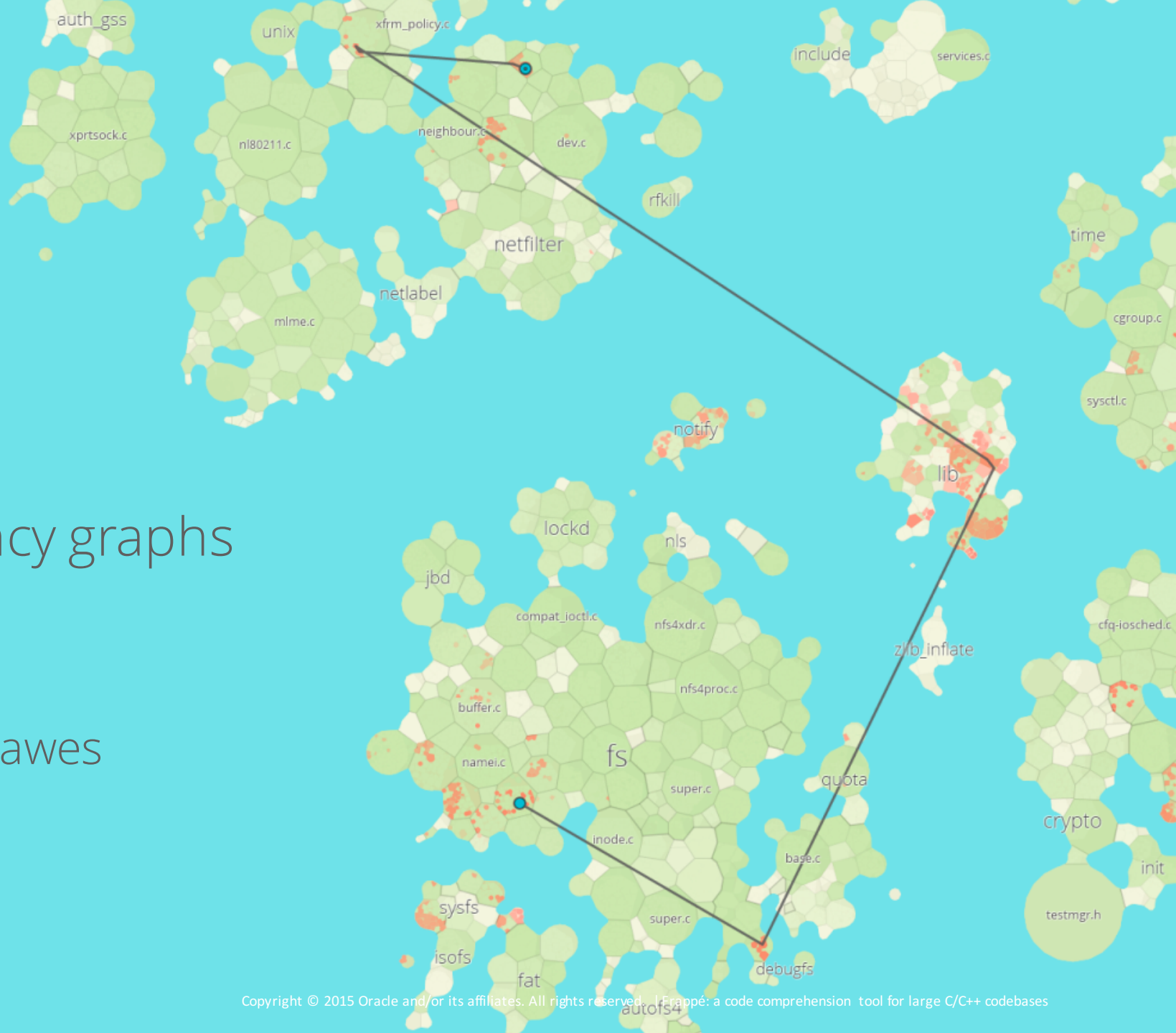


# FRAPPÉ

## Querying and managing evolving code dependency graphs

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Oracle Labs Australia

June 2016

ORACLE

 

# Safe Harbour

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# The Truth is in the Source!

