Getting the right module structure: using Wrangler to fix your projects

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CODE
CODE
CODE

Overview

Refactoring Erlang in Wrangler

Clone detection and elimination

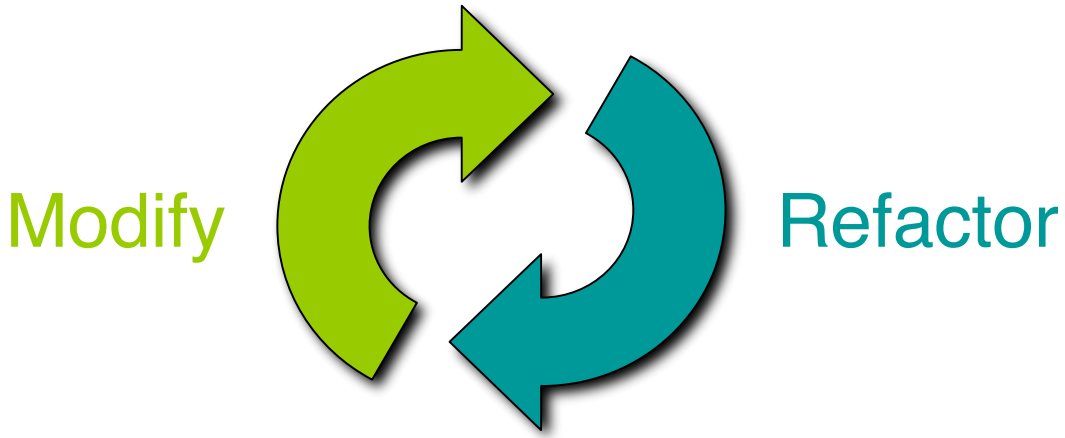
Case study: SIP message manipulation

Improving module structure

Introduction

Refactoring

Refactoring means changing the design or structure of a program … without changing its behaviour.

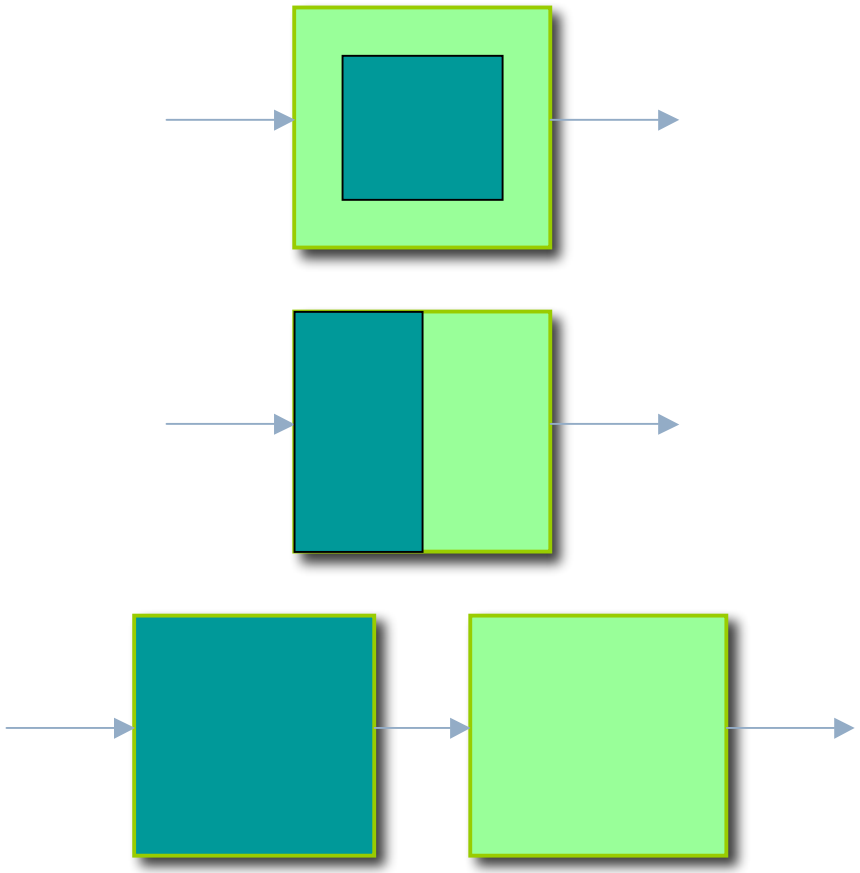


Soft-ware

There's no single correct design …

… different options for different situations.

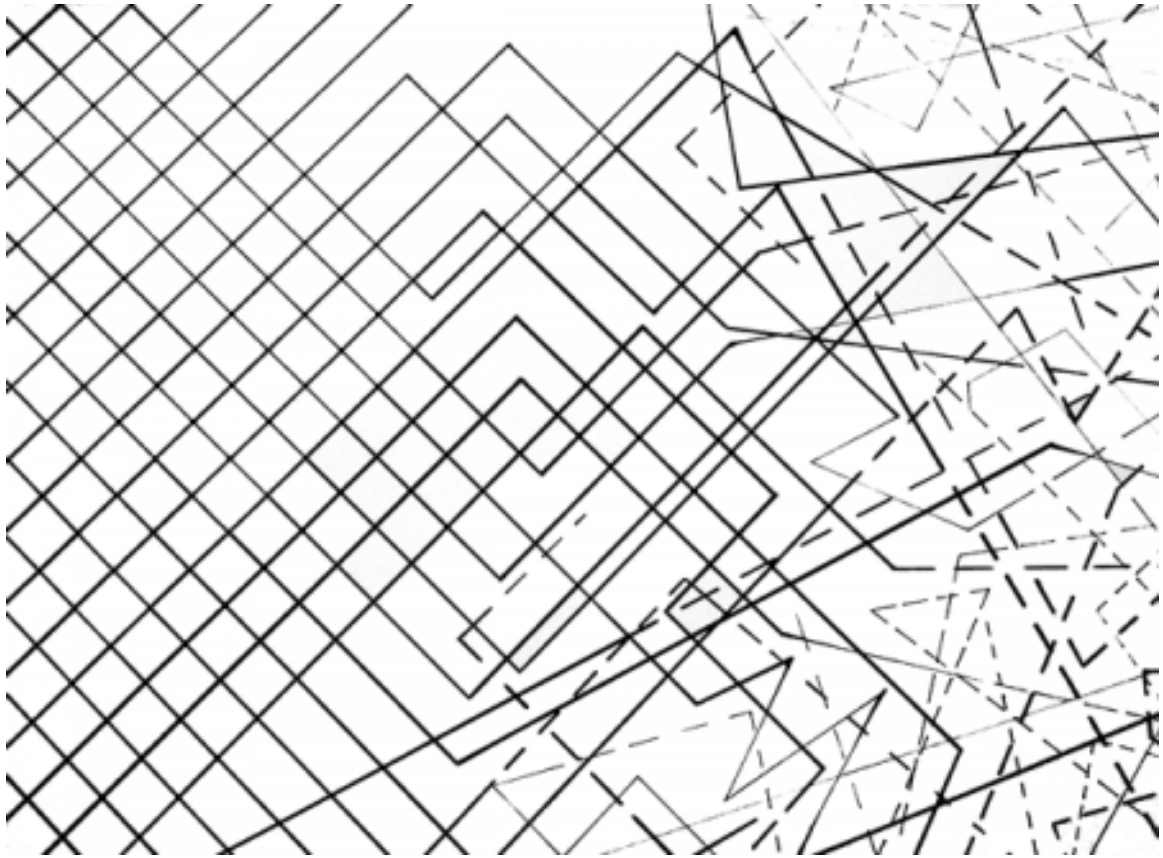
Maintain flexibility as the system evolves.



From order to chaos …

The best designs decay …

- Clones
- Module structure "bad smells".
- …



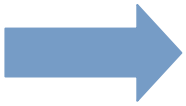
Generalisation and renaming

```
-module (test).
-export([f/1]).

add_one ([H|T]) ->
  [H+1 | add_one(T)];

add_one ([]) -> [].

f(X) -> add_one(X).
```



```
-module (test).
-export([f/1]).

add_int (N, [H|T]) ->
 [H+N | add_int(N,T)];

add_int (N,[]) -> [].

f(X) -> add_int(1, X).
```

