First Pass, remove combo rules

Pgm = kwdprog Vargroup Fcndefs Main
Main = kwdmain BBlock
BBlock = brace1 Vargroup Stmts brace2

Pgm = kwdprog Vargroup Fcndefs kwdmain brace1 Vargroup Stmts brace2

Vargroup = kwdvars PPvarlist
Vargroup = eps
PPvarlist = parens1 Varlist parens2
Varlist = Varitem semi Varlist
Varlist = eps
Varitem = Vardecl
Varitem = Vardecl equal Varinit
Varitem = Classdecl
Varitem = Classdef
Vardecl = Simplekind Varspec
Simplekind = Basekind
Simplekind = Classid
Basekind = int
Basekind = float
Basekind = string
Classid = id
Varspec = Varid
Varspec = Arrspec
Varspec = Deref_id
Varid = id
Arrspec = Varid KKint
KKint = bracket1 int bracket2
Deref_id = Deref id
Deref = aster

Varinit = Expr
Varinit = BBexprs
BBexprs = brace1 Exprlist brace2
BBexprs = brace1 brace2
Exprlist = Expr Moreexprs
Moreexprs = comma Exprlist

Moreexprs = eps

Classdecl = kwdclass Classid
Classdef = Classheader BBclassitems
BBClassitems = brace1 Classitems brace2
Classheader = Classdecl Classmom Interfaces
Classmom = colon Classid
Classmom = eps
Classitems = Classgroup Classitems
Classitems = eps
Classgroup = Class_ctrl
Classgroup = Varlist
Classgroup = Mddecls
Class_ctrl = colon id // in {public, protected, private}
Interfaces = colon Classid Interfaces
Interfaces = eps

Mddecls = Mdheader Mddecls
Mddecls = eps
Mdheader = kwdfcn Md_id PParmlist Retkind
Md_id = Classid colon Fcnid

Fcndefs = Fcndef Fcndefs
Fcndefs = eps
Fcndef = Fcnheader BBlock

Fcnheader = kwdfcn Fcnid PParmlist Retkind
Fcnid = id
Retkind = Kind
PParmlist = parens1 Varspecs parens2
PParmlist = PPonly
Varspecs = Varspec More_varspecs
More_varspecs = comma Varspecs
More_varspecs = eps
PPonly = parens1 parens2

Stmts = Stmt semi Stmts
Stmts = eps
Stmt = Stasgn

Stmt = Fcall
Stmt = Stif
Stmt = Stwhile
Stmt = Stprint
Stmt = Strtn

Stasgn = Lval equal Expr
Lval = Varid
Lval = Aref
Lval = Deref_id
Aref = Varid KKexpr
KKexpr = bracket1 Expr bracket2

Fcall = Fcnid PPexprs
PPexprs = parens1 Exprlist parens2
PPExprs = PPonly

Stif = kwdif PPexpr BBlock Elsepart
Elsepart = kwdelseif PPexpr BBlock Elsepart
Elsepart = kwdelse BBlock
Elsepart = eps

Stwhile = kwdwhile PPexpr BBlock
Stprint = kprint PPexprs

Strtn = kwdreturn Expr
Strtn = kwdreturn

PPexpr = parens1 Expr parens2
Expr = Expr Oprel Rterm
Expr = Rterm
Rterm = Rterm Opadd Term
Rterm = Term
Term = Term Opmul Fact
Term = Fact
Fact = Basekind
Fact = Lval
Fact = Addrof_id
Fact = Fcall

Fact = PPexpr
Addrof_id = ampersand id
Oprel = opeq
Oprel = opne
Oprel = Lthan
Oprel = ople
Oprel = opge
Oprel = Gthan
Lthan = angle1
Gthan = angle2
Opadd = plus
Opadd = minus
Opmul = aster
Opmul = slash
Opmul = caret

Second Pass, LRE

Pgm = kwdprog Vargroup Fcndefs Main
Main = kwdmain BBlock
BBlock = brace1 Vargroup Stmts brace2

Vargroup = kwdvars PPvarlist
Vargroup = eps
PPvarlist = parens1 Varlist parens2
Varlist = Varitem semi Varlist
Varlist = eps
Varitem = Vardecl
Varitem = Vardecl equal Varinit
Varitem = Classdecl
Varitem = Classdef
Vardecl = Simplekind Varspec
Simplekind = Basekind
Simplekind = Classid
Basekind = int
Basekind = float
Basekind = string
Classid = id

Varspec = Varid
Varspec = Arrspec
Varspec = Deref_id
Varid = id
Arrspec = Varid KKint
KKint = bracket1 int bracket2
Deref_id = Deref id
Deref = aster

Varinit = Expr
Varinit = BBexprs
BBexprs = brace1 Exprlist brace2
BBexprs = brace1 brace2
Exprlist = Expr Moreexprs
Moreexprs = comma Exprlist
Moreexprs = eps

Classdecl = kwdclass Classid
Classdef = Classheader BBclassitems
BBClassitems = brace1 Classitems brace2
Classheader = Classdecl Classmom Interfaces
Classmom = colon Classid
Classmom = eps
Classitems = Classgroup Classitems
Classitems = eps
Classgroup = Class_ctrl
Classgroup = Varlist
Classgroup = Mddecls
Class_ctrl = colon id // in {public, protected, private}
Interfaces = colon Classid Interfaces
Interfaces = eps