**But the source is often complicated, multi-language and really really big**

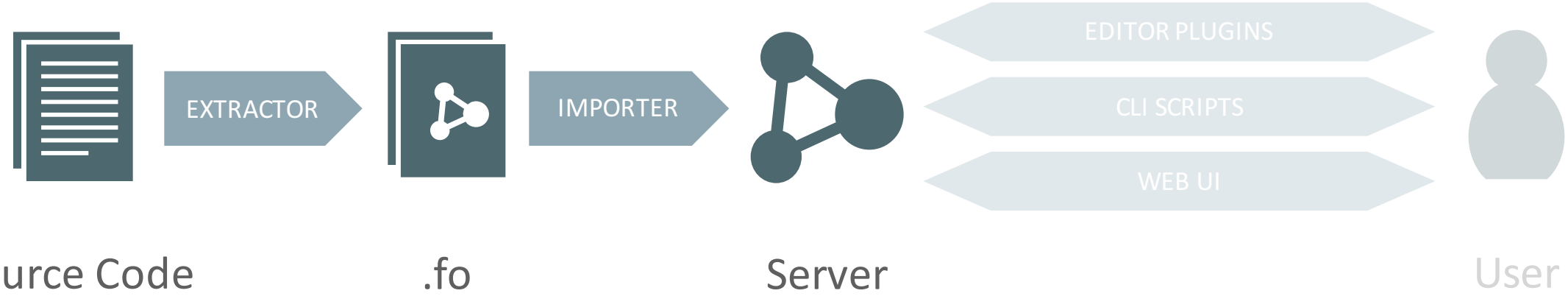
 

# Frappé: code as a property graph

- Graph natural in this domain
  - Call graph, directory hierarchy, type hierarchy, data/control flow graphs
- Overlay data from different spaces
  - File system, build, preprocessor, AST, cross-language
- Lets users specify queries in terms of this graph

# How it works



# Graph model example

foo.h

```
int bar(int);
```

foo.c

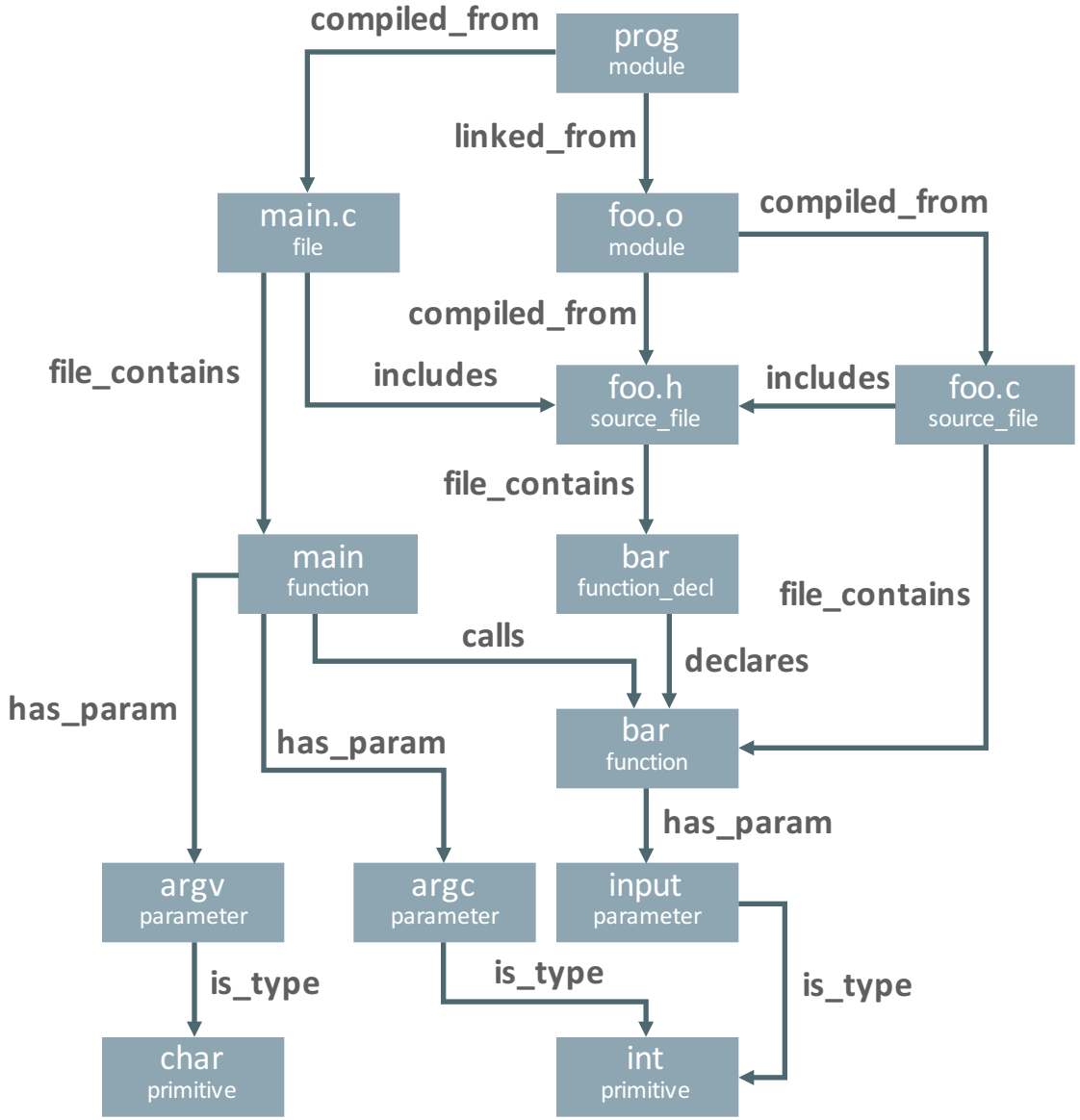
```
#include “foo.h”
int bar(int *input) {
  return *input * 2;
}
```

main.c

```
#include “foo.h”
int main(int argc, char **argv) {
  return bar(&argc);
}
```