Refactoring tool support

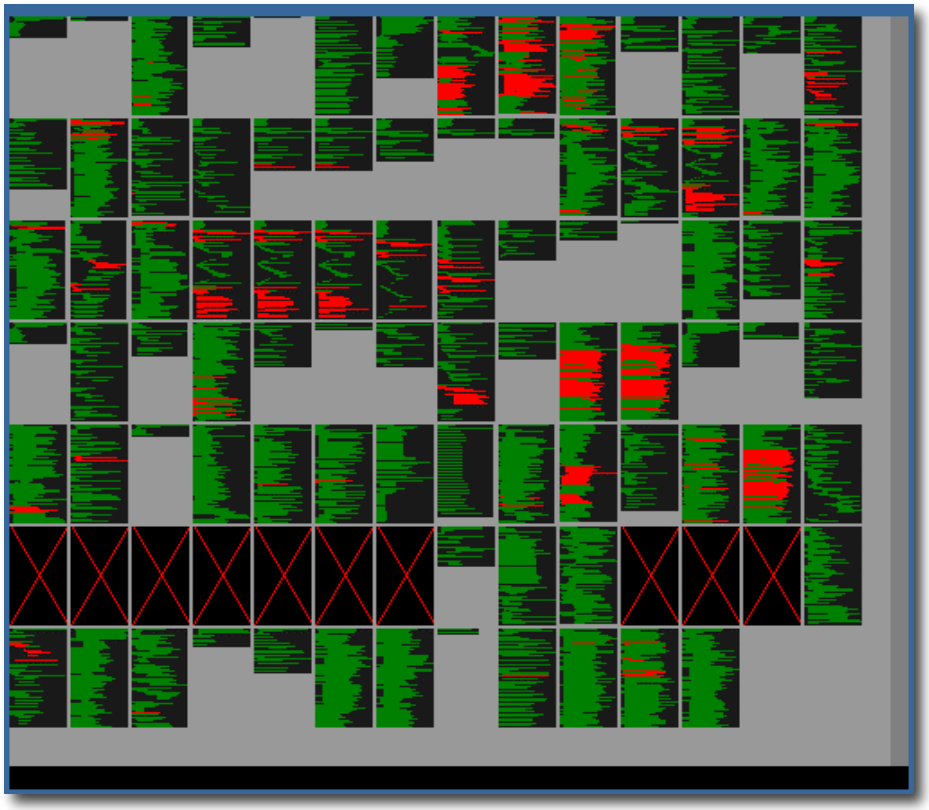
Bureaucratic and diffuse.

Tedious and error prone.

