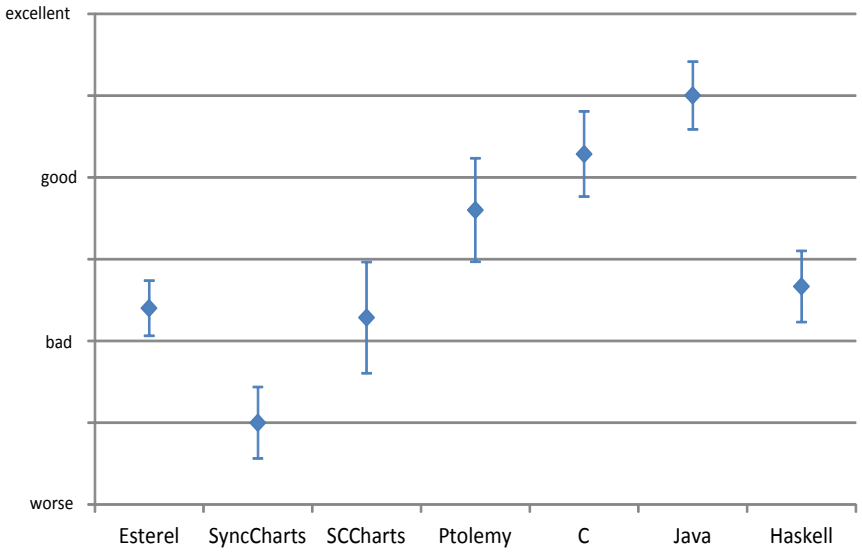
Separate Timing & Functionality



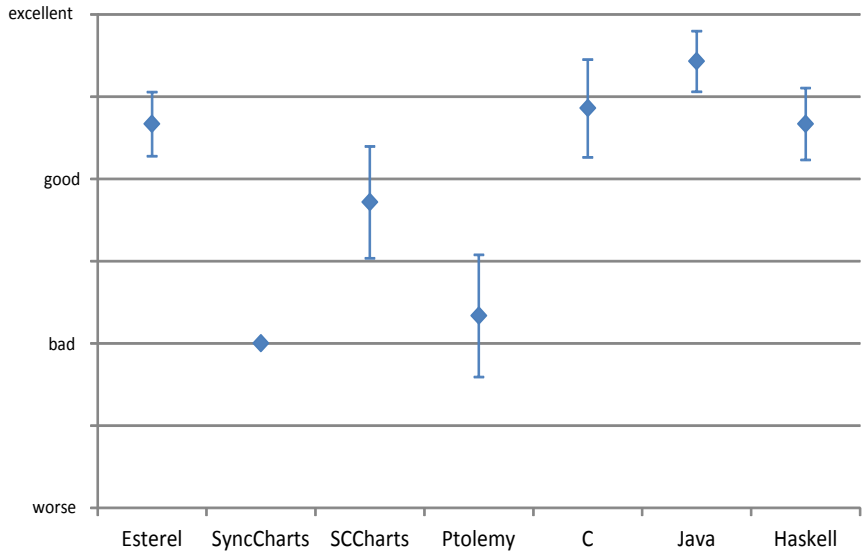
Maintainability



Debugging



Team development



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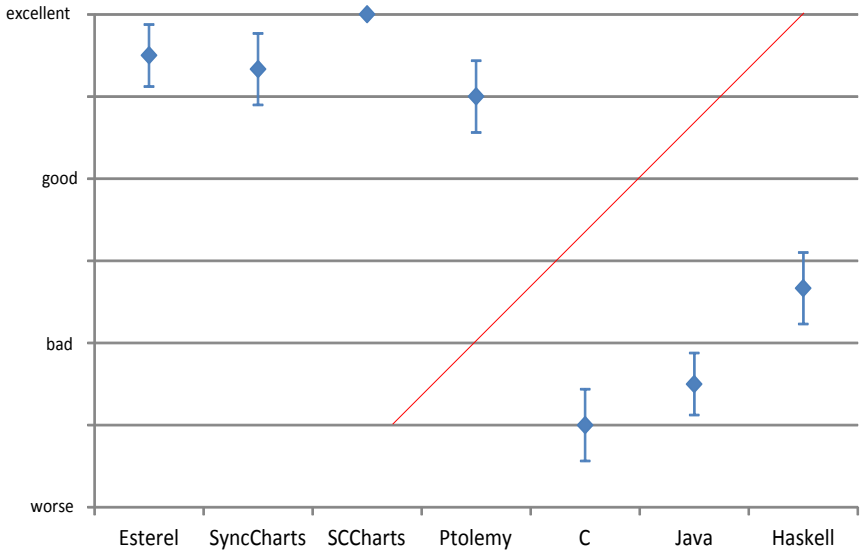
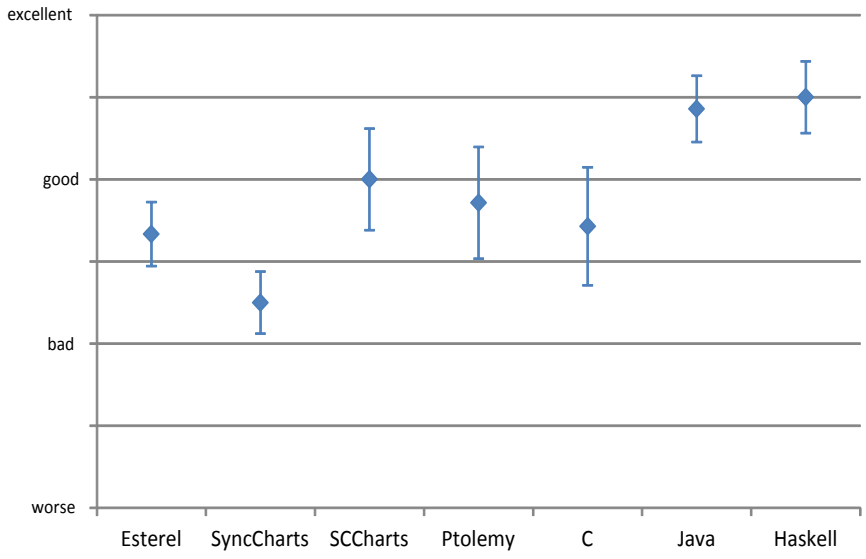