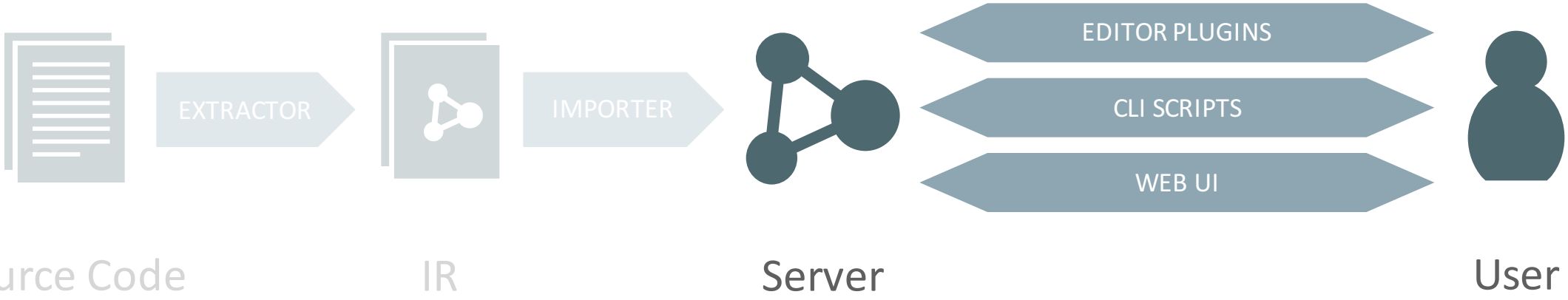
build

```
gcc foo.c –c –o foo.o
gcc main.c foo.o –o prog
```



# How it works



# Use cases

- Code search
- Code navigation
  - Go to definition
  - Find references

- Code comprehension
  - Visualization
  - Transitive closure calls, includes, etc.
  - Shortest path queries

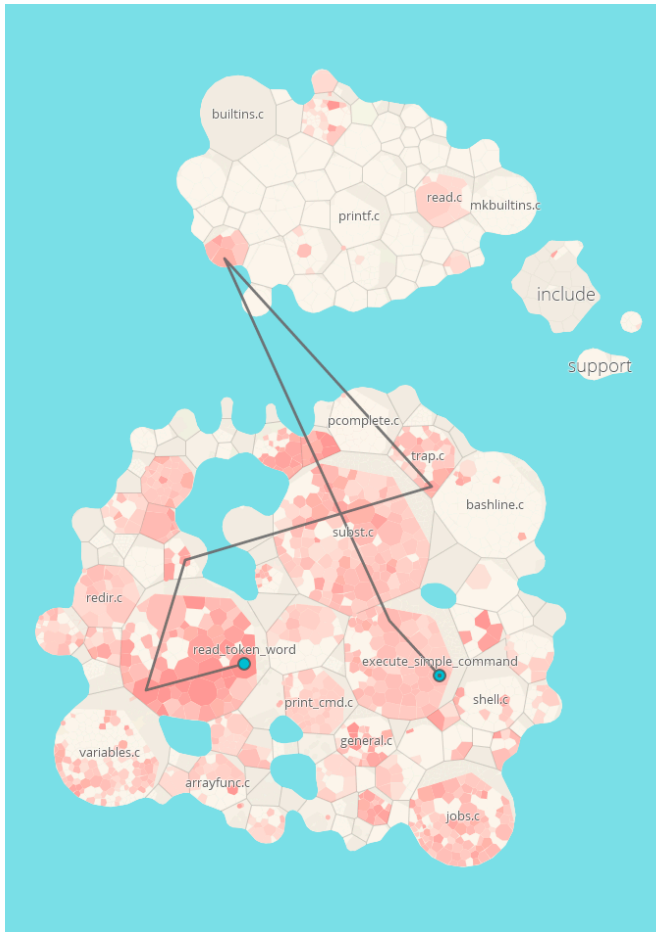
 

# How it looks

```
357
358 /* Return the working directory for the curren
359    job_working_directory, this does not call r
360    of the functions it calls.  This is so that
361    from a signal handler. */
362 static char *
363 current_working_directory ()
364 {
365   char *dir;
366   static char d[PATH_MAX];
367
368   dir = get_string_value ("PWD");
369
370   if (dir == 0 && the_current_working_director
371     dir = the_current_working_directory;
372
373   if (dir == 0)
374     {
375       dir = getcwd (d, sizeof(d));
376       if (dir)
377         dir = d;
378     }
jobs.c
References to "current_working_directory" (node 1
declared by Function… current_working…
called by   Function  print_pipeline   at jobs.c
called by   Function  start_job        at jobs.c
called by   Function  notify_of_job_s… at jobs.c
called by   Function  notify_of_job_s… at jobs.c
~
~
~
```