Semantics: scopes, types, modules, …

Undo/redo

Enhanced creativity



Wrangler

Refactoring tool for Erlang

Integrated into Emacs and Eclipse / ErlIDE

Multiple modules

Structural, process, macro refactorings

Basic refactorings

Wrangler

Duplicate code detection …

… and elimination

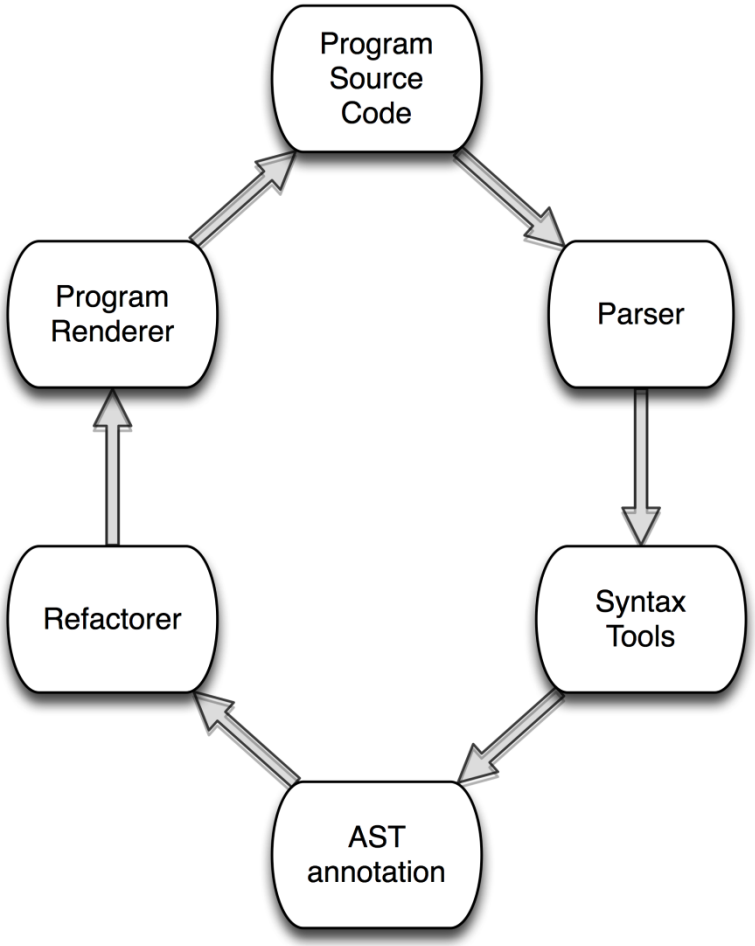
Explore and improve module structure

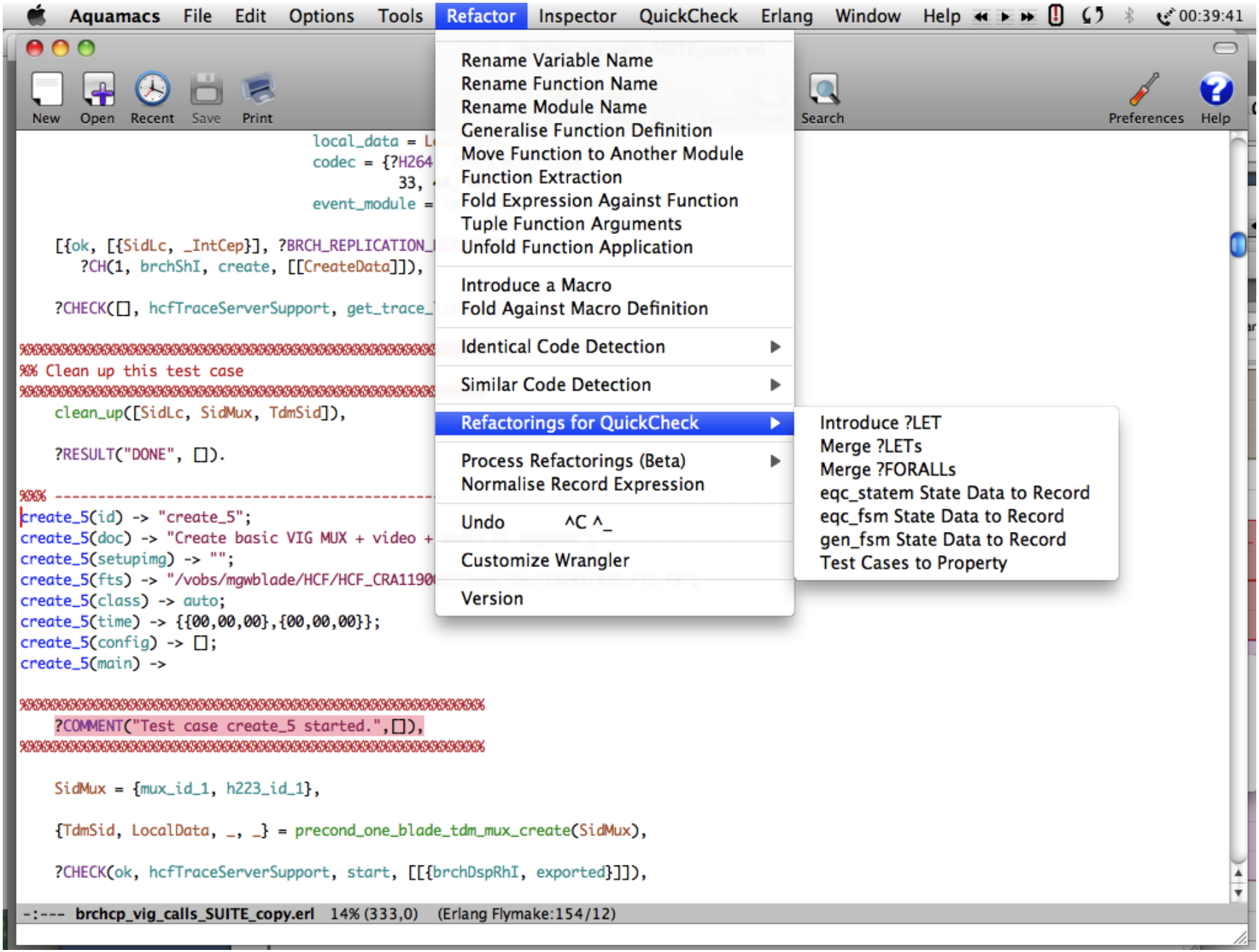
Testing / refactoring

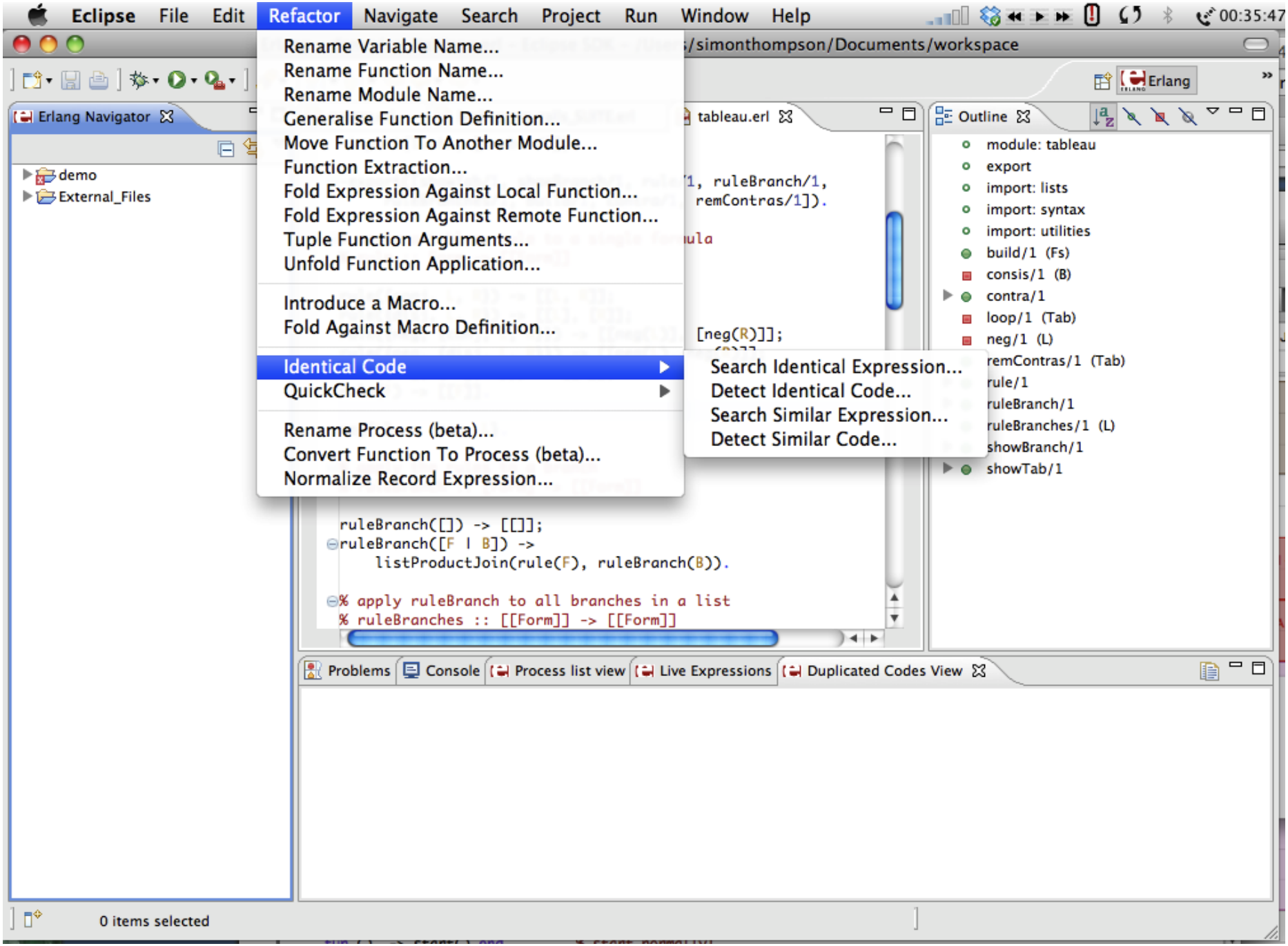
Property discovery

Clone detection + removal	Improve module structure
Basic refactorings	

Architecture of Wrangler




Aquamacs File Edit Options Tools Refactor Inspector QuickCheck Erlang Window Help 00:39:41
New Open Recent Save Print Search Preferences Help
Rename Variable Name
Rename Function Name
Rename Module Name
Generalise Function Definition
Move Function to Another Module
Function Extraction
Fold Expression Against Function
Tuple Function Arguments
Unfold Function Application
Introduce a Macro
Fold Against Macro Definition
Identical Code Detection
Similar Code Detection
Refactorings for QuickCheck
Process Refactorings (Beta)
Normalise Record Expression
Undo ^C ^_
Customize Wrangler
Version
Introduce ?LET
Merge ?LETs
Merge ?FORALLs
eqc_statem State Data to Record
eqc_fsm State Data to Record
gen_fsm State Data to Record
Test Cases to Property
%% Clean up this test case
clean_up([SidLc, SidMux, TdmSid]),
?RESULT("DONE", []).
create_5(id) -> "create_5";
create_5(doc) -> "Create basic VIG MUX + video +
create_5(setupimg) -> "";
create_5(fts) -> "/vobs/mgwblade/HCF/HCF_CRA11900
create_5(class) -> auto;
create_5(time) -> {{00,00,00},{00,00,00}};
create_5(config) -> [];
create_5(main) ->
?COMMENT("Test case create_5 started.",[]),
SidMux = {mux_id_1, h223_id_1},
{TdmSid, LocalData, _, _} = precond_one_blade_tdm_mux_create(SidMux),
?CHECK(ok, hcfTraceServerSupport, start, [[{brchDspRhI, exported}]]),
-:--- brchcp_vig_calls_SUITE_copy.erl 14% (333,0) (Erlang Flymake:154/12)


Eclipse File Edit Refactor Navigate Search Project Run Window Help
Rename Variable Name...
Rename Function Name...
Rename Module Name...
Generalise Function Definition...
Move Function To Another Module...
Function Extraction...
Fold Expression Against Local Function...
Fold Expression Against Remote Function...
Tuple Function Arguments...
Unfold Function Application...
Introduce a Macro...
Fold Against Macro Definition...
Identical Code
QuickCheck
Rename Process (beta)...
Convert Function To Process (beta)...
Normalize Record Expression...
Search Identical Expression...
Detect Identical Code...
Search Similar Expression...
Detect Similar Code...
Erlang Navigator
demo
External_Files
tableau.erl
Outline
module: tableau
export
import: lists
import: syntax
import: utilities
build/1 (Fs)
consis/1 (B)
contra/1
loop/1 (Tab)
neg/1 (L)
remContras/1 (Tab)
rule/1
ruleBranch/1
ruleBranches/1 (L)
showBranch/1
showTab/1
ruleBranch([]) -> [[]];
ruleBranch([F | B]) ->
listProductJoin(rule(F), ruleBranch(B)).
% apply ruleBranch to all branches in a list
% ruleBranches :: [[Form]] -> [[Form]]
Problems
Console
Process list view
Live Expressions
Duplicated Codes View
0 items selected

Demo

Clone detection

Duplicate code considered harmful

It's a *bad smell* …

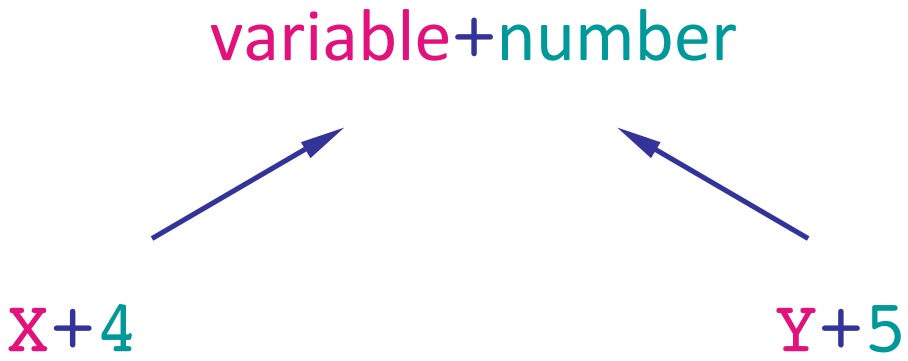
- increases chance of bug propagation,
- increases size of the code,
- increases compile time, and,
- increases the cost of maintenance.

But … it's not always a problem.

Clone detection

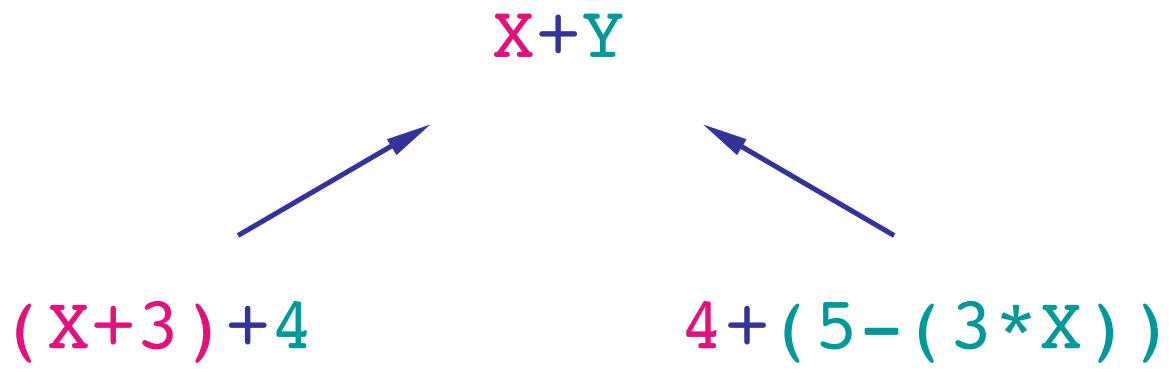
- Hybrid clone detector
  - relatively efficient (suffix tree)
  - no false positives (AST analysis)
- User-guided interactive removal of clones.
- Integrated into development environments.

What is ‘identical’ code?



Identical if values of literals and variables ignored, but respecting binding structure.

What is ‘similar’ code?



The anti-unification gives the (most specific) common generalisation.

Detection	Expression search
All clones in a project meeting the threshold parameters …	All instances of expressions similar to this expression …
… and their common generalisations.	… and their common generalisation.
Default threshold: ≥ 5 expressions and similarity of ≥ 0.8.	Default threshold: ≥ 20 tokens.

