Statistical-based Clone Detection

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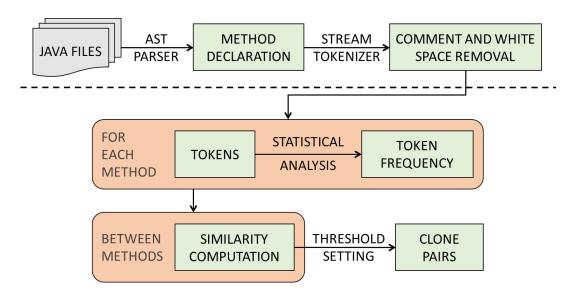
Outline

- Problem and Solution
- Technical Challenges
- Experiment Results
- Things We Learn



Problem and Solution

- Problem and Goal
 - Code Clone Detection is important
 - To detect code clones between methods based on tokens
- Solution: STCD
 - Overall Prior Project Diagram





 ASTParser 	X
 Variables Comparison 	X
 Similarity Calculation 	X
 Manual Weights 	X
 Data Collection 	X
 Results Comparison 	X
UI Development	X



• ASTParser	X
 Variables Comparison 	×
 Similarity Calculation 	×
 Manual Weights 	×
 Data Collection 	×
 Results Comparison 	X
UI Development	X



ASTParser

X

- Excessive time cost
- Improve the method parsing process
- e.g. Regular expression
- Build-in functions are helpful
- Variables Comparison



- e.g. errorLineMessage and messageErrorLine
- Bigram Algorithm has been applied
- Threshold is 0.7



 ASTParser 	X
 Variables Comparison 	✓
 Similarity Calculation 	X
 Manual Weights 	X
 Data Collection 	X
 Results Comparison 	X
UI Development	X



Similarity Calculation

- Old Similarity Algorithm for token Lists
 - Sim(List_x, List_y) = 1 / (1 + Distance(List_x, List_y))
 - Distance (List_x, List_y): Euclidean Distance
 - Not consider the list length
- Example 1
 - List_x= {<a, 3>, <b, 3>, ..., <y, 3>, <z, 1>}
 - List_v= {<a, 3>, <b, 3>, ..., <y, 3>, <z, 10>}
 - $Sim(List_x, List_y) = 1 / (1 + 9) = 0.1$
- Example 2
 - List_x= {<a, 3>, <b, 5>, <c, 4>, <d, 1>}
 - List_v= {<a, 0>, <b, 2>, <c, 1>, <d, 4>}
 - $Sim(List_x, List_y) = 1 / (1 + 6) = 0.14$

methodPara methodType
methodType
tokenListNum
tokenListType
tokenListKeyword
tokenListMarker
tokenListOperator
tokenListOther1
tokenListOther2



Similarity Calculation



- New Similarity Algorithm for token Lists
 - Diff(Elem_{x_a}, Elem_{y_a}) = abs(Freq_{x_a} Freq_{y_a})
 - $Sim(List_x, List_y) = 1 \sum Diff(Elem_x_i, Elem_y_i) / (\sum Freq_x_i + \sum Freq_y_i)$
 - Similar to Levenshtein distance

• Example 1

- List_x= {<a, 3>, <b, 3>, ..., <y, 3>, <z, 1>}
- List_v= {<a, 3>, <b, 3>, ..., <y, 3>, <z, 10>}
- $Sim(List_x, List_y) = 1 9 / (76 + 85) = 0.94$

Example 2

- List_x= {<a, 3>, <b, 5>, <c, 4>, <d, 1>}
- List_v= {<a, 0>, <b, 2>, <c, 1>, <d, 4>}
- $Sim(List_x, List_y) = 1 12 / (13 + 7) = 0.4$