F **rl_rubout**
lib/readline/text.c

```
1058 /* Rubout the character behind point. */
1059 int
1060 rl_rubout (count, key)
1061      int count, key;
1062 {
1063   if (count < 0)
1064     return (rl_delete (-count, key));
1065
1066   if (!rl_point)
1067     {
1068       rl_ding ();
1069       return -1;
1070     }
1071
1072   if (rl_insert_mode == RL_IM_OVERWRITE)
1073     return (_rl_overwrite_rubout (count, key));
1074
1075   return (_rl_rubout_char (count, key));
1076 }
```



# Use cases

- Code search
- Code navigation
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- Code comprehension
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  - Transitive closure calls, includes, etc.
  - Reachability queries

Queries and Neo4j performance detailed in GRADES'15 paper:

"Frappé: Querying the Linux Kernel dependency graph"

 

# Code search


 

# Code search


```
(n with name='foo.c')
```



 

# Code search


```
(n with name='foo.c')
```

```
struct foo {
    int c;
}
```

 

# Code search

foo.c

```
(c with name='foo')
   -[:contains]->
 (n with name='c')
        UNION
(n with name='foo.c')
```

```
struct foo {
    int c;
}
```



 

# Code search

foo.c

```
(c with name='foo')
   -[:contains]->
  (n with name='c')
        UNION
(n with name='foo.c')
```

```
struct bar {
    int c;
}

typedef struct bar foo;
```

 

# Code search

foo.c

```
(c with name ‘foo’)
-[:aliases*]->()-[:contains]->
(n with name=‘c’)
UNION
(n with name=‘foo.c’)
```

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# Code search

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# Use cases

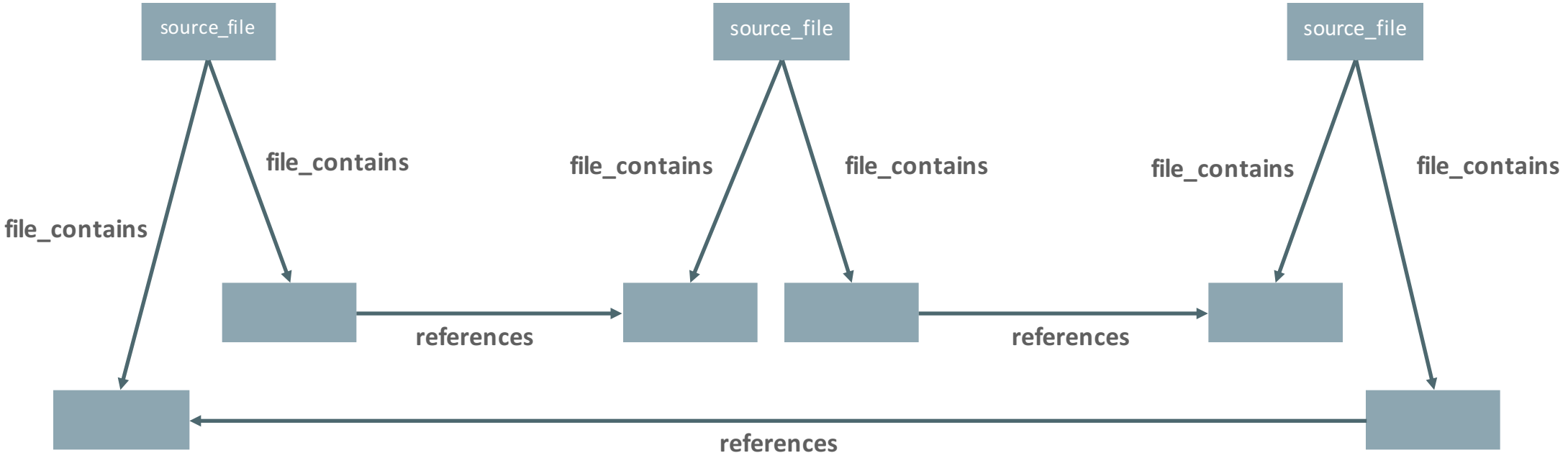
- Code search
- Code navigation
  - Go to definition
  - Find references
- Code comprehension
  - Visualization
  - Transitive closure calls, includes, etc.
  - Reachability queries

- Custom user queries
  - (Anti) pattern detection
  - *Expose query language*

Queries and Neo4j performance detailed in GRADES'15 paper:

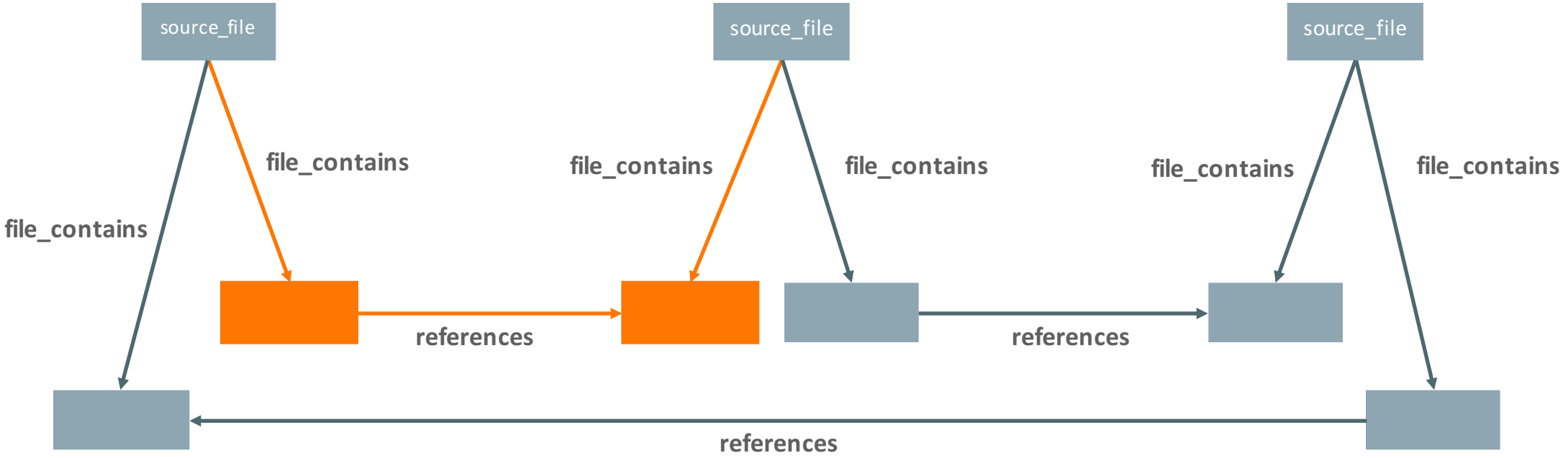
"Frappé: Querying the Linux Kernel dependency graph"

# Dependency cycle



# Dependency cycle



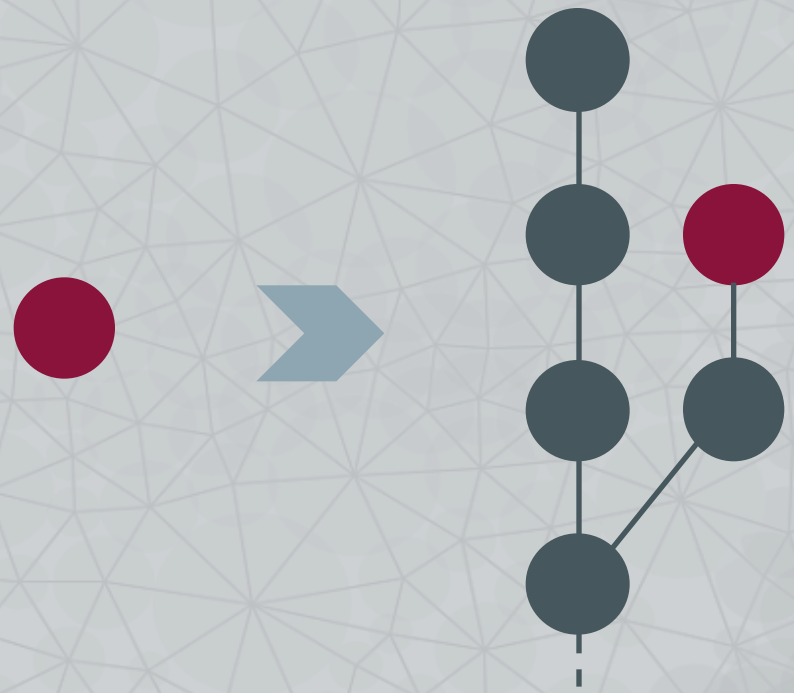
# Dependency cycle


```
                                    ()-[
:includes | uses_namespace | expands | interrogates | undefined | aliases |
  uses_enumerator | has_friend | isa_type | extends | uses_type | throws |
has_ret_type | has_param_type | calls | may_call | overridden_by | declares
| reads | writes | dereferences | address_of | type_of | size_of | align_of
                                    | casts_to
                                    ]->()
```

# BUT

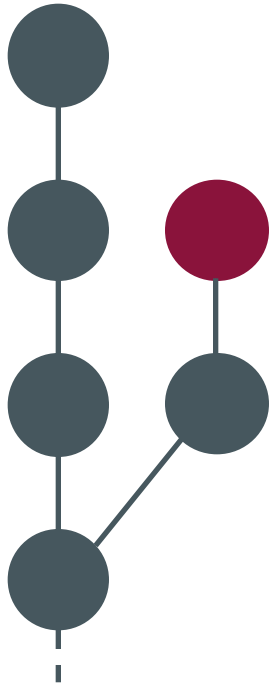
**Developers working off of different versions of the code**



# Target Scenario

- 1000s of developers working from main branch
- Changes merged regularly
- Most developers working off of versions from the past **30** days