Similarity

Threshold: anti-unifier should be big enough relative to the class members:

$$\text{similarity} = \min\left(\frac{\|X+Y\|}{\|(X+3)+4\|}, \frac{\|X+Y\|}{\|4+(5-(3*X))\|}\right)$$

Can also threshold lllength of expression sequence, or number of tokens, or … .

Example: clone candidate

```
S1 = "This",
S2 = " is a ",
S3 = "string",
[S1,S2,S3]
```

```
S1 = "This",
S2 = "is another ",
S3 = "String",
[S3,S2,S1]
```

```
D1 = [1],
D2 = [2],
D3 = [3],
[D1,D2,D3]
```

```
D1 = [X+1],
D2 = [5],
D3 = [6],
[D3,D2,D1]
```

```
? = ?,
? = ?,
? = ?,
[?,?,?]
```

Example: clone from sub-sequence

```
S1 = "This",
S2 = " is a ",
S3 = "string",
[S1,S2,S3]
```

```
S1 = "This",
S2 = "is another ",
S3 = "String",
[S3,S2,S1]
```

```
D1 = [1],
D2 = [2],
D3 = [3],
[D1,D2,D3]
```

```
D1 = [X+1],
D2 = [5],
D3 = [6],
[D3,D2,D1]
```

```
new_fun(NewVar_1,
        NewVar_2,
        NewVar_3) ->
  S1 = NewVar_1,
  S2 = NewVar_2,
  S3 = NewVar_3,
  {S1,S2,S3}.
```

Example: sub-clones

```
S1 = "This",
S2 = " is a ",
S3 = "string",
[S1,S2,S3]
```

```
S1 = "This",
S2 = "is another ",
S3 = "String",
[S3,S2,S1]
```

```
D1 = [1],
D2 = [2],
D3 = [3],
[D1,D2,D3]
```

```
D1 = [X+1],
D2 = [5],
D3 = [6],
[D3,D2,D1]
```

```
new_fun(NewVar_1,
        NewVar_2,
        NewVar_3) ->
  S1 = NewVar_1,
  S2 = NewVar_2,
  S3 = NewVar_3,
  [S1,S2,S3].
```

```
new_fun(NewVar_1,
        NewVar_2,
        NewVar_3) ->
  S1 = NewVar_1,
  S2 = NewVar_2,
  S3 = NewVar_3,
  [S3,S2,S1].
```

Demo

SIP Case Study

Why test code particularly?

Many people touch the code.

Write some tests … write more by copy, paste and modify.

Similarly with long-standing projects, with a large element of legacy code.

“Who you gonna call?”

Can reduce by 20% just by aggressively removing all the clones identified …

… what results is of no value at all.

Need to call in the domain experts.

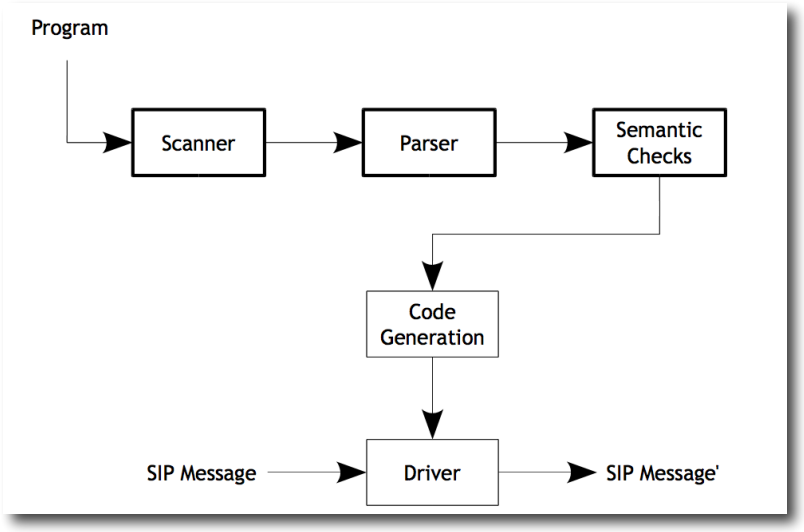
SIP case study

ERICSSON
TAKING YOU FORWARD

SIP message manipulation allows rewriting rules to transform messages.

Test by `smm_SUITE.erl`, 2658 LOC.

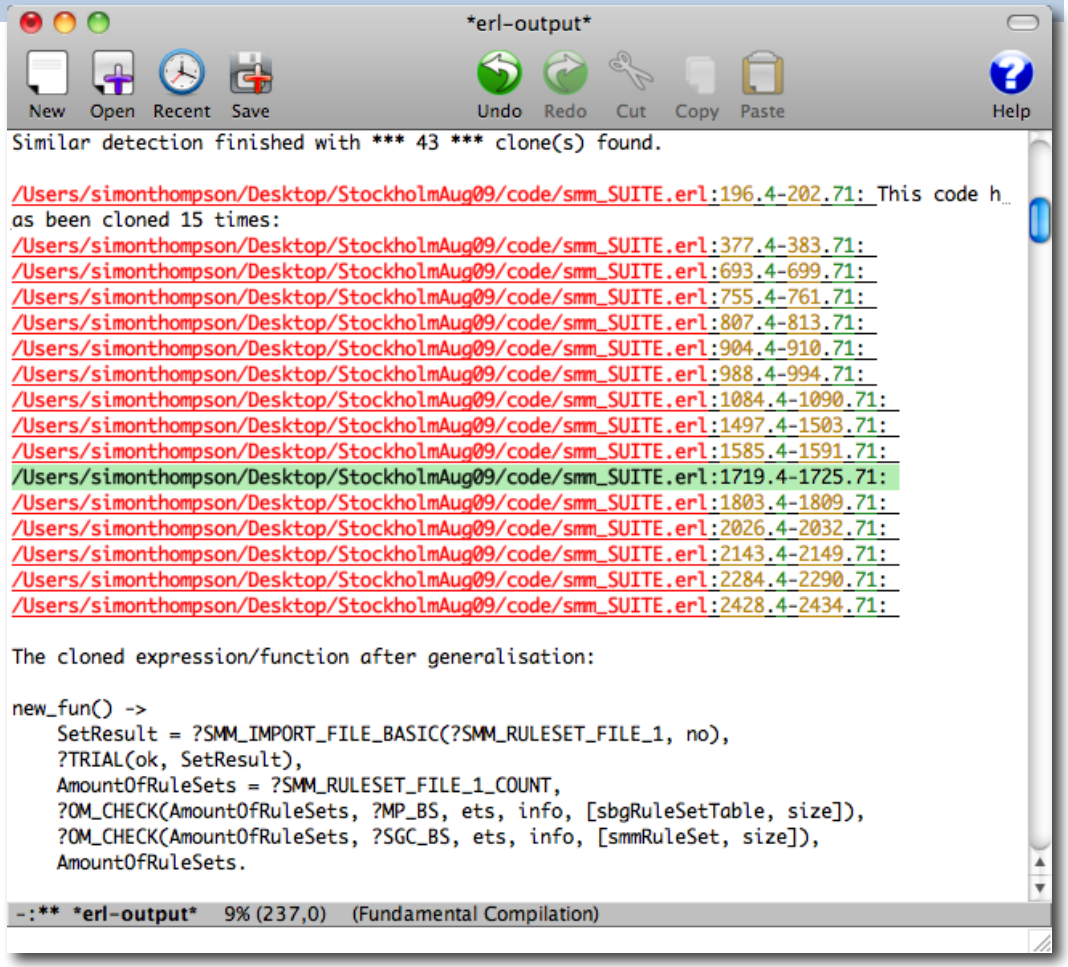
2658 to 2042 in twelve steps.



Step 1

The largest clone class has 15 members.

The suggested function has no parameters, so the code is literally repeated.