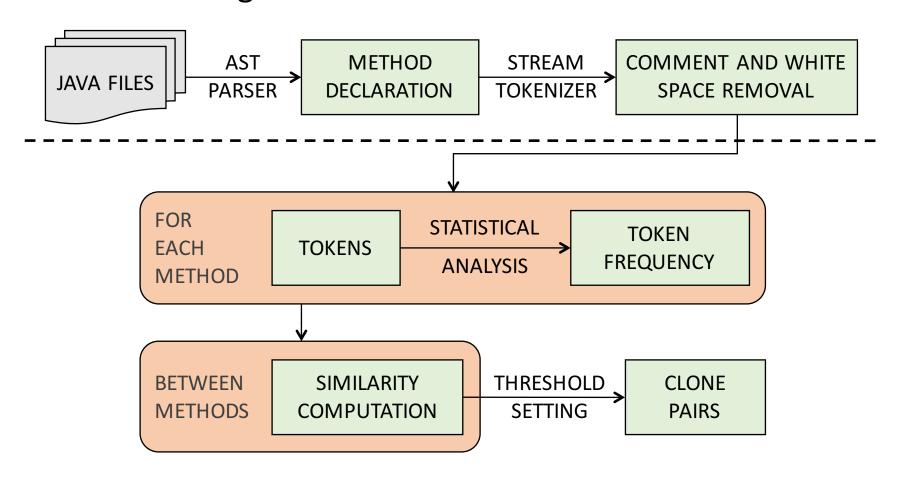
Vector
methodPara
methodType
tokenListNum
tokenListType
tokenListKeyword
tokenListMarker
tokenListOperator
tokenListOther1
tokenListOther2



 ASTParser 	X
 Variables Comparison 	✓
 Similarity Calculation 	✓
 Manual Weights 	×
 Data Collection 	×
 Results Comparison 	×
UI Development	X