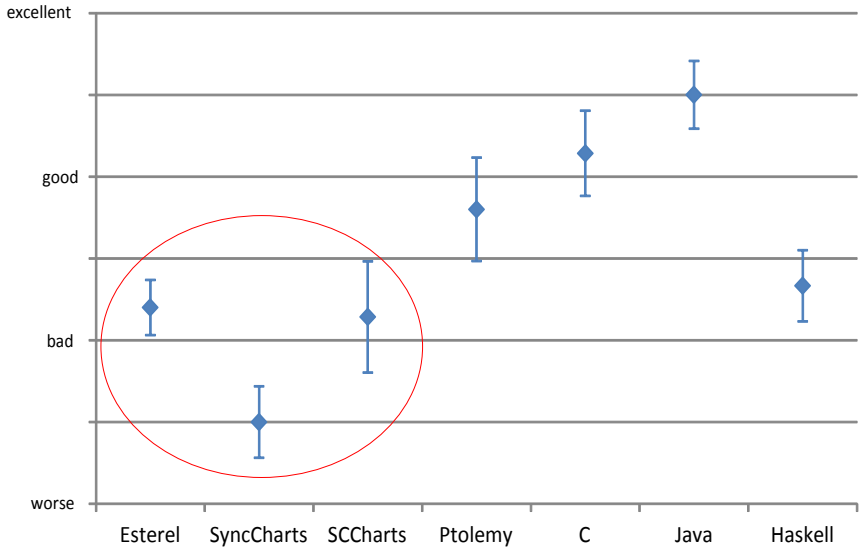


Maintainability



Debugging



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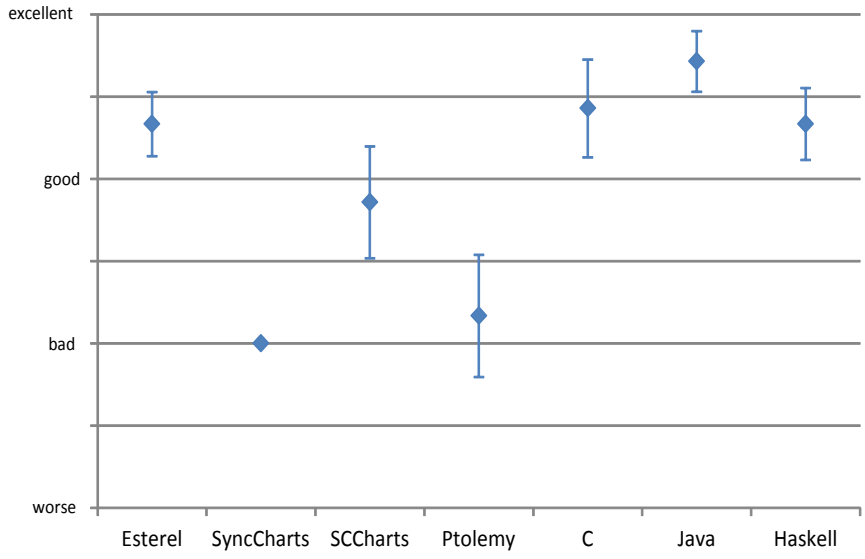

Language Evaluation

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- ... and feature specific problems

Language Evaluation

First conclusions...