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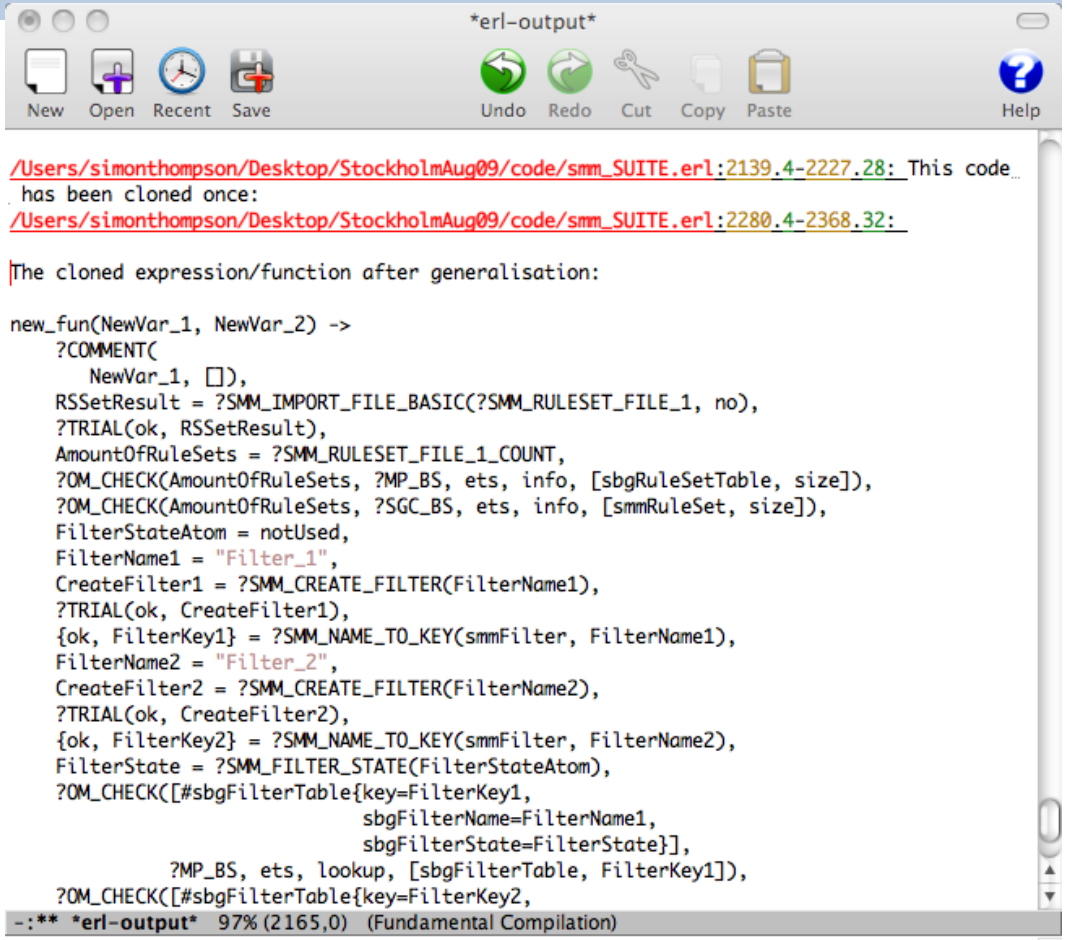
Not step 1

The largest clone has 88 lines, and 2 parameters.

But what does it represent?

What to call it?

Best to work bottom up.



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The general pattern

Identify a clone.

Introduce the corresponding generalisation.

Eliminate all the clone instances.

So what's the complication?

What is the complication?

Which clone to choose?

Include all the code?

How to name functions and variables?

When and how to generalise?

'Widows' and 'orphans'

Module structure inspection

Modularity "Bad Smells"

- Module structure deteriorates over time during development.
- This can be avoided by incremental modularity maintenance.
- Not a "push button" operation …
- … need to know both the problem domain and the program.

Modularity Smells

- Cyclic module dependency.
- Export of functions that are meant to be used internally.
- Module with multiple purposes.
- Very large modules.

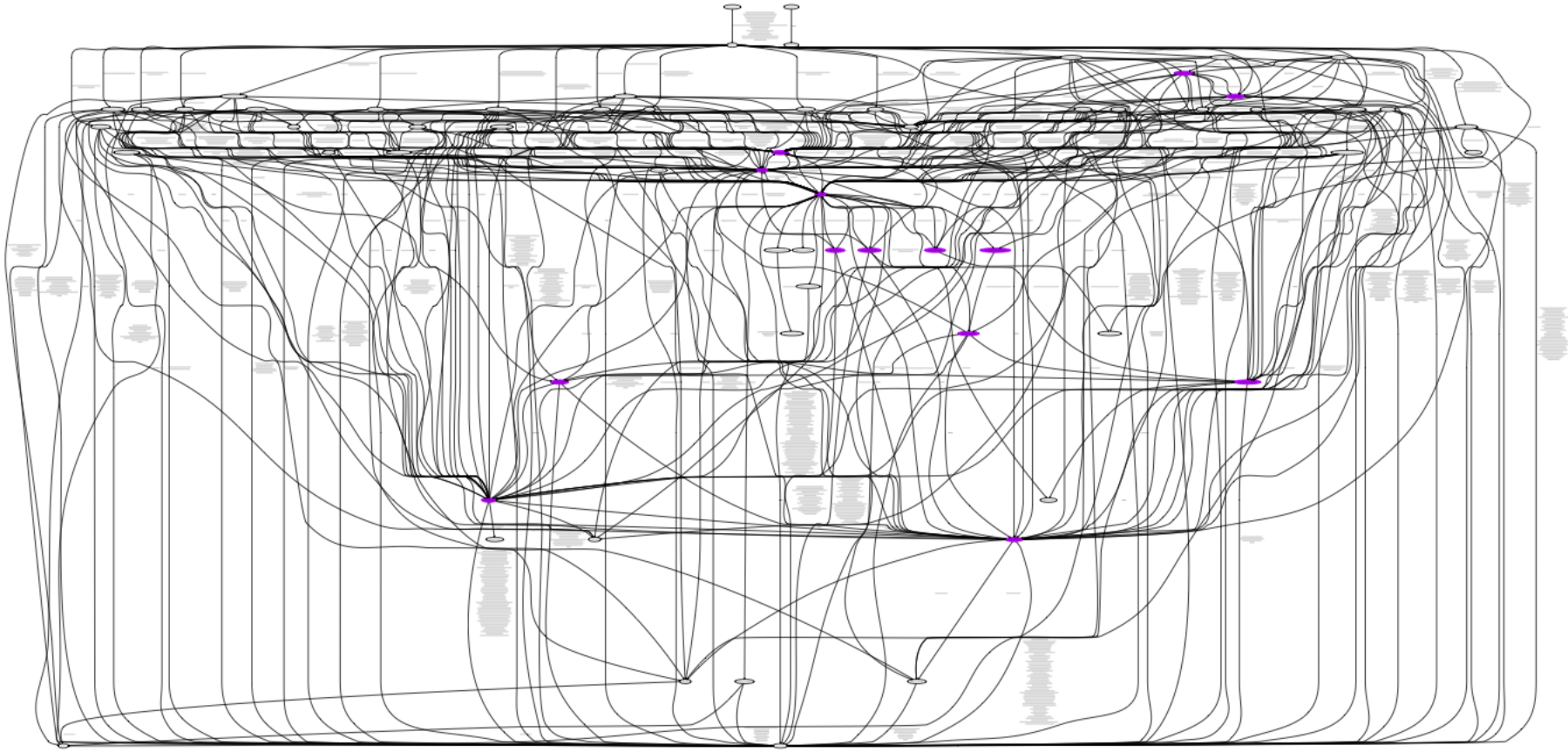
Modularity Smell Elimination

- Key refactoring …

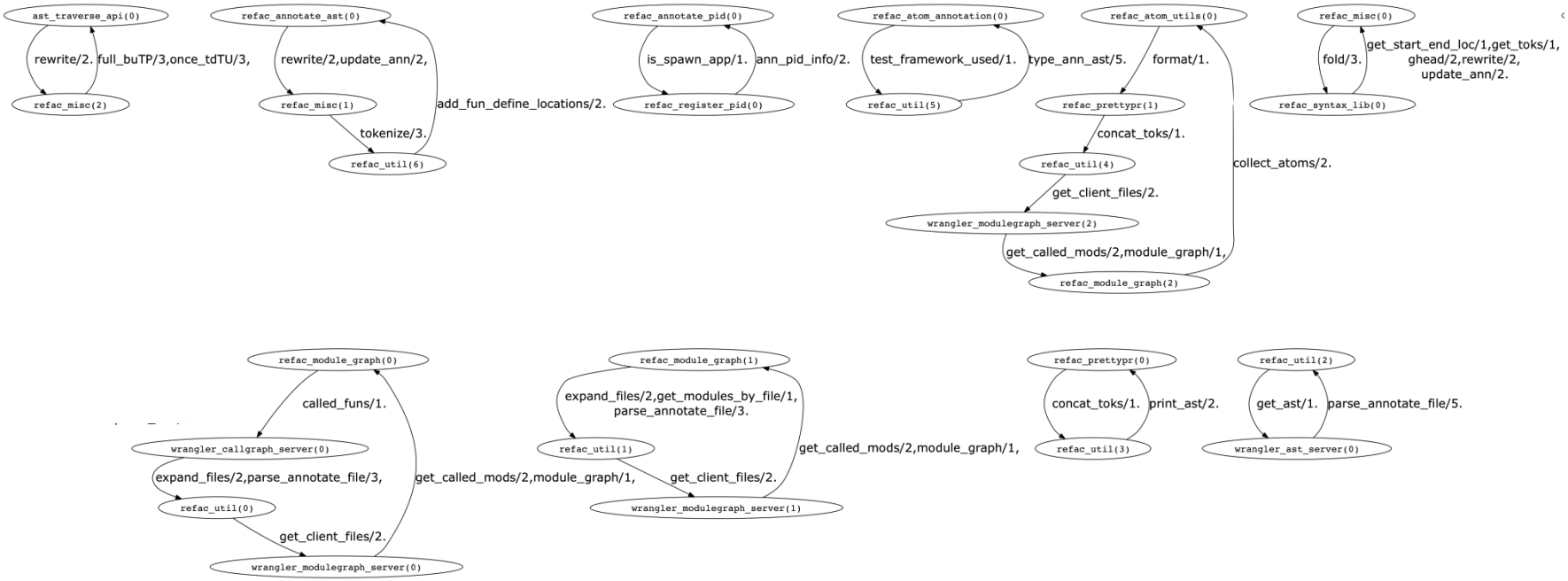
  Move function(s) from one module to another.