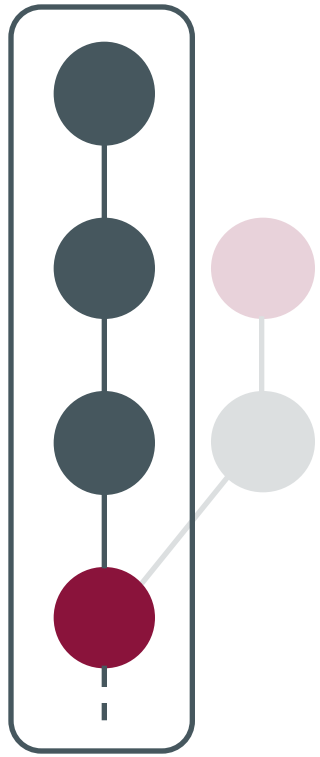


# Current Deployment

- Separate Neo4j instance for the most recent **5** versions of the code
- New graph generated in nightly regression
- Script on the client to determine which server to connect to

- Deployment effort and complexity
- Inefficient use of resources
  - Redundant data
  - Memory requirements





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- Separate Neo4j instance for the most recent **5** versions of the code
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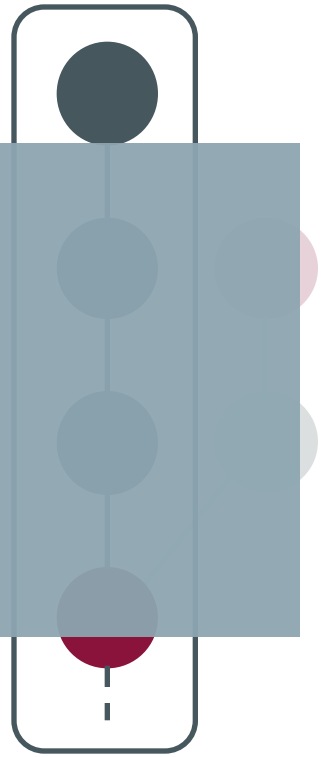
Single logical server with multiple versions and efficient storage



# Use cases for multiple versions

- Single version use cases per version

Select version

- Code review: 2 versions
  - Are there any architectural constraints being newly violated?
  - Are there any new usages of deprecated methods?
  - Are any methods now unused?

# Version selection

```
PATH vcalls := () -[:call WITH 1013 between fromV and toV]-> ()
SELECT path
FROM freebsd
WHERE path =
  (:function WITH name='source’, 1013 between fromV and toV)
  -/:vcalls*/->
  (:function WITH name='sink’, 1013 between fromV and toV)
```

VS

```
SELECT path
FROM freebsd@1013
WHERE path =
  (:function WITH name='source') -/:calls*/-> (:function WITH name='sink')
```

# Use cases for multiple versions

- Single version use cases per version

- Code review: 2 versions
  - Are there any architectural constraints being newly violated?
  - Are there any new usages of deprecated methods?
  - Are any methods now unused?

Match in each version
+
Compare results

# Compare results

```
SELECT path
FROM freebsd@1013
WHERE path =
  (:function WITH name='source') -/:calls*/-> (:function WITH name='sink')
DIFFERENCE
SELECT path
FROM freebsd@1014
WHERE path =
  (:function WITH name='source') -/:calls*/-> (:function WITH name='sink')
```

VS

```
SELECT DIFFERENCE path
FROM freebsd@1013, freebsd@1014
WHERE path =
  (:function WITH name='source') -/:calls*/-> (:function WITH name='sink')
```