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- Performs better than other synchroneous languages,

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- is understandable, simplistic and maintainable,

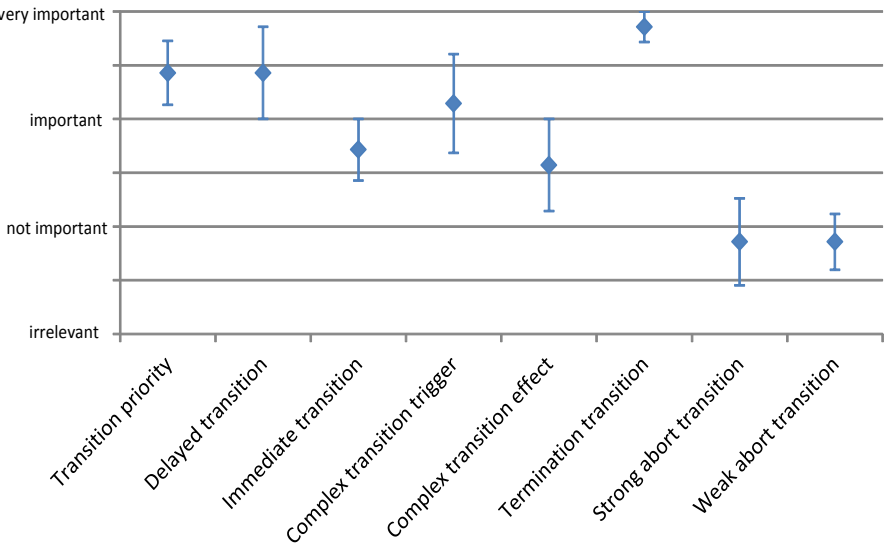
Language Evaluation

First conclusions...

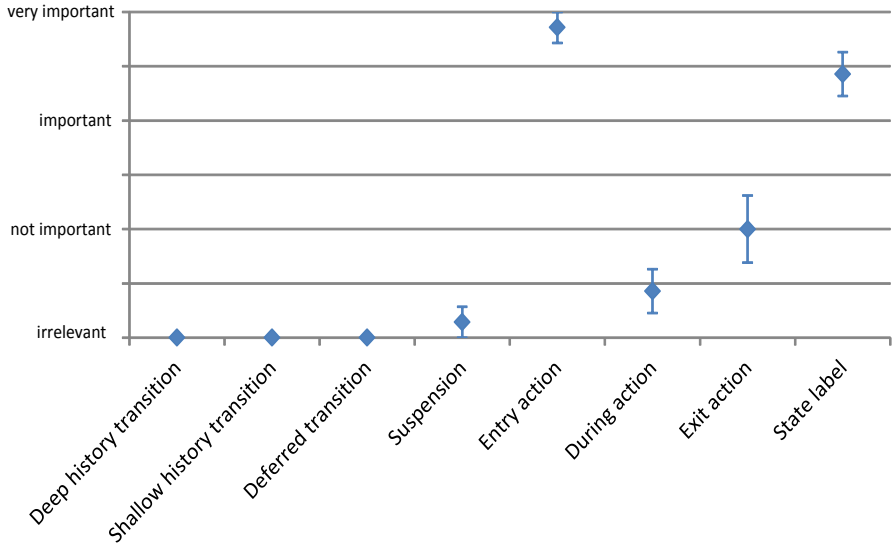
- Performs better than other synchroneous languages,
- is understandable, simplistic and maintainable,
- but still needs better support for debugging, composability and team development.