- … but, which functions to move, and to where?
- Wrangler aims to detect modularity smells and give refactoring suggestions.

Wrangler module graph



Wrangler cycles



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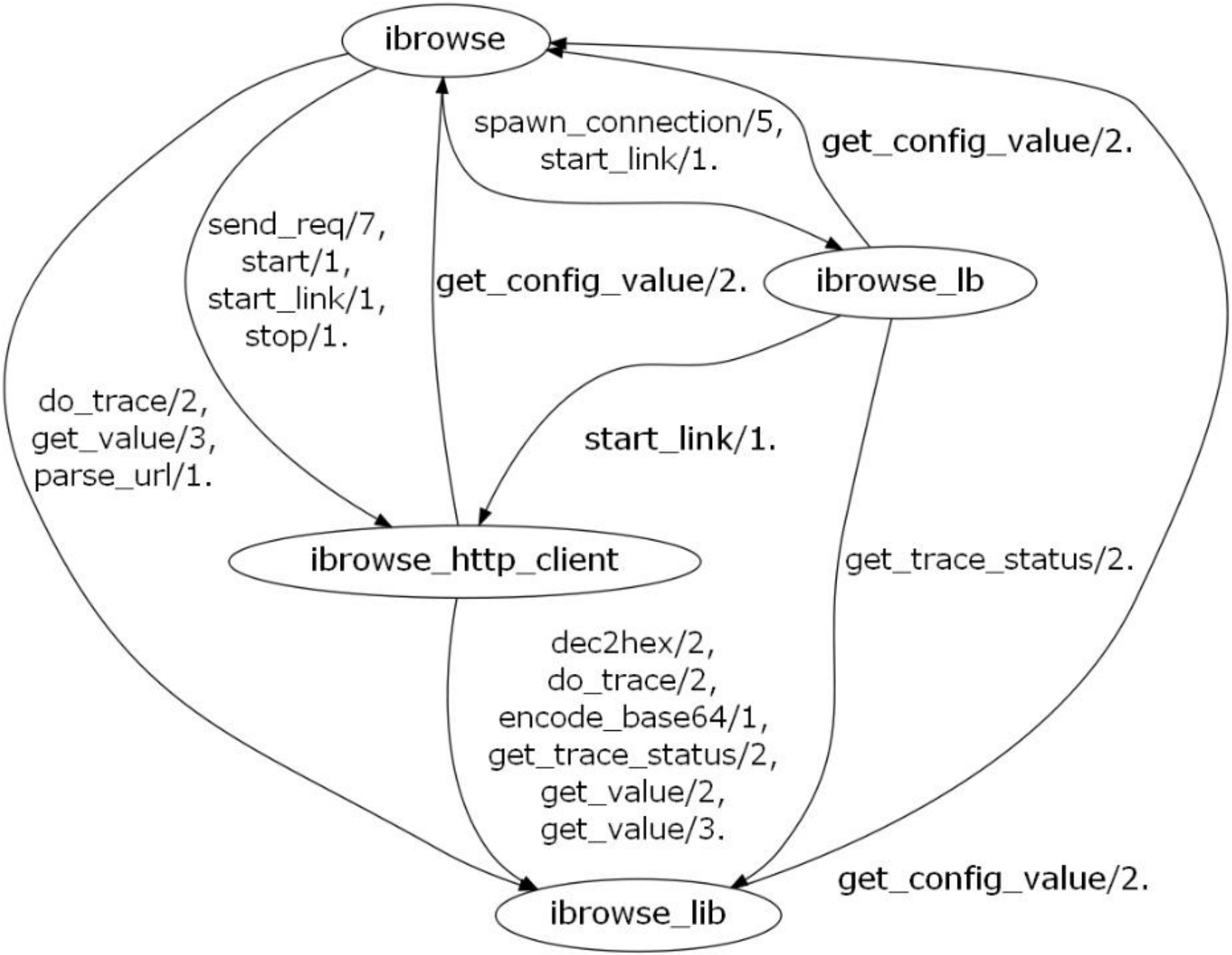
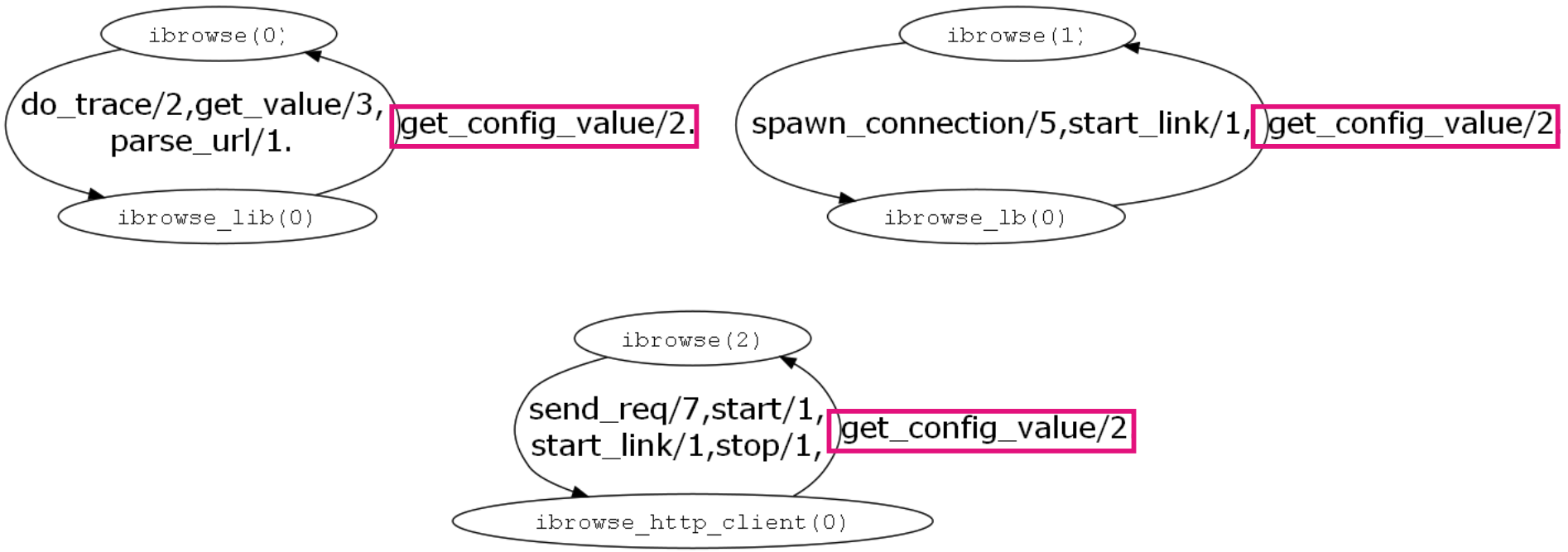
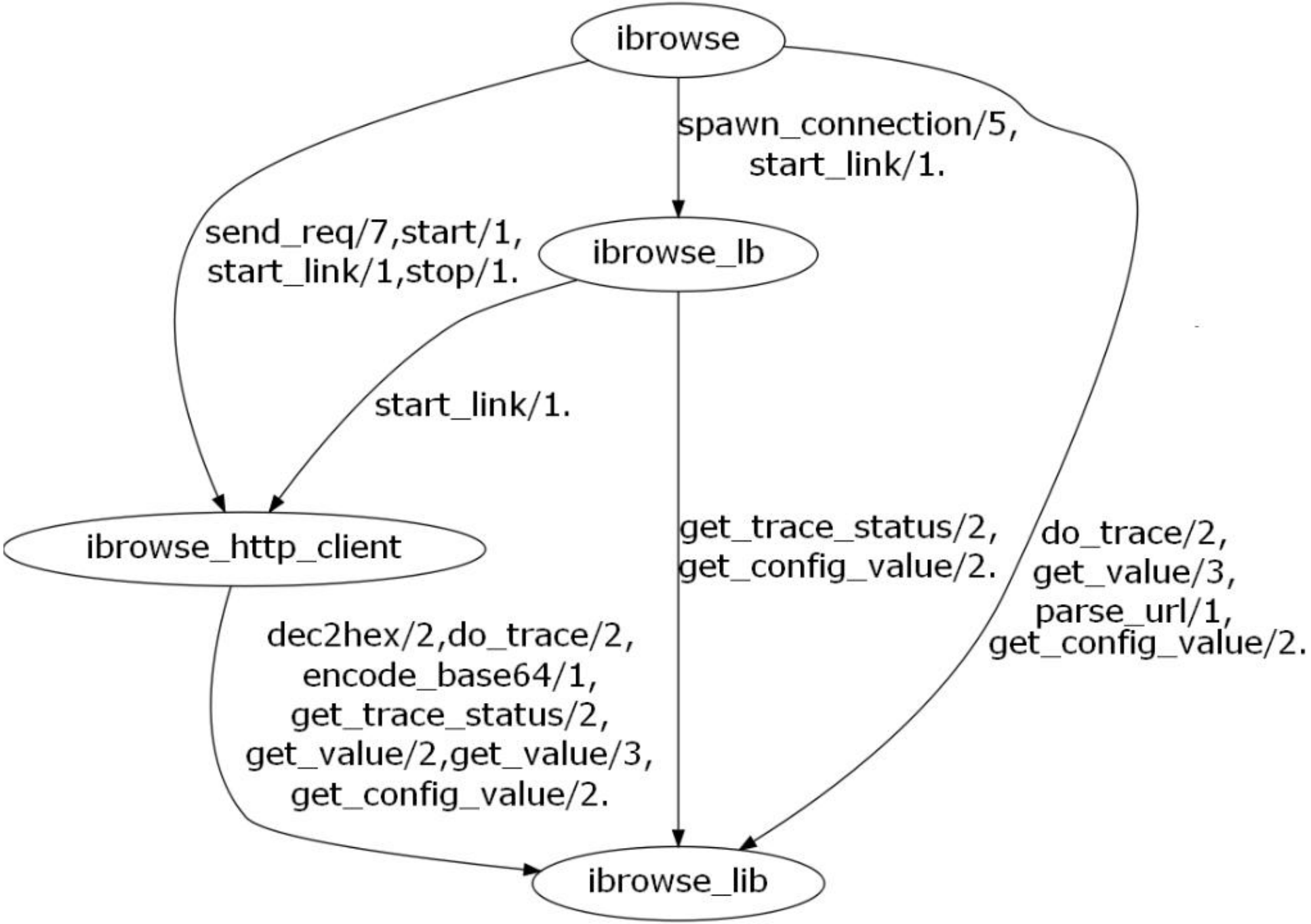

