**Not tested**

Rules implemented: **1,** 2,3,4,5, 6, 7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26

Left:

Typechecker changes:

1. ~~Binary chain 2 rules, in assign~~
2. ~~Binary expression: Add: and, mod, or~~

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1. Program ∷= Name List<ParamDec> Block

        class Name implements Runnable{

*variables declared in List<ParamDec> are instance variables of the class*

             public Name(String args){

                initialize instance variables with values from args.

                 }

             public static void main(String[] args){

                Name instance = new Name(args);

                        instance.run();

                 }

                 public void run(){

                declarations and statements from block

                 }

           }

2. ParamDec ∷= type ident

        instance variable in class, initialized with values from command line arguments (add file and url)

3. Block ∷= List<Dec>  List<Statement>

Decs are local variables in current scope of run method

Statements are executed in run method

Must label beginning and end of scope, and keep track of local variables, their slot in the local variable array, and their range of visibility.

If a statement was a BinaryChain, it will have left a value on top of the stack.  Check for this and pop it if necessary.

4. Dec ∷= type ident

Assign a slot in the local variable array to this variable and save it in the new slot attribute in the Dec class.

frame maps to cop5556sp17.PLPRuntimeFrame

image maps to java.awt.image.BufferedImage

5. Statement ∷= SleepStatement | WhileStatement | IfStatement | Chain| AssignmentStatement

6. SleepStatement ∷= Expression

        invoke java/lang/Thread/sleep.

Hint:  You will need to change the integer expression to a long with “I2L”

7. AssignmentStatement ∷= IdentLValue Expression

* store value of Expression into location indicated by IdentLValue
* if the type of elements is image, this should copy the image.
* use PLPRuntimeImageOps.copyImage

IMPORTANT:

            insert the following statement into your code for an Assignment Statement

        after value of expression is put on top of stack and before it is written into the IdentLValue

            CodeGenUtils.*genPrintTOS*(GRADE, mv,assignStatement.getE().getType());

8. Chain ∷= ChainElem | BinaryChain

9. ChainElem ::= IdentChain | FilterOpChain | FrameOpChain | ImageOpChain

10. IdentChain ∷= ident

* Handle the ident appropriately depending on its type and whether it is on the left or right side of binary chain.
* If on the left side, load its value or reference onto the stack.
* If this IdentChain is the right side of a binary expression,
* store the item on top of the stack into a variable (if INTEGER or IMAGE),
* or write to file (if FILE),
* or set as the image in the frame (if FRAME).

11. FilterOpChain ∷= filterOp Tuple (Tuple contents are parameters to PLPfoobarMethods)

* Assume that a reference to a BufferedImage is on top of the stack.
* Generate code to invoke the appropriate method from PLPRuntimeFilterOps.

12. FrameOpChain ∷= frameOp Tuple

* Assume that a reference to a PLPRuntimeFrame is on top of the stack.
* Visit the tuple elements to generate code to leave their values on top of the stack.
* Generate code to invoke the appropriate method from PLPRuntimeFrame.

13. ImageOpChain ∷= imageOp Tuple

* Assume that a reference to a BufferedImage  is on top of the stack.
* Visit the tuple elements to generate code to leave their values on top of the stack.
* Generate code to invoke the appropriate method from PLPRuntimeImageOps or PLPRuntimeImageIO .

14. BinaryChain ∷= Chain (arrow | bararrow)  ChainElem

* Visit the left expression.
* **If the left Chain is a URL, generate code to invoke PLPRuntimeImageIO.readFromURL and leave a reference to a BufferedImage object on top of the stack.**
* **If the left expression is a File, generate code to invoke PLPRuntimeImageIO.readFromFile and leave a reference to a BufferedImage object on top of the stack.**
* Otherwise generate code to leave the left object on top of the stack.
* Visit the right ChainElem and handle as given above.
* Hint:  integers, for example, could appear on either side of a BinaryChain, in one the action is load, the other is store.  You need to figure out a way to communicate to the IdentChain which one.
* Hint:  although some combinations have a type NONE, it is easiest to let all binary chain instances leave something on top of the stack.  In many cases, this value will be consumed by a parent.  At the top level it should be popped.

15. WhileStatement ∷= Expression Block

              goto GUARD

   BODY     Block

   GUARD  Expression

                  IFNE  BODY

16. IfStatement ∷= Expression Block

                  Expression

                  IFEQ AFTER

              Block

       AFTER …

17. Expression ∷=   IdentExpression | IntLitExpression | BooleanLitExpression

         | ConstantExpression | BinaryExpression

always generate code to leave value of expression on top of stack.

18. IdentExpression ∷= ident

       load value of variable (this could be a field or a local var)

19. IdentLValue ∷= ident

              store value on top of stack to this variable (which could be a field or local var). Add image and frame

20. IntLitExpression ∷= intLit

       load constant

21. BooleanLitExpression ∷= booleanLiteral

       load constant

22. ConstantExpression ∷= screenWidth | screenHeight

* Generate code to invoke PLPRuntimeFrame.getScreenWidth or PLPRuntimeFrame.getScreenHeight.

23. BinaryExpression ∷= Expression op Expression

* **Visit children to generate code to leave values of arguments on stack.**
* **Generate code to perform operation, leaving result on top of the stack.**
* **New in Assignment 6:  methods to add two images, subtract two images, etc.  Routines are provided in PLPRuntimeImageOps.**
* **New in assignment 6:  implement &, |, and %.**
* **Expressions should be evaluated from left to write consistent with the structure of the AST.**
* **You may need to modify your TypeCheckVisitor t**

24. Tuple :≔ List<Expression>

* Visit expressions to generate code to leave values on top of the stack

         25. op ∷= relOp | weakOp | strongOp

implement operators and %

26. type ∷= integer | image | frame | file | boolean | url