Language Evaluation - Features

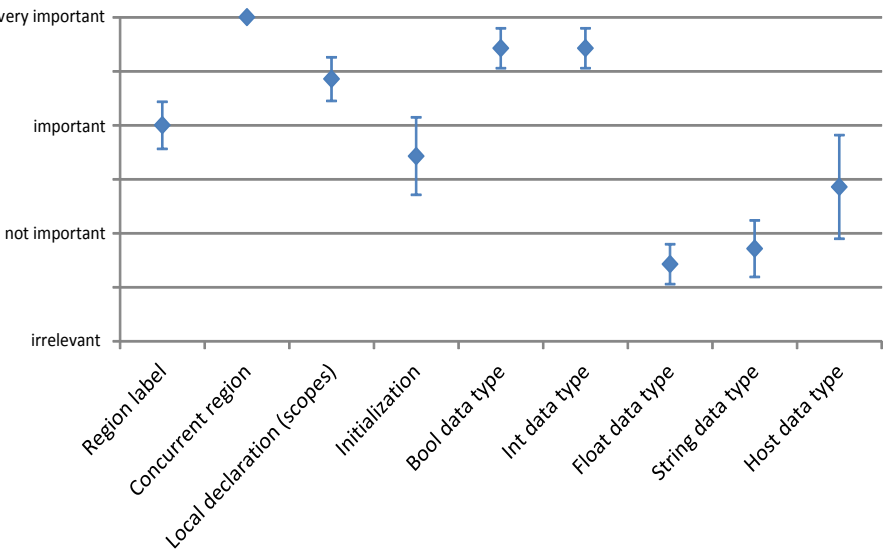
Extended features 1/4



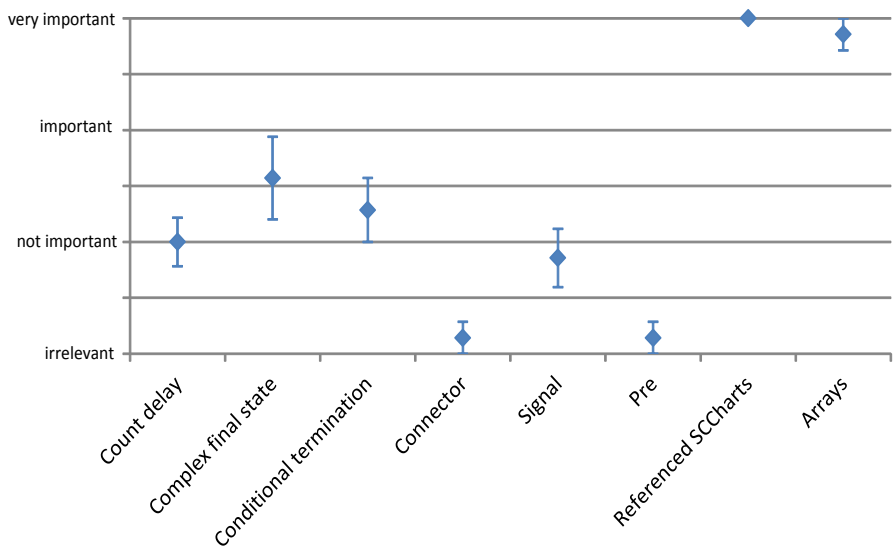
Extended features 2/4



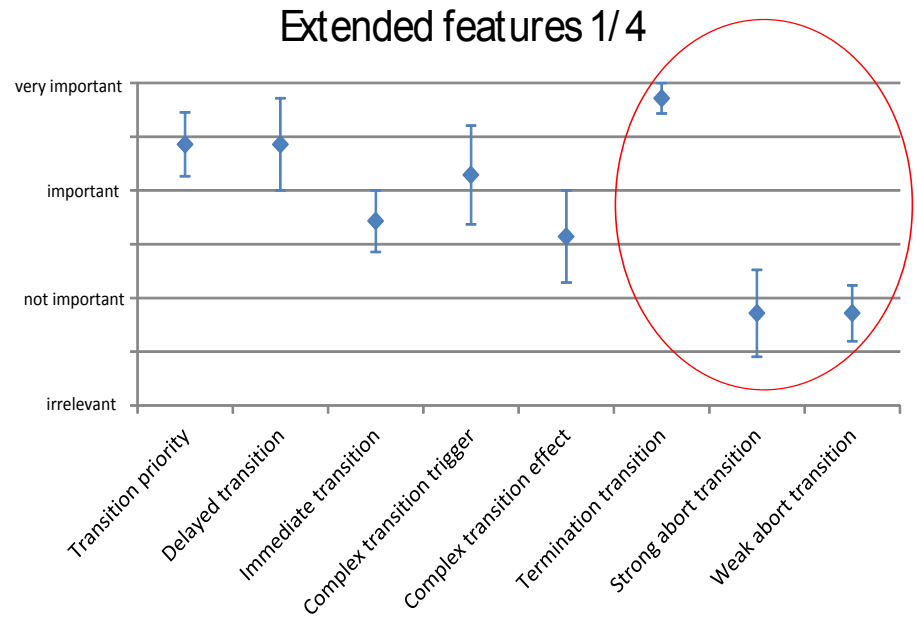
Extended features 3/4

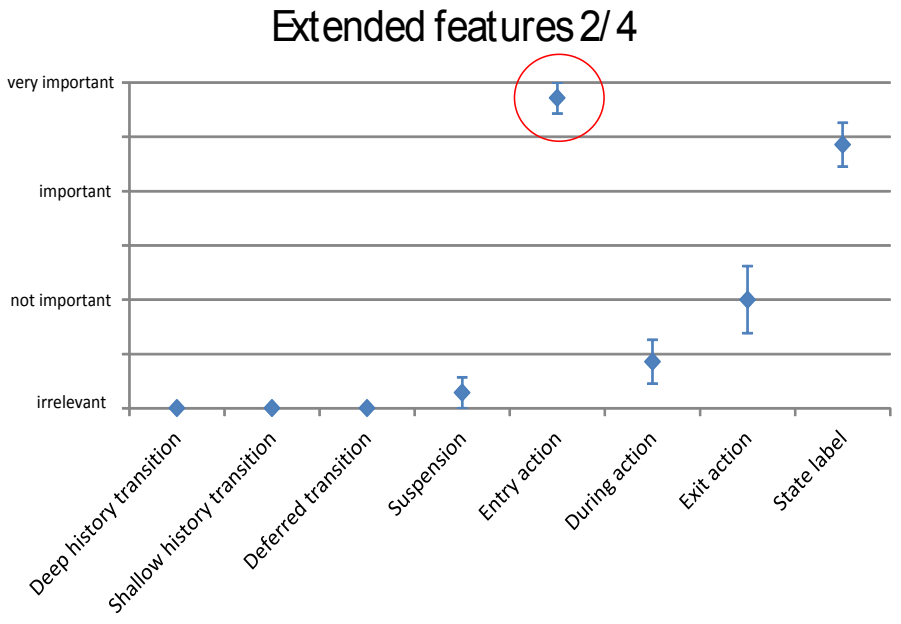