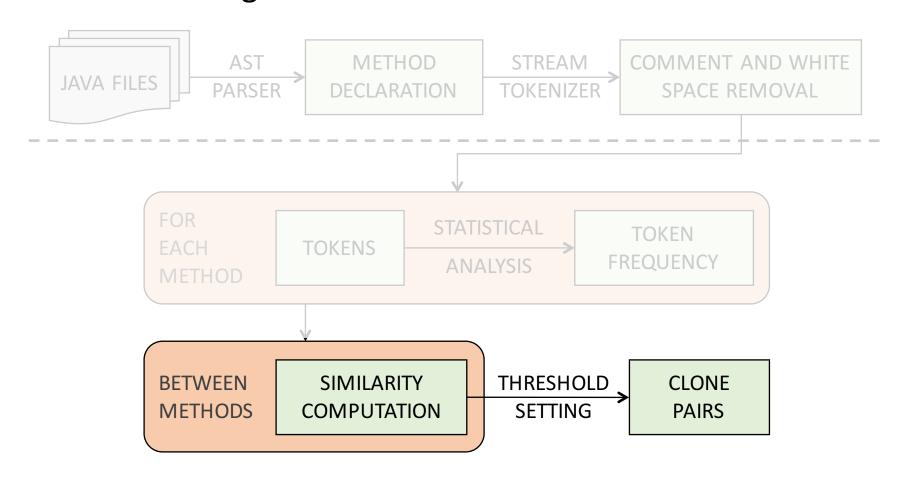


Manual Weights



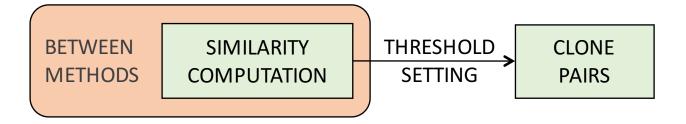


Manual Weights

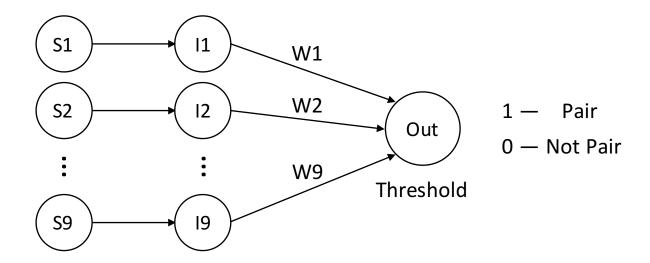




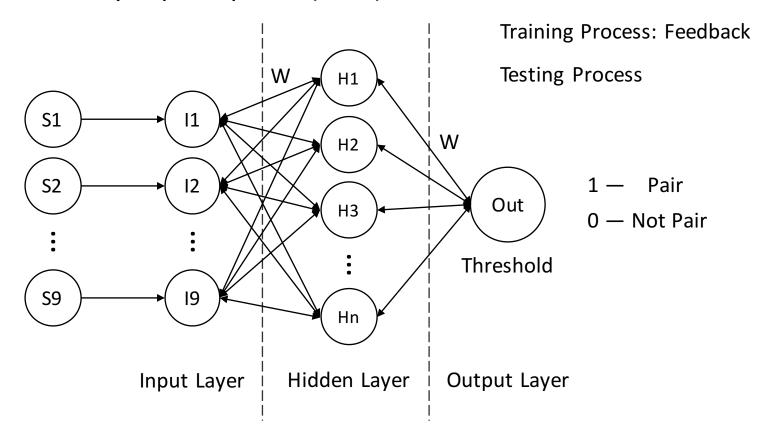
Manual Weights

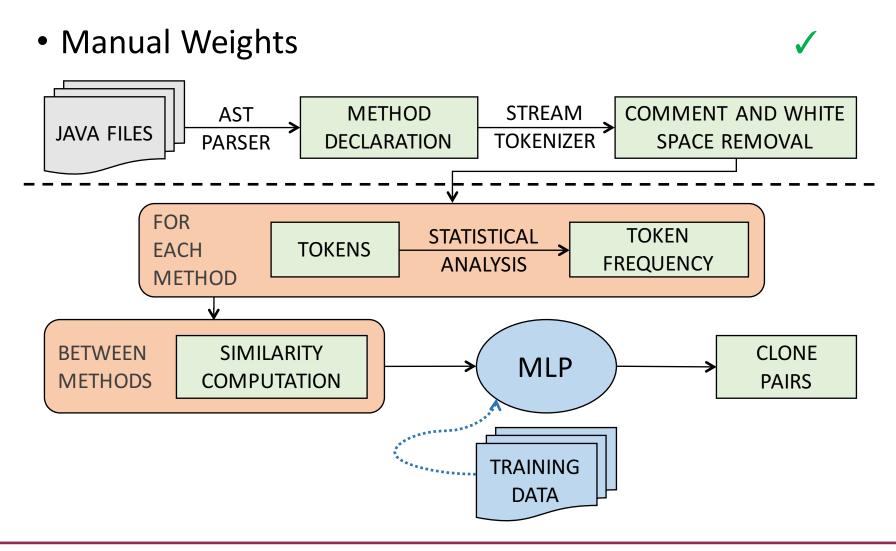


Abstraction



- Manual Weights
 - Multilayer perceptron (MLP)







 ASTParser 	X
 Variables Comparison 	✓
 Similarity Calculation 	✓
 Manual Weights 	✓
Data Collection	X
 Results Comparison 	X
UI Development	X

Data Collection

/

- See Experiment Results
- Results Comparison

/

- See Experiment Results
- UI Development



- From Swing to SWT 4.5 release
- Native elements and native behavior



•	ASTParser	X
•	Variables Comparison	✓
•	Similarity Calculation	✓
•	Manual Weights	✓
•	Data Collection	✓
•	Results Comparison	✓
•	UI Development	✓

- Source: https://github.com/CSCC5704
 - ASTParserTool.java
 - BiGramSimilarity.java
 - CCDTool.java
 - MethodList.java
 - MethodSimilarity.java
 - MethodTokenizerTool.java
 - MethodVector.java
 - MultiplePerceptronTool.java
 - Result.java
 - TokenList.java
 - TokenVector.java



- Detection of Software Clones
 - http://www.bauhaus-stuttgart.de/clones/
 - A general repository and information center for Detection of Software Clones
 - Accept files with labeled clones for clone detection tool evaluation
 - An example of submission file:

#1:	foo.c	12	56	bar.c	68	90	1
#2:	wom.c	34	50	bat.c	90	124	2
#3:	wom.c	69	100	bar.c	45	70	1
#4:	wom.c	69	100	foo.c	59	80	1

 Does not meet our requirement so we use manual selection to find ground truth



Training Data: SWT (# of methods 12~125)

Combo.txt Label.txt Text.txt

DragSource.txt Printer.txt WebKit.txt

DropTarget.txt Program.txt

FormData.txt Shell.txt

Test Data: SWT(# of methods 38~276)

Accessible.java Menu.java ToolBar.java

Button.java Spinner.java Toolltem.java

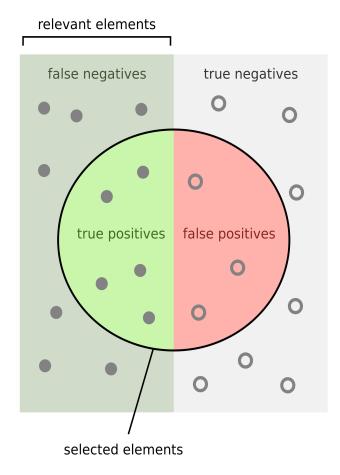
Control.java TabFolder.java Tracker.java

