

	Fix pattern	Calculated cluster	Manual Cluster	Expanded TBar FP
1	Insert a null pointer checker with return Insert: (IF_STATEMENT, BINARY_EXPRESSION_EQUALS, NAME_EXPRESSION, SIMPLE_NAME, NULL_LITERAL_EXPRESSION, BLOCK_STATEMENT, RETURN_STATEMENT, BOOLEAN_LITERAL_EXPRESSION_FALSE)	<u>cha-14</u> _{1..4}	cha-14 _{1..4}	Insert Null Pointer Checker and Return Literal (FP2.6): + if (exp == null) return literal;
2	Insert a zero checker Insert: (IF_STATEMENT, BINARY_EXPRESSION_NOT_EQUALS, NAME_EXPRESSION, SIMPLE_NAME, INTEGER_LITERAL_EXPRESSION, BLOCK_STATEMENT)	<u>tim-3</u> _{1..10}	tim-3 _{1..10}	Insert Zero Checker (FP4.4.1): + if (var != 0) { statement; ... + }
3	Insert an if block with a statement Insert: (IF_STATEMENT, METHOD_CALL_EXPRESSION, NAME_EXPRESSION, SIMPLE_NAME, SIMPLE_NAME, NAME_EXPRESSION, SIMPLE_NAME, BLOCK_STATEMENT), Insert: (BLOCK_STATEMENT), Insert: (EXPRESSION_STATEMENT, METHOD_CALL_EXPRESSION, SIMPLE_NAME, NAME_EXPRESSION, SIMPLE_NAME, NAME_EXPRESSION, SIMPLE_NAME, NAME_EXPRESSION, SIMPLE_NAME, NAME_EXPRESSION, SIMPLE_NAME)	cli-22 ₁ , <u>clo-58</u> , jaC-2 ₁	cli-22 ₁ , jaC-2 ₁ , jaC-9 ₁	Insert if Block with Statement (FP4.4.2): + if (conditional_exp) { statement; ... + }
4			clo-58	Insert if-else Block with Statement (FP4.4.3): + if (conditional_exp) { ... + } else { statement; ... + }
5	Insert an assignment Insert: (EXPRESSION_STATEMENT, ASSIGN_EXPRESSION, NAME_EXPRESSION, SIMPLE_NAME, NULL_LITERAL_EXPRESSION)	<u>com-2</u> ₁ , jaD-87 ₁ , jso-39	<u>com-2</u> ₁ , jaD-87 ₁ , jso-39	Insert Assignment with Literal (FP4.5.1.): + var = literal
6	Insert a method invocation Insert: (METHOD_CALL_EXPRESSION) Insert: (SIMPLE_NAME)	clo-90 ₁ , jso-73 ₁ , jso-86 , lan-4, <u>moc-23</u> ₁	jso-86	Mutate Method Invocation Expr. (FP10.1.1): - method1() + method2().method3()
7			jso-73 ₁	Mutate Object and Method (FP13.1.3): - obj1.method1(args) + obj2.method2().method1(args)
8	Insert a method invocation Insert: (BINARY_EXPRESSION_OR), Insert: (METHOD_CALL_EXPRESSION, NAME_EXPRESSION, SIMPLE_NAME, SIMPLE_NAME)	clo-3 ₁ , <u>clo-113</u> , jaD-110, jso-51, jso-56 ₁	clo-3 ₁ -	Mutate Method Invocation Expr. (FP10.4.1): - method1() + method1(arg)
9	Remove a method invocation Delete: (METHOD_CALL_EXPRESSION), Delete: (SIMPLE_NAME)	<u>cli-1</u> _{1,2} , jaD-95 ₁ , jso-4 , jso-8	jso-8	Mutate Method Invocation Expr. (FP10.6): - method1().method2() + method3()
10			<u>cli-1</u> _{1,2} , jso-4	Remove Method Invocation (FP15.1.1): - method()
11	Remove a field access Delete: (FIELD_ACCESS_EXPRESSION), Delete: (SIMPLE_NAME)	lan-60 ₁ , <u>mat-49</u> _{1..4} , mat-98 _{1,2}	lan-60 ₁ , mat-49 _{1..4} , mat-98 _{1,2}	Mutate Object (FP13.1.1): - obj.attr + var
12	Insert a variable Insert: (NAME_EXPRESSION), Insert: (SIMPLE_NAME)	cli-18 ₁ , clo-144 ₁ , jso-66 ₁ , moc-19 ₁	jso-66 ₁	Mutate Object (FP13.1.2): - obj1.method() + obj2.method()
13	Insert a variable Insert: (NAME_EXPRESSION, SIMPLE_NAME)	<u>clo-165</u> ₁ , clo-175 ₁ , clo-30 ₁ , clo-37 ₁ , clo-79 ₁ , com-43 _{1,2} , jaD-103 _{1..22} , jaD-52, jaD-75 ₁ , jaD-97, jso-66 ₁ , lan-26, mat-70, moc-21 ₁ , moc-25 ₁ , moc-30 ₁ , moc-35 ₁ , tim-26 _{1..8}	jaD-103 _{1..22}	Mutate Object and Method (FP13.1.4): - obj1.method1() + obj2.method2(obj1)
14	Insert a method invocation and an attribute Insert: (METHOD_CALL_EXPRESSION), Insert: (SIMPLE_NAME), Insert: (NAME_EXPRESSION, SIMPLE_NAME)	<u>jaD-25</u> _{1..3} , jaD-3 ₁	jaD-25 _{1..4}	Mutate Object and Method (FP13.1.5): - obj1.method1(obj2) + obj3.method2().method3(obj1, obj2)
15	Change: (PRIMITIVE_TYPE_BOOLEAN) to (CLASS_OR_INTERFACE_TYPE), Insert: (SIMPLE_NAME)	<u>clo-169</u> _{1..5}	clo-169 _{1..5}	Mutate Method Definition (FP16): - modifier T method(T1 arg1, ...) ... + modifier T method(T2 arg2, ...) ...

Table 1: Fix patterns (based on JavaParser AST node types) and centroids of clusters that extend TBar fix pattern (FP) taxonomy.