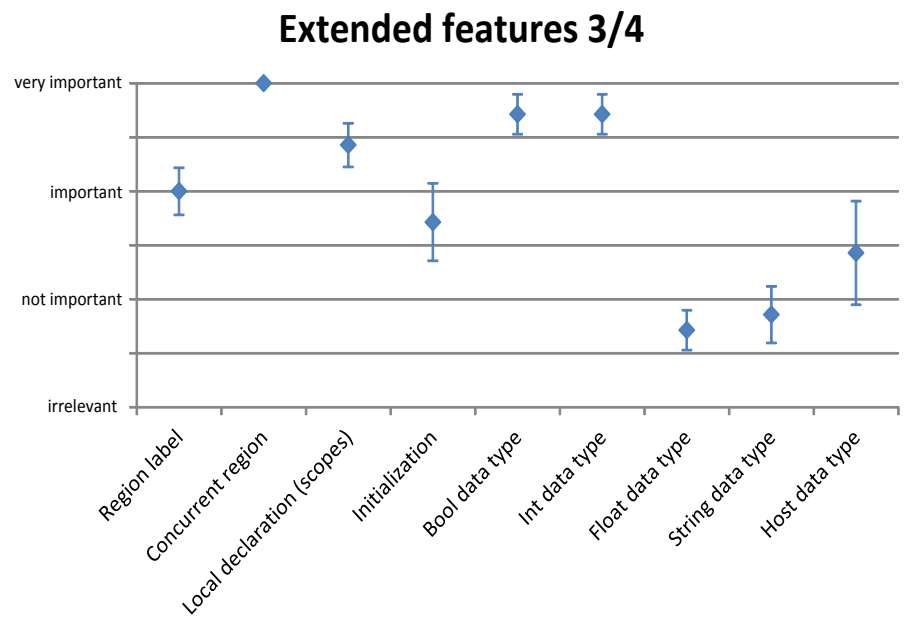
Extended features 4/4

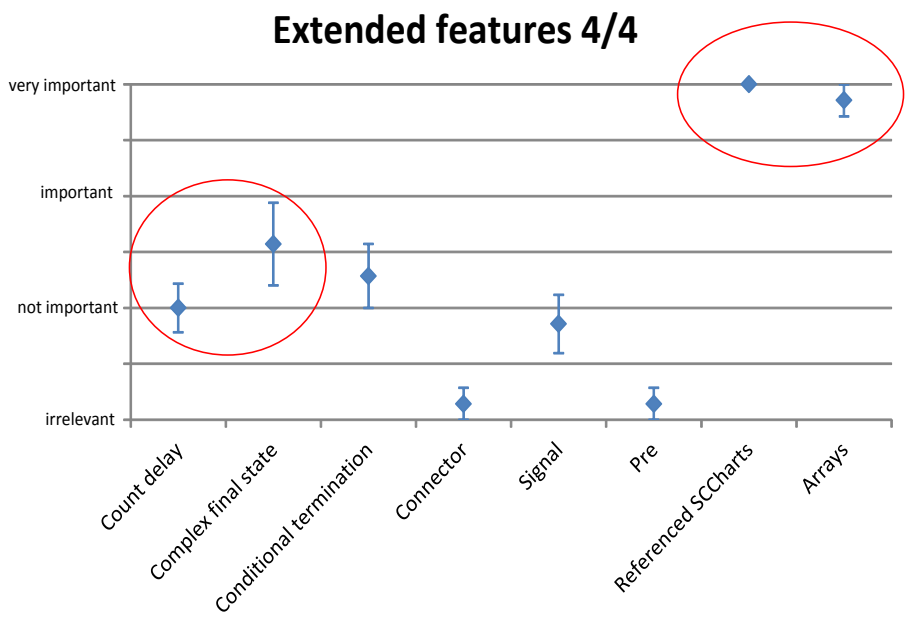


Language Evaluation - Features









Language Evaluation - Features

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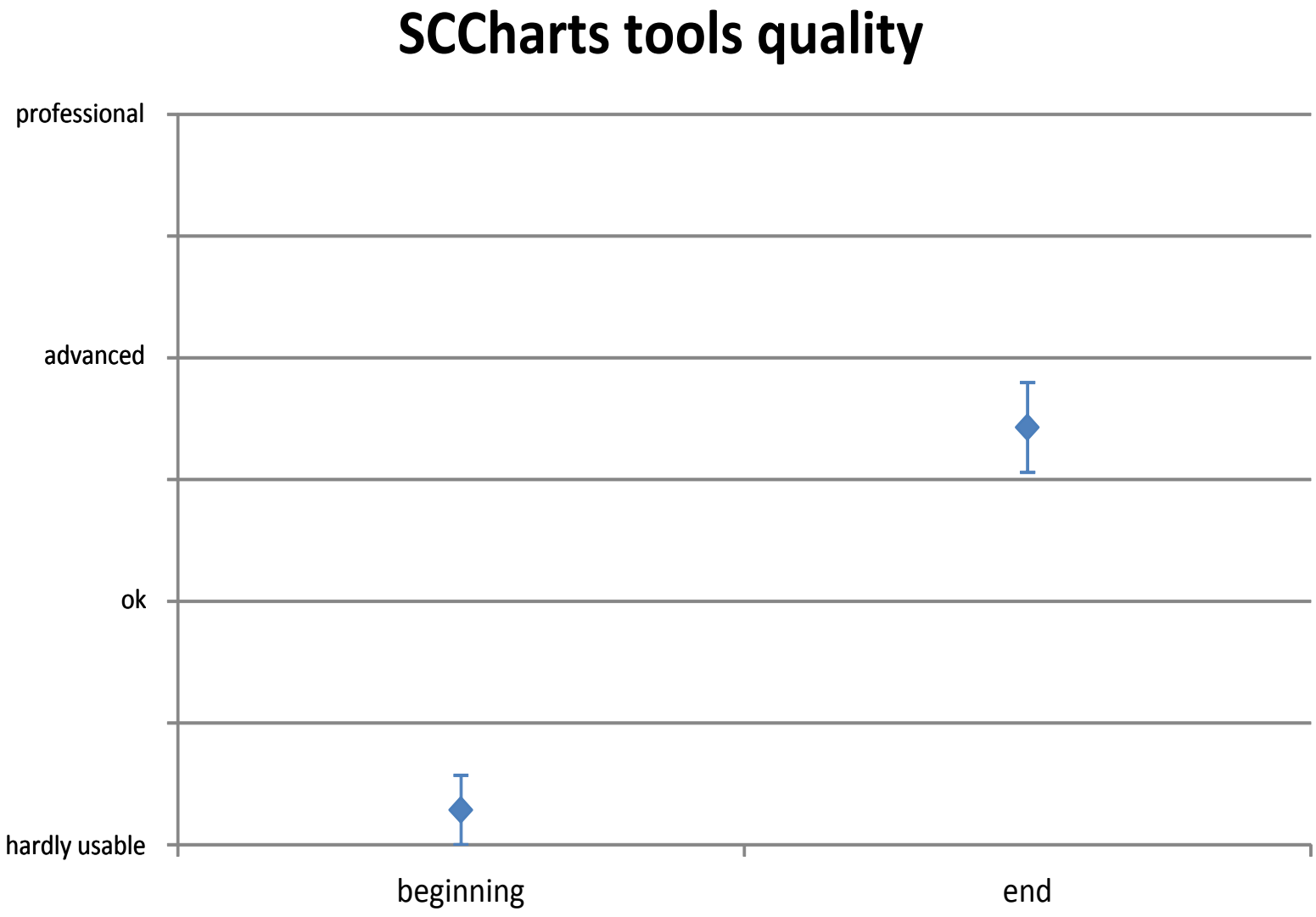