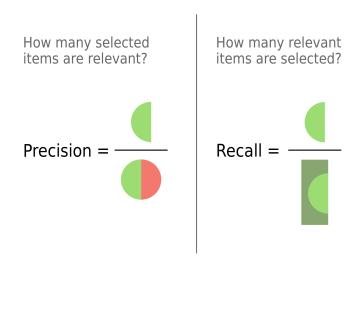
CoolBar.java Table.java Tree.java

Display.java TableItem.java



Evaluation: Precision and Recall





• Experiment 1

Test Files	TP + FN (Actual Clones)	TP + FP (Clones Detected)	ТР
Button.java	0	4	0
CoolBar.java	11	12	10
Menu.java	1	0	0
Spinner.java	2	2	2
TabFolder.java	3	2	2
TableItem.java	20	20	18
ToolBar.java	4	4	4
ToolItem.java	3	3	3
Tracker.java	1	1	1
Tree.java	11	13	9

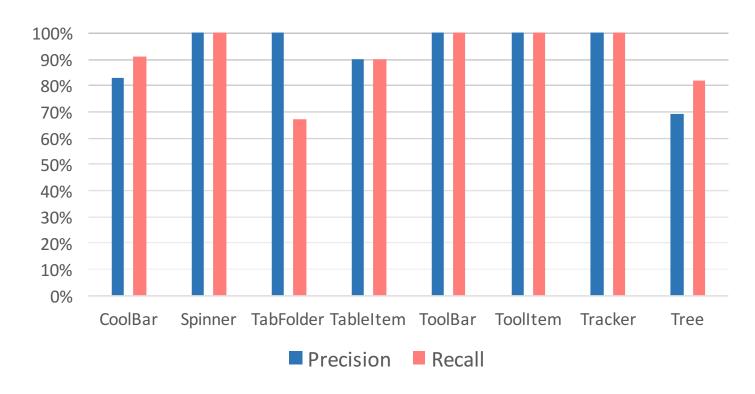


• Experiment 1

Test Files	TP + FN (Actual Clones)	TP + FP (Clones Detected)	TP
Button.java	0	4	0
CoolBar.java	11	12	10
Menu.java	1	0	0
Spinner.java	2	2	2
TabFolder.java	3	2	2
TableItem.java	20	20	18
ToolBar.java	4	4	4
Toolltem.java	3	3	3
Tracker.java	1	1	1
Tree.java	11	13	9

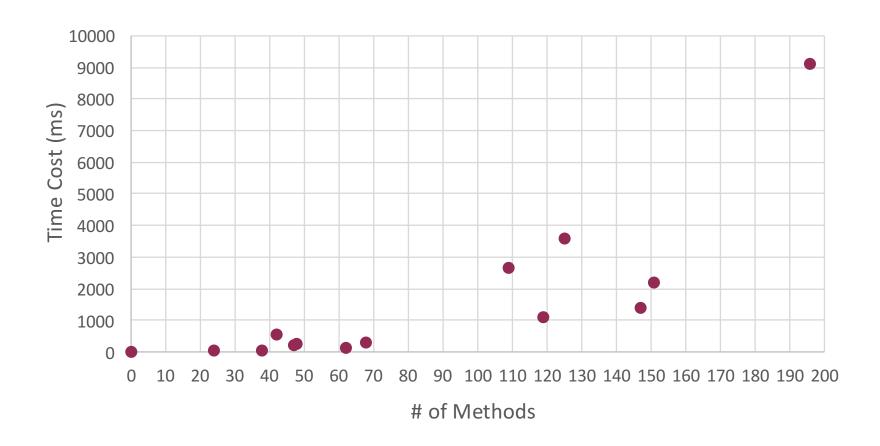


- Experiment 1
 - Avg. Precision = 92.75%
 - Avg. Recall = 91.25%





• Experiment 2





Things We Learn

- Lectures
 - ASTParser Tool
 - Bigram Algorithm
 - Precision and Recall
- Papers
 - Similarity Algorithms
 - Other Detection Methods
 - CMCD, Boreas, AnDarwin, RTF
- Others
 - First time to use SWT
 - Collaboration and discussion



Final Oral Presentation

Thank you!