ibrowse
spawn_connection/5,
start_link/1.
get_config_value/2.
send_req/7,
start/1,
start_link/1,
stop/1.
get_config_value/2.
ibrowse_lb
do_trace/2,
get_value/3,
parse_url/1.
start_link/1.
ibrowse_http_client
get_trace_status/2.
dec2hex/2,
do_trace/2,
encode_base64/1,
get_trace_status/2,
get_value/2,
get_value/3.
get_config_value/2.
ibrowse_lib

Ibrowse cycles

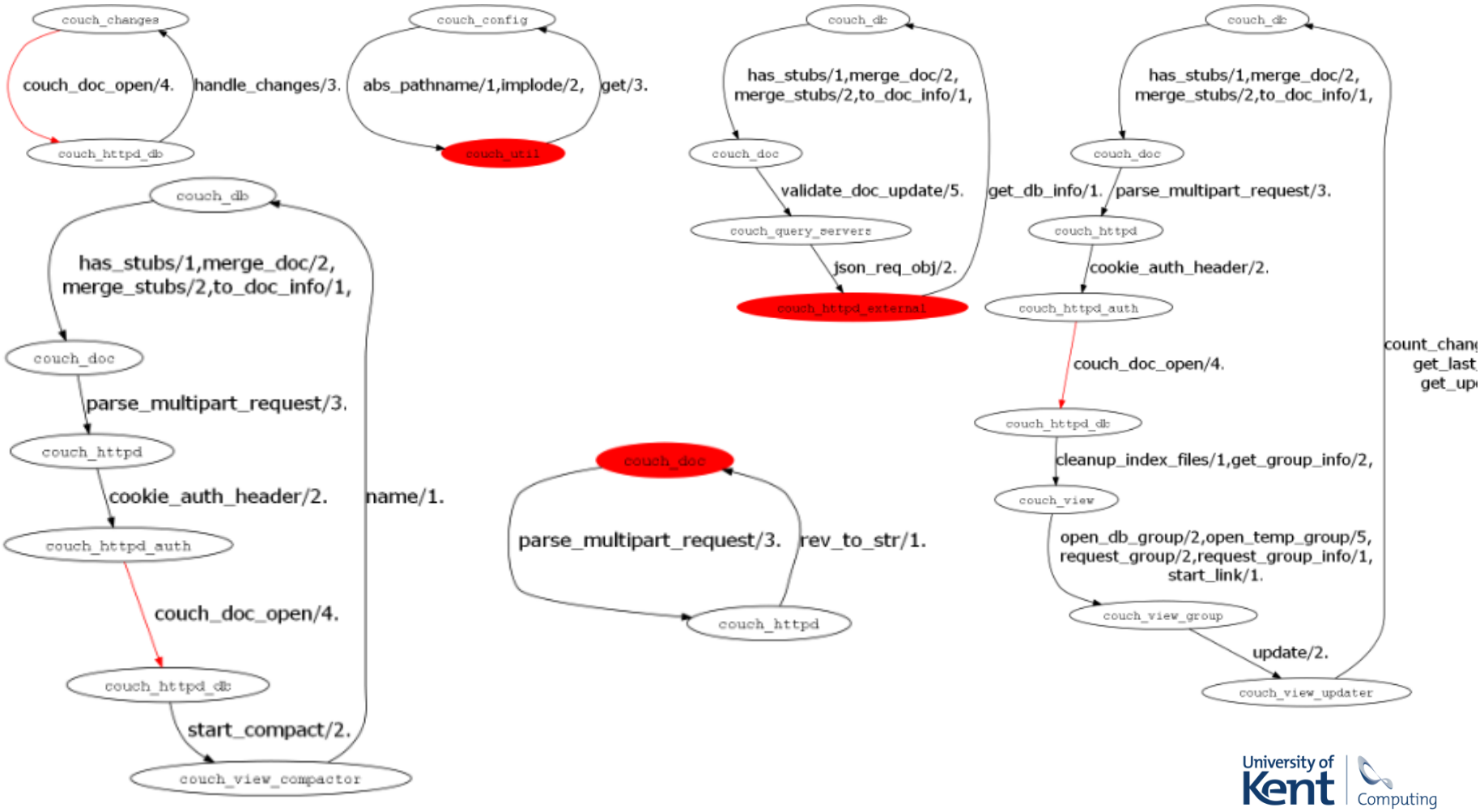



ibrowse
spawn_connection/5,
start_link/1.
send_req/7,start/1,
start_link/1,stop/1.
ibrowse_lb
start_link/1.
ibrowse_http_client
get_trace_status/2,
get_config_value/2.
do_trace/2,
get_value/3,
parse_url/1,
get_config_value/2.
dec2hex/2,do_trace/2,
encode_base64/1,
get_trace_status/2,
get_value/2,get_value/3,
get_config_value/2.
ibrowse_lib

Cyclic Module Dependency

- Reasons for cyclic module dependency:
  - Mutual recursive function definition across multiple modules.
  - API Functions from different logical layers of the system coexist in the same module.
- Some cyclic module dependencies might be legitimate.

Some CouchDB cycles



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Some terminology

- **Intra**-layer dependency: mutually recursive functions across multiple modules.
- **Inter**-layer dependency: mutually recursive modules, but not mutually recursive functions.

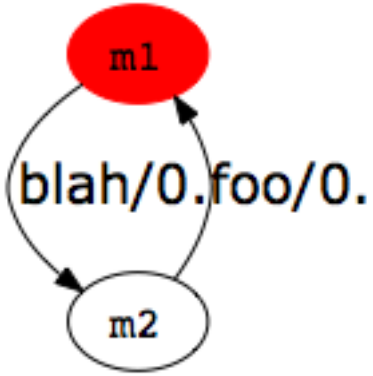
Resolving inter-module cycle

```
-module(m1).
-export([foo/0,bar/0]).

foo() -> 1.
bar() -> m2:blah().
```

```
-module(m2).
-export([blah/0]).

blah() -> m1:foo().
```




```
-module(m1).
-export([bar/0]).

bar() -> m2:blah().
```

```
-module(m2).
-export([blah/0]).

blah() -> m3:foo().
```

```
-module(m3).
-export([foo/0]).

foo() -> 1.
```

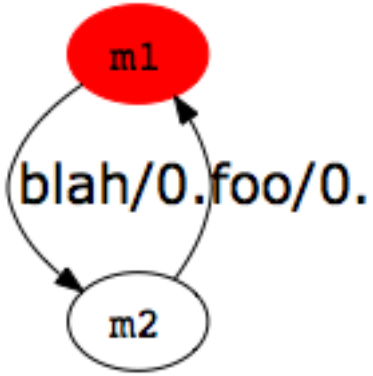
Resolving inter-module cycle

```
-module(m1).
-export([foo/0,bar/0]).

foo() -> 1.
bar() -> m2:blah().
```

```
-module(m2).
-export([blah/0]).

blah() -> m1:foo().
```




```
-module(m1).
-export([bar/0]).

foo() -> 1.
```

```
-module(m2).
-export([blah/0]).

blah() -> m1:foo().
```

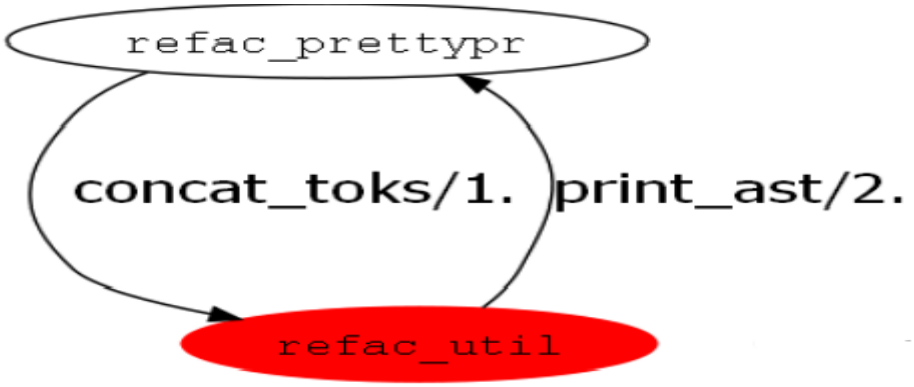
```
-module(m3).
-export([bar/0]).

bar() -> m2:blah().
```

Cyclic Module Dependency

- For each cyclic module dependency, Wrangler gives refactoring suggestions.

e.g.