  $\longrightarrow$ Nice!

Overview

Tooling Evaluation

Your opinion about the overall quality of the SCCharts development tools...



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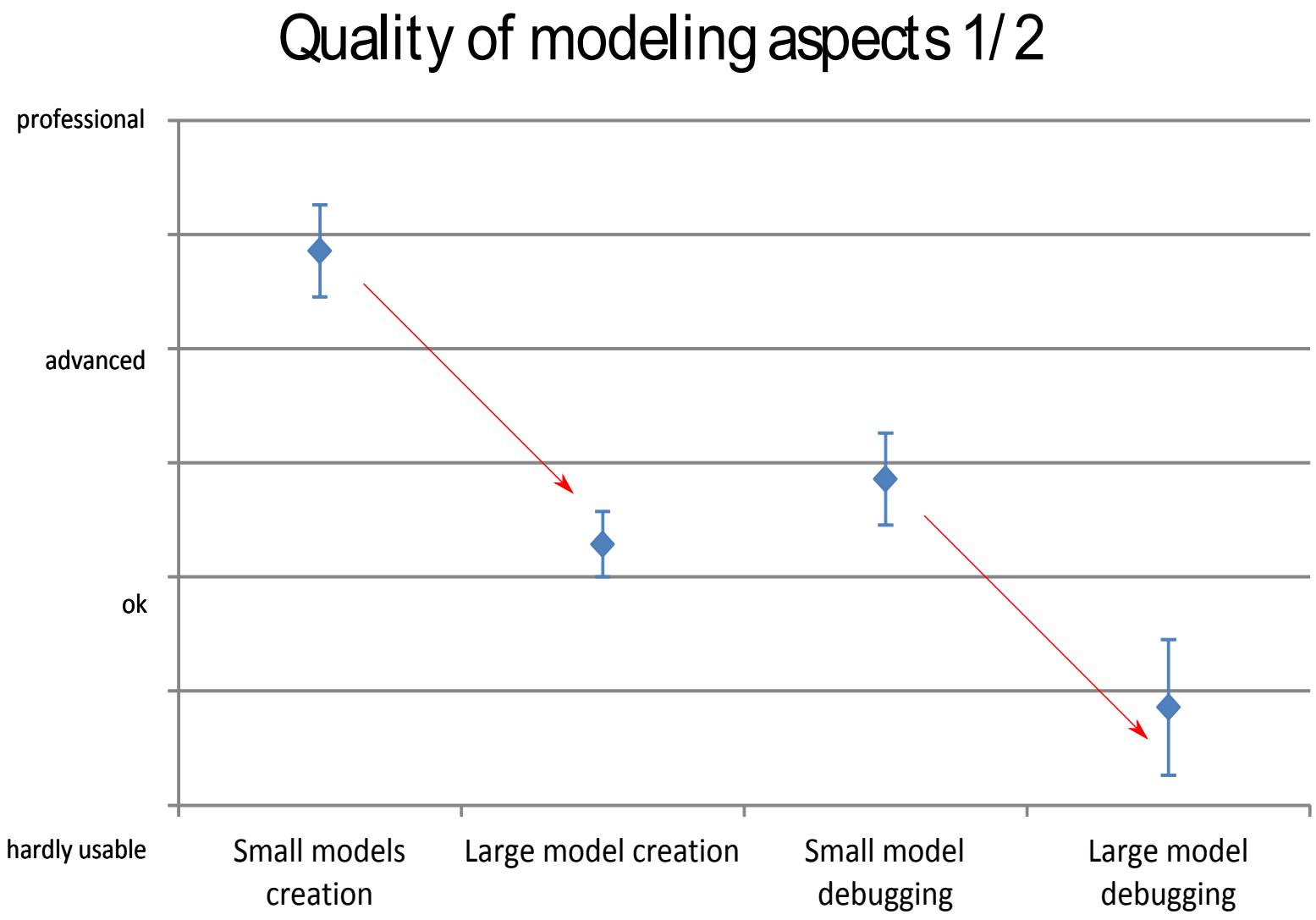