# Open Questions

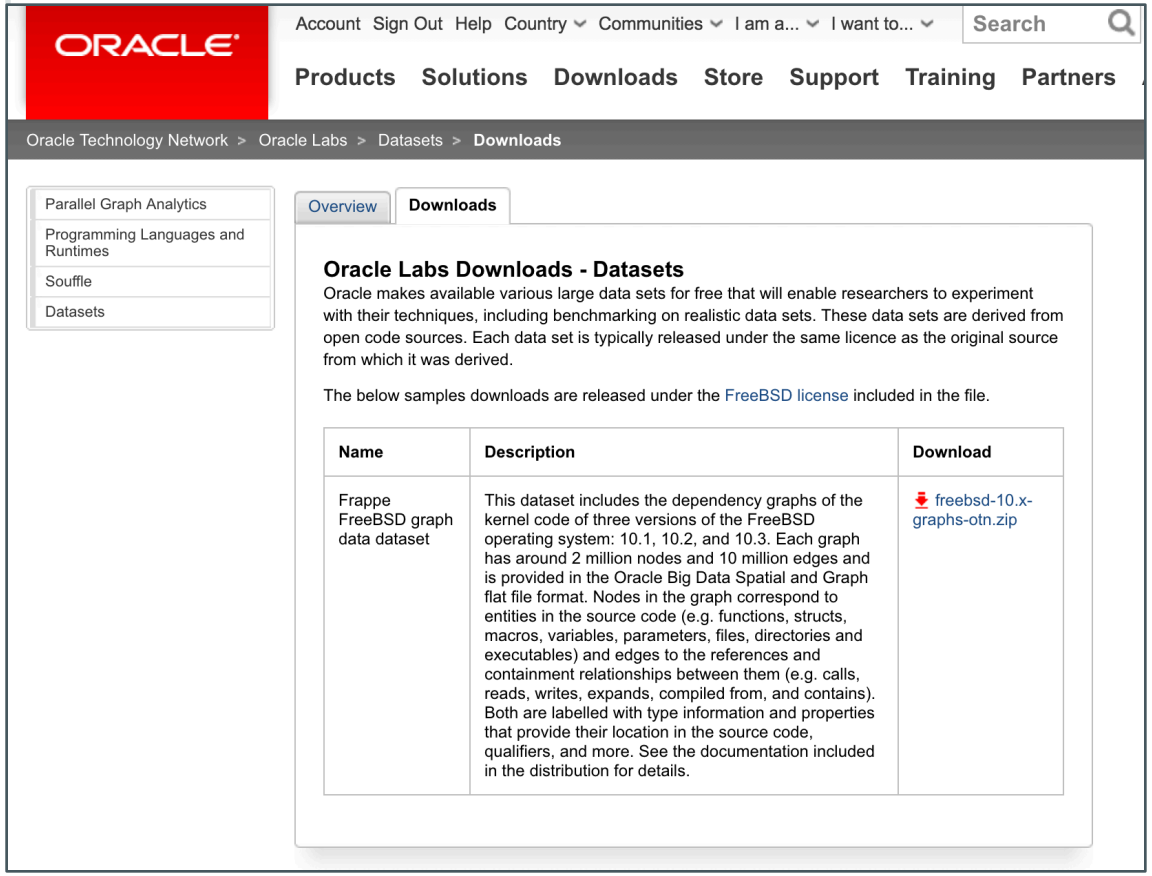
- Node/Edge identity
  - Supplied or derived using graph information
- Query language expressiveness
  - Regular path expressions
  - Multiple edge labels
- Efficient storage and querying for multiple graph versions:
  - List or ideally DAG of versions
  - Union, intersection, difference of results from different versions
  - Query language that abstracts away versioning

# FreeBSD dataset available on OTN

- Includes graphs of 10.1, 10.2, 10.3 kernel + documentation
- Each graph
  - Extracted from 10M LOC
  - 2 million vertices
  - 10 million edges
- Try it out and get in touch:
  - nathan.hawes@oracle.com
    david meibusch@oracle.com
    ben.barham@oracle.com

http://www.oracle.com/technetwork/oracle-labs/datasets/downloads/index.html

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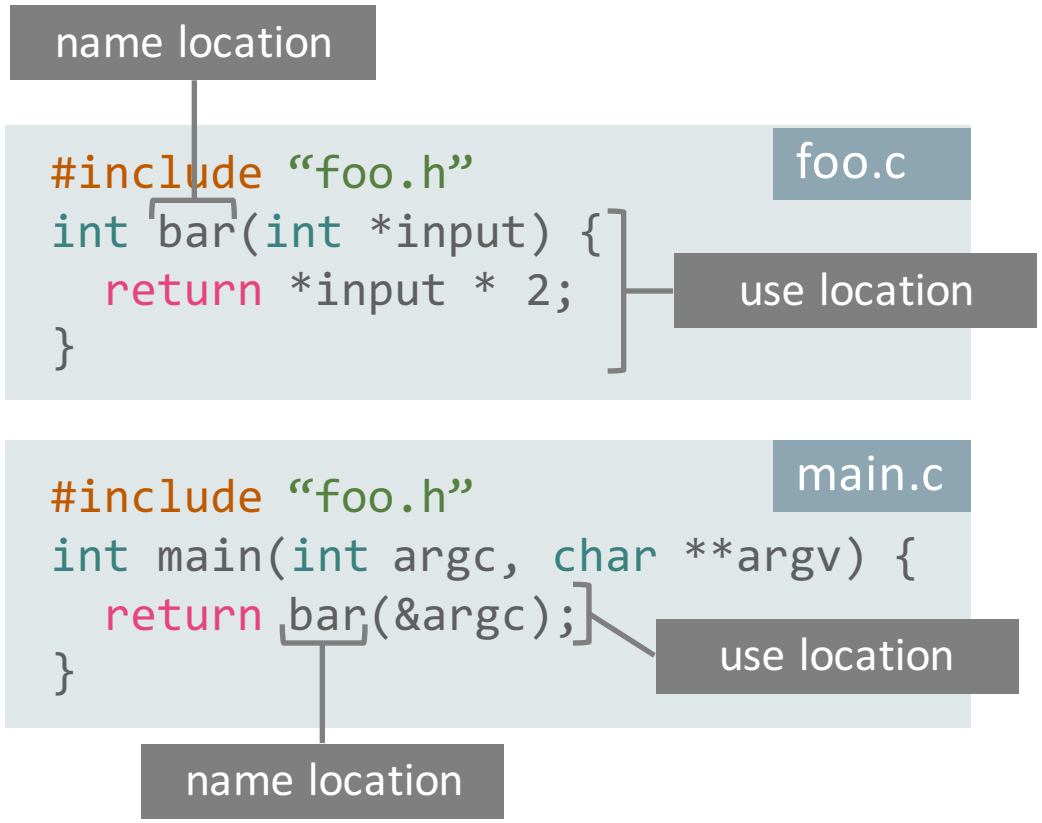
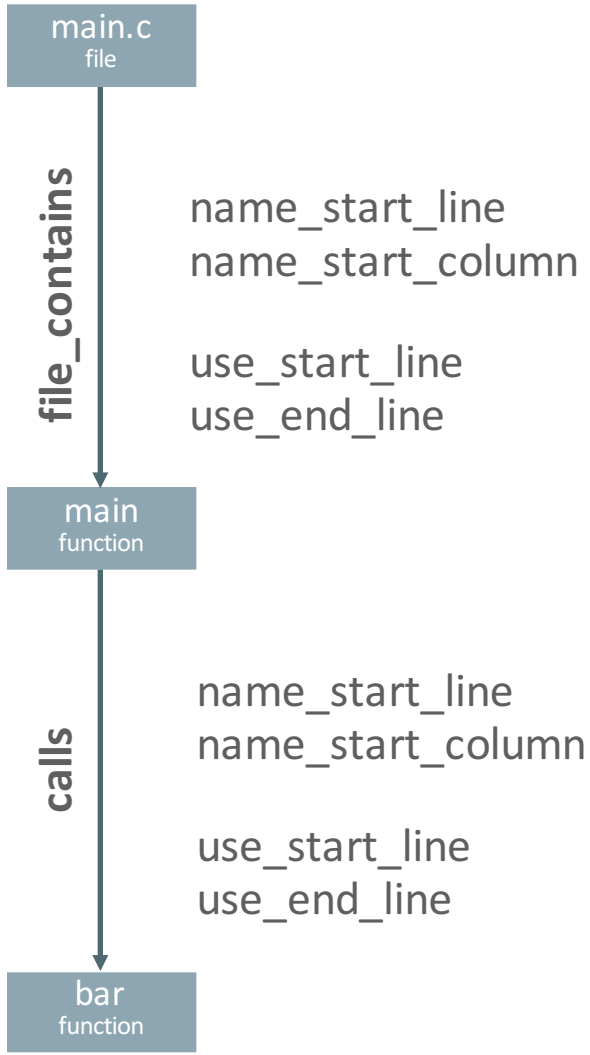
# Graph model example