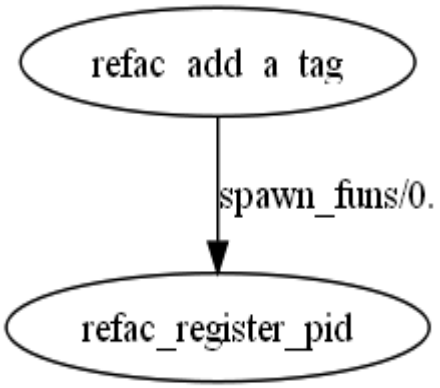

```
Inter-layer cyclic module dependency: [refac_prettypr,refac_util]
Refactoring suggestion:
move_fun(refac_util, [{write_refactored_files,1},
{write_refactored_files,3}, {write_refactored_files,4}],
user_supplied_target_mod).
```

Identifying "API" functions

- Identify by examining call graph.
- API functions are those …
  - … not used internally,
  - … "close to" other API functions
- Others are seen as *internal*, external calls to these are deemed *improper*.

Improper inter-module calls

```
wrangler_code_inspector:improper_inter
_module_calls("/Users/simonthompson/De
sktop/improper_module_dependency.dot",
["/Users/simonthompson/erlang/systems/
wrangler-0.8.8/src"]).
```



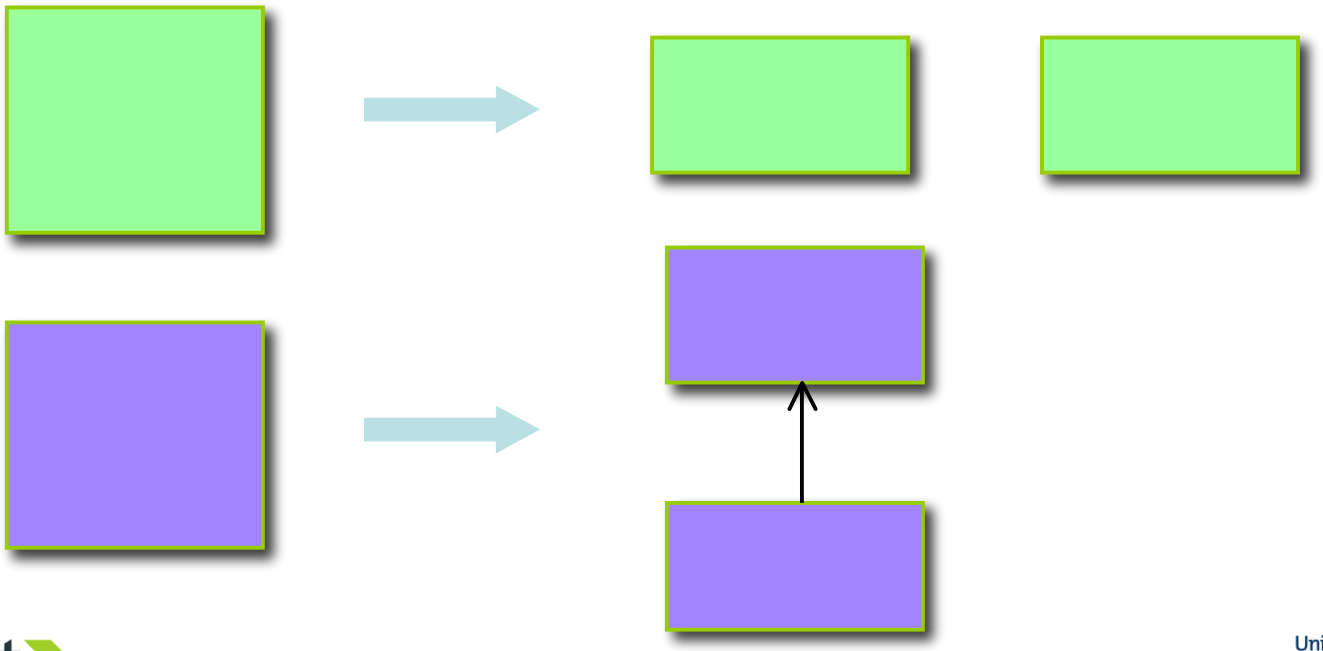

```
Refactoring suggestions:
refac_move_fun:move_fun({refac_register_pid,spawn_fun
s,0},[refac_syntax_lib,refac_misc,refac_annotate_pid,
refac_slice,refac_syntax,ast_traverse_api,interface_a
pi,refac_util]).
```

Large Modules

- A module should not contain more that 400 lines of source code according to the Erlang programming rules.
- A very large module is likely to serve more than one purpose or contain too many internal functions.

Large Modules

- A large module could be partitioned into two or more smaller modules.



Large Modules

- Partition the exports of a module into groups using similarity metrics, each group forms an export attribute.
- Agglomerative hierarchical algorithm using Jaccard similarity coefficient.
- Functions specified in an export attribute can be moved to another module together.

Demo

Going further

Property discovery in Wrangler

Find (test) code that is similar …

… build a common abstraction

… accumulate the instances

… and generalise the instances.

Example:

Test code from Ericsson: different media and codecs.

Generalisation to all medium/codec combinations.

www.cs.kent.ac.uk/projects/wrangler/
→ GettingStarted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Next steps

Refine the notion of similarity …

… to take account of insert / delete in command seqs.

Scaling up: look for incremental version; check vs. libraries …

Refactorings of tests and properties themselves.

Extracting FSMs from sets of tests.

Support property extraction from 'free' and EUnit tests.

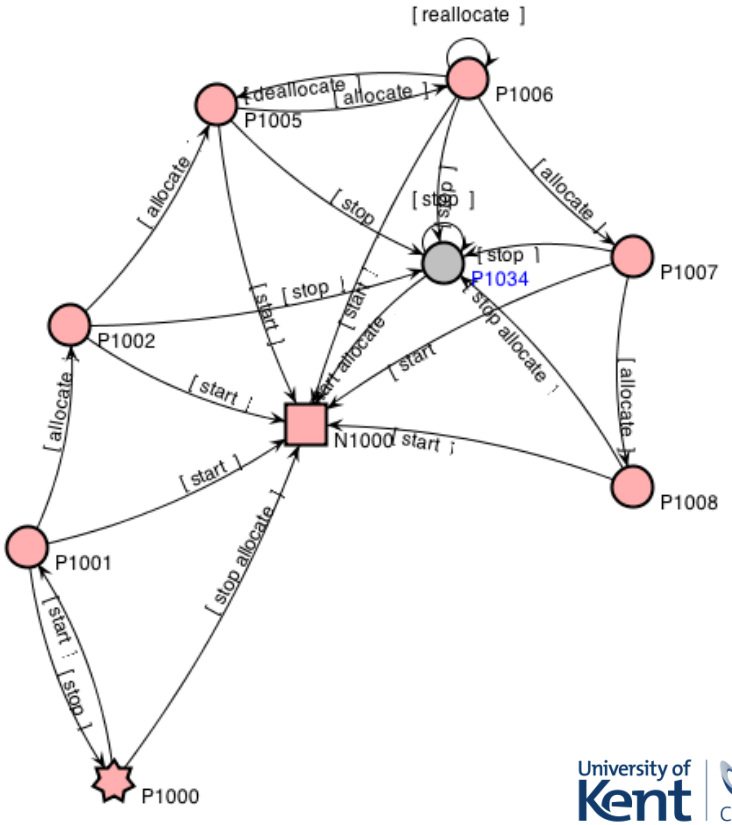
Systems test: FSM discovery

Use FSM to model expected behaviour.

Test random paths through the FSM to test system function.

Extract the FSM from sets of existing test cases.

Use +ve and -ve cases.



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Refactoring and testing

Refactor tests e.g.

- Tests into EUnit tests.
- Group EUnit tests into a single test generator.
- Move EUnit tests into a separate test module.
- Normalise EUnit tests.
- Extract setup and tear-down into EUnit fixtures.

Respect test code in EUnit, QuickCheck and Common Test …

… and refactor tests along with refactoring the code itself.

www.cs.kent.ac.uk/projects/wrangler/
→ GettingStarted