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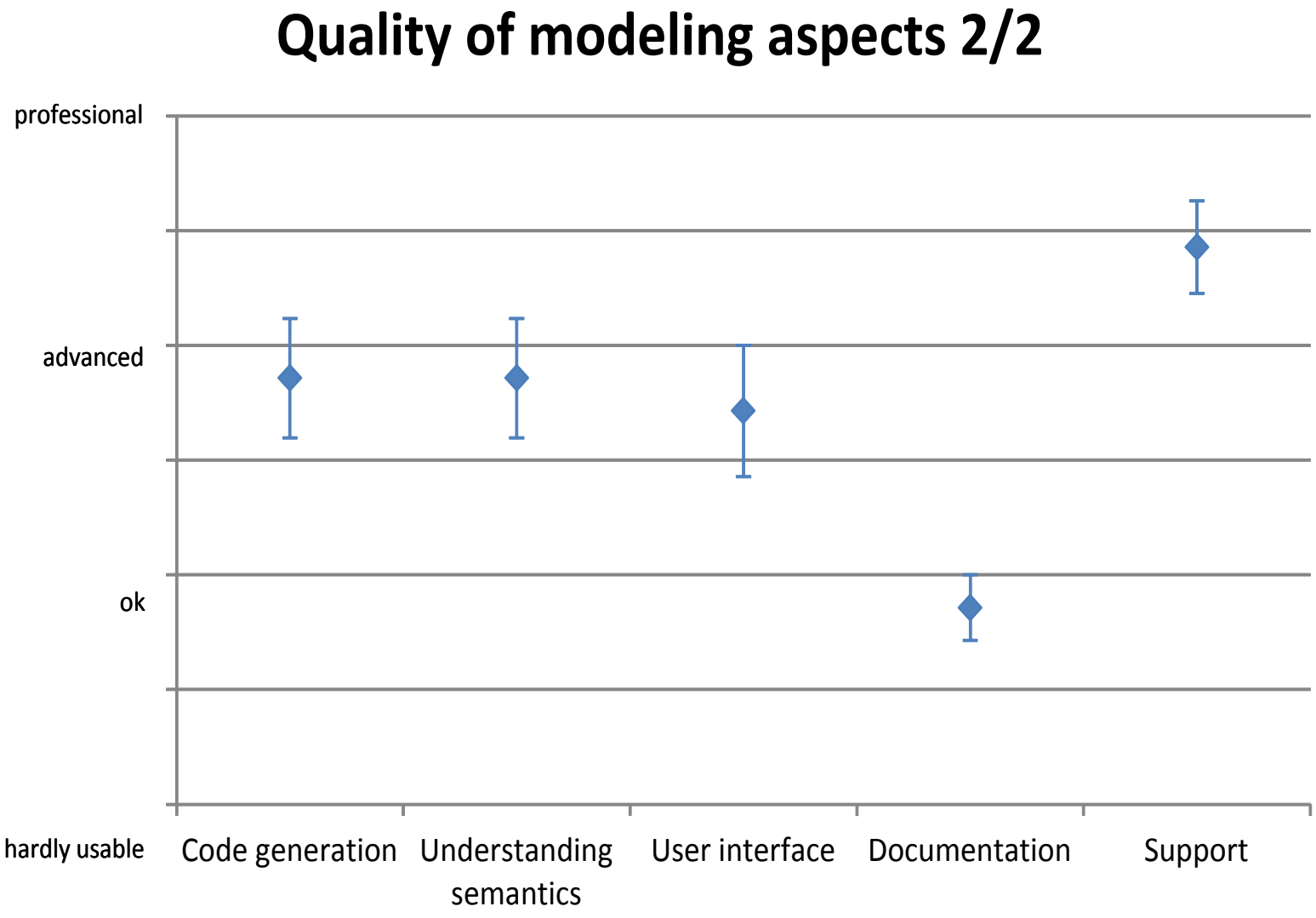
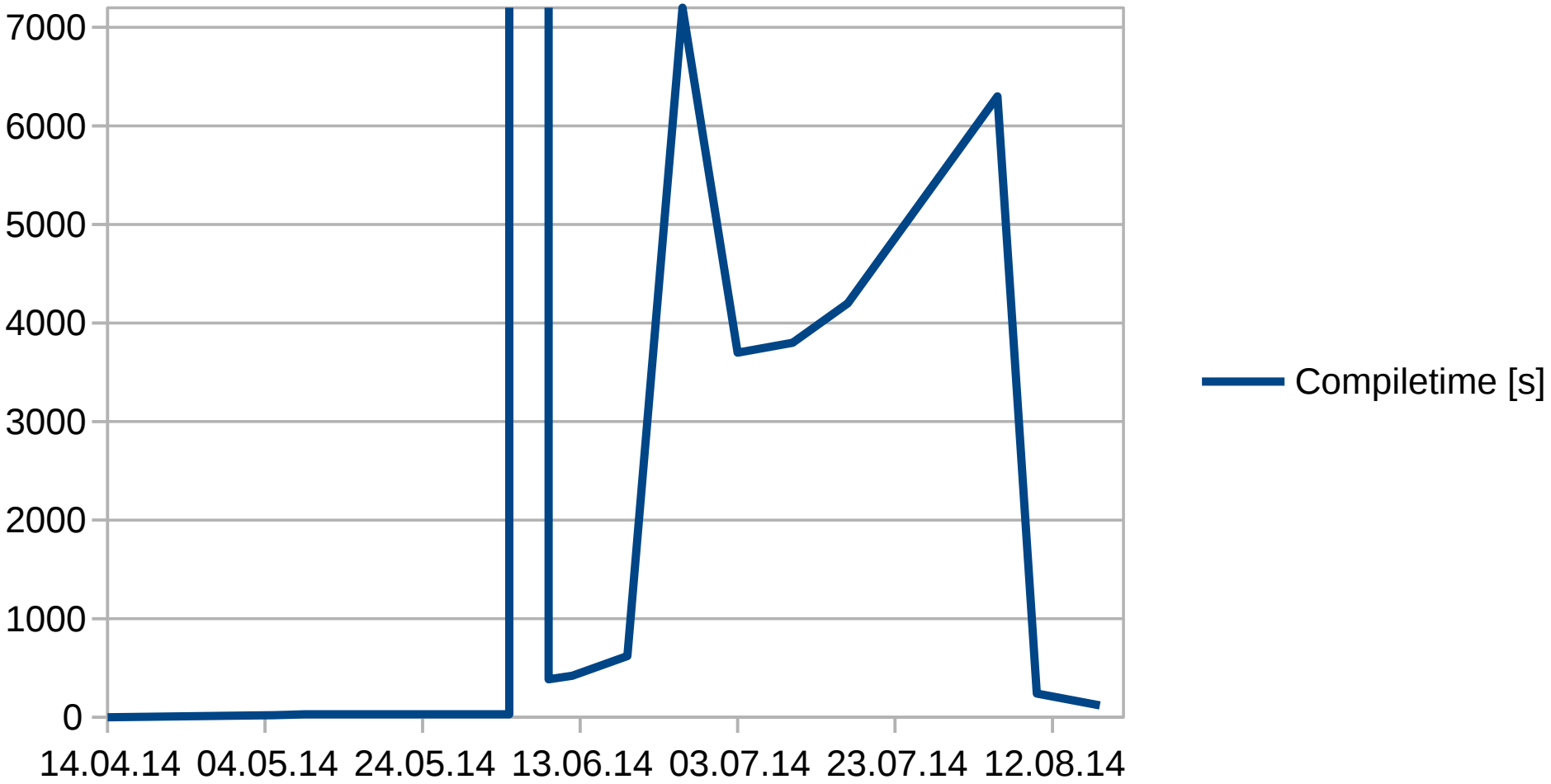