# Graph model example

foo.h

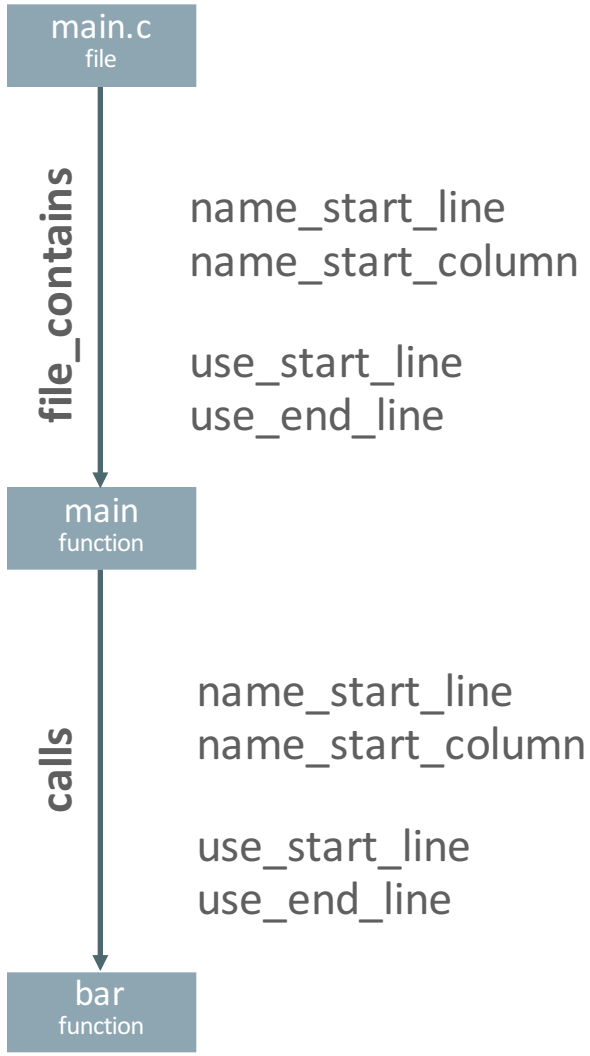
```
#define BAR(A) bar(A)
int bar(int);
```

foo.c

```
#include “foo.h”
int bar(int *input) {
  return *input * 2;
}
```

main.c

```
#include “foo.h”
int main(int argc, char **argv) {
  return BAR(&argc);
}
```



# Graph model example

foo.h

```
#define BAR(A) bar(A)
int bar(int);
```

name location

foo.c

```
#include “foo.h”
int bar(int *input) {
  return *input * 2;
}
```

main.c

```
#include “foo.h”
int main(int argc, char **argv) {
  return BAR(&argc);
}
```

use location