Handling #ifdef Expressions in CPPSTATS

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Preparation Processing * Global Pool * Summary Introduction Example

Outline

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- 2 Example
- 3 Source-Code Preparation Before Generating SRCML files
- Processing of Expressions During File Analysis *
- Global #ifdef Expression Pool *
- 6 Summary

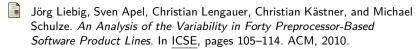
Outline of the CPPSTATS Mechanisms

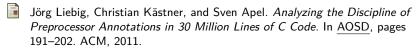
- Source-Code Preparation Before Generating SRCML files
 - Multi-Line #ifdef Expressions
 - Rewriting of #ifdef and #ifndef
 - Removal of Include Guards
- Processing of Expressions During File Analysis *
- Global #ifdef Expression Pool
 - Listing of #ifdef Expressions per File *
 - Construction of Global Expression Pool

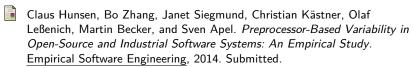
* – affects scattering and tangling measurement over #ifdefs

Studies using CPPSTATS

This algorithm have been used in the following studies:







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Global Pool *

Example of Three Files

```
#ifdef A
                                                      #ifndef Z H
                                                      #define Z H
  #ifdef B
                                                     #ifdef C
  #endif
                           #if defined(A) \
#endif
                               && defined(B)
                                                      #elif defined(D)
#ifdef A
                           #else
                                                     #endif
                                                  13 #endif // Z_H
#endif
                           #endif
```

- (a) Nested #ifdef in file X . c
- (b) #else branch in file Y.c
- (c) #elif branch and include guard in file 7.h.

Figure: Short examples of the patterns that occur while using CPP and that are treated by CPPSTATS. Each example and their rewriting rules are explained in this very document.

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Multi-Line #ifdef Expressions

```
#if defined(A) \
&& defined(B)
#else
#endif
```

```
#if defined(A) && defined(B)
6
  #else
  #endif
```

(a) Repetition of Fig. 1b, containing a multi-line expression on Lines 5 and 6.

(b) The same code with single-line expressions.

Figure: An #ifdef expression in file Y.c, (a) before and (b) after rewriting multi-line expressions into single-line fashion.

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Rewriting of #ifdef and #ifndef

#ifdef E

,

#if defined(E)

#ifndef F

#if !defined(F)

Removal of Include Guards

```
#ifndef Z H
   #define Z H
   #ifdef C
                                       #if defined(C)
10
11
   #elif defined(D)
                                       #elif (!(defined(C))) && (defined(D))
12
                                    12
   #endif
                                       #endif
13
   #endif //ZH
                                    13
```

- (a) Include guard in file Z.h (Lines 8, 9, and 13).
- (b) The example after removal of the include guard.

Figure: The file Z.h (a) before and (b) after removal of the include guard.

Introduction

Preparation: Before and After

```
1 #ifdef A
2 #ifdef B
3 #endif
4 #endif
5 #ifdef A
6 #endif
```

```
5 #if defined(A) \
6     && defined(B)
7 #else
8 #endif
```

```
8 #ifndef Z_H
9 #define Z_H
10 #ifdef C
11 #elif defined(D)
12 #endif
13 #endif // Z_H
```

```
#if defined(A)
#if defined(B)
#endif
#endif
#if defined(A)
#endif
```

```
5 #if defined(A) && defined(B)
6 7 #else
8 #endif
```

```
8 9 10 #if defined(C) 11 #elif defined(D) 12 #endif 13
```

(a) Before preparation.

(b) After preparation.

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- 4 Processing of Expressions During File Analysis *
- Global #ifdef Expression Pool *

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Processing Steps

- Look at each #ifdef expression.
- Rewrite if nested, #elif, or #else *

 nested conjoin expressions from inner and outer #ifdefs

 #elif conjoin expression with negation of all previous expressions

 #else use conjunction of all previous expressions as negations

Processing #ifdef Expressions *

```
#if defined(A)
                                       #if defined(A)
     #if defined(B)
                                         #if defined(A) && defined(B)
    #endif
                                         #endif
  #endif
                                     4 #endif
  #if defined(A)
                                     5 #if defined(A)
   #endif
                                       #endif
   #if defined(A) && defined(B)
                                       #if defined(A) && defined(B)
6
                                     6
   #else
                                     7 #elif !(defined(A) && defined(B))
   #endif
                                       #endif
8
9
10
  #if defined(C)
                                    10 #if defined(C)
   #elif defined(D)
                                    11 #elif (!(defined(C))) && (defined(D))
12
   #endif
                                    12
                                       #endif
13
                                    13
```

(a) Before processing.

(b) After processing.

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Global #ifdef Expression Pool

- Local #ifdef Expression Pools *
 - Take each expression **only once** per file
 - Comparison via string equality
- Construction of Global Expression Pool

Local #ifdef Expression Pools *

```
#if defined(A)
#if defined(A) && defined(B)
#endif
#endif
#if defined(A)
#endif
```

```
defined(A)
  defined(A) && defined(B)
3 defined(A)
```

```
#if defined(A) && defined(B)
6
  #elif !(defined(A) && defined(B))
  #endif
```

```
defined(A) && defined(B)
!(defined(A) && defined(B))
```

```
8
 9
10 #if defined(C)
   #elif (!(defined(C))) && (defined(D))
12
   #endif
```

```
defined(C)
(!(defined(C))) && (defined(D))
```

13

Construction of Global Expression Pool

```
defined(A)
defined(A) && defined(B)

defined(A) && defined(B)

(defined(A) && defined(B))

defined(C)
(!(defined(C))) && (defined(D))
```

(a) Pools per file.

```
(b) Global expression pool.
```

defined(A) && defined(B)

defined(A) && defined(B)

!(defined(A) && defined(B))

(!(defined(C))) && (defined(D))

defined(A)

defined(C)

Note

Scattering and tangling analyses are performed based on the global pool!

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Summary

- Processing of #ifdef expressions and construction of local expression pools (one per file) affect scattering and tangling analyses that work per #ifdef.
- Nesting analyses is not affected.