Mddecls = Mdheader Mddecls
Mddecls = eps
Mdheader = kwdfcn Md_id PParmlist Retkind
Md_id = Classid colon Fcnid

Fcndefs = Fcndef Fcndefs
Fcndefs = eps

Fcndef = Fcnheader BBlock

Fcnheader = kwdfcn Fcnid PParmlist Retkind
Fcnid = id
Retkind = Kind
PParmlist = parens1 Varspecs parens2
PParmlist = PPonly
Varspecs = Varspec More_varspecs
More_varspecs = comma Varspecs
More_varspecs = eps
PPonly = parens1 parens2

Stmts = Stmt semi Stmts
Stmts = eps
Stmt = Stasgn
Stmt = Fcall
Stmt = Stif
Stmt = Stwhile
Stmt = Stprint
Stmt = Strtn

Stasgn = Lval equal Expr
Lval = Varid
Lval = Aref
Lval = Deref_id
Aref = Varid KKexpr
KKexpr = bracket1 Expr bracket2

Fcall = Fcnid PPexprs
PPexprs = parens1 Exprlist parens2
PPExprs = PPonly

Stif = kwdif PPexpr BBlock Elsepart
Elsepart = kwdelseif PPexpr BBlock Elsepart
Elsepart = kwdelse BBlock
Elsepart = eps

Stwhile = kwdwhile PPexpr BBlock
Stprint = kprint PPexprs

Strtn = kwdreturn Expr
Strtn = kwdreturn

Q = eps

PPexpr = parens1 Expr parens2
Expr = Expr Oprel Rterm
Expr = Expr Oprel Rterm Q
Q = Oprel Rterm Q
Expr = Rterm
Rterm = Rterm Opadd Term
Rterm = Rterm Opadd Term Q
Q = Opadd Term Q
Rterm = Term
Term = Term Opmul Fact
Term = Term Opmul Fact Q
Q = Opmul Fact Q
Term = Fact
Fact = Basekind
Fact = Lval
Fact = Addrof_id
Fact = Fcall
Fact = PPexpr
Addrof_id = ampersand id
Oprel = opeq
Oprel = opne
Oprel = Lthan
Oprel = ople
Oprel = opge
Oprel = Gthan
Lthan = angle1
Gthan = angle2
Opadd = plus
Opadd = minus
Opmul = aster
Opmul = slash
Opmul = caret

Third Pass, identify disappearing Non-Terminals

Disappearing Non-Terminals:
Direct:
Vargroup
Varlist
Moreexprs
Classmom
Classitems
Interfaces
Mddecls
Fcndefs
More_varspecs
Stmts
Elsepart

Indirect:
Rule 44: Classgroup → Varlist → eps
Rule 45: Classgroup → Mddecls → eps

1. Pgm = kwdprog Vargroup Fcndefs Main
2. Main = kwdmain BBlock
3. BBlock = brace1 Vargroup Stmts brace2

4. Vargroup = kwdvars PPvarlist
5. Vargroup = eps
6. PPvarlist = parens1 Varlist parens2
7. Varlist = Varitem semi Varlist
8. Varlist = eps
9. Varitem = Vardecl
10. Varitem = Vardecl equal Varinit

11. Varitem = Classdecl
12. Varitem = Classdef
13. Vardecl = Simplekind Varspec
14. Simplekind = Basekind
15. Simplekind = Classid
16. Basekind = int
17. Basekind = float
18. Basekind = string
19. Classid = id
20. Varspec = Varid
21. Varspec = Arrspec
22. Varspec = Deref_id
23. Varid = id
24. Arrspec = Varid KKint
25. KKint = bracket1 int bracket2
26. Deref_id = Deref id
27. Deref = aster

28. Varinit = Expr
29. Varinit = BBexprs
30. BBexprs = brace1 Exprlist brace2
31. BBexprs = brace1 brace2
32. Exprlist = Expr Moreexprs
33. Moreexprs = comma Exprlist
34. Moreexprs = eps

35. Classdecl = kwdclass Classid
36. Classdef = Classheader BBclassitems
37. BBClassitems = brace1 Classitems brace2
38. Classheader = Classdecl Classmom Interfaces
39. Classmom = colon Classid
40. Classmom = eps
41. Classitems = Classgroup Classitems
42. Classitems = eps
43. Classgroup = Class_ctrl
44. Classgroup = Varlist
45. Classgroup = Mddecls
46. Class_ctrl = colon id // in {public, protected, private}
47. Interfaces = colon Classid Interfaces

48. Interfaces = eps

49. Mddecls = Mdheader Mddecls
50. Mddecls = eps
51. Mdheader = kwdfcn Md_id PParmlist Retkind
52. Md_id = Classid colon Fcnid

53. Fcndefs = Fcndef Fcndefs
54. Fcndefs = eps
55. Fcndef = Fcnheader BBlock

56. Fcnheader = kwdfcn Fcnid PParmlist Retkind
57. Fcnid = id
58. Retkind = Simplekind   //Asked professor during lab and said he needed to correct
    it from Retkind = Kind