Tooling Evaluation - Compiler Performance



(taken from the final presentation of the railway project)

Tooling Evaluation - Compiler Performance

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However, visualization of large models is another problem!

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- Still a lot of bugs/not working features
- Debugging not schedulable models is a pain
- Only one processor core is used
- Big automata often confusing (visualization)
- Eclipse crashes
- SCCharts is a science project: language has it's roots in theory. Some features are theoretically very nice and interesting but in practice not really necessary.

Tooling Evaluation

PRO remarks

Tooling Evaluation

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- Good/Awesome support x2

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Tooling Evaluation

PRO remarks

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- SCCharts is a science project: quick bugfixing direct contact to developers

Overview

Outlook - Brainstorming

At the moment we're working on/thinking about...

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  - needs fine tuning
  - however, is there a best fit?

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Outlook - Brainstorming

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- Adaptive Zooming
  - needs fine tuning
  - however, is there a best fit?
- Lazy Loading for referenced SCCharts
- Transformation tracing
  - propagate compilation results to top level
- Further assessment of the project results
  - First large models
  - Survey results
  - Technical Report
  - Upcoming student theses

Outlook - Upcoming lectures

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- Embedded System Design in WSem 14/15
  - Controlling the NXTs with SCCharts
- Embedded System Project in SSem 15
  - Probably also an NXT project

The End

Thank you very much for your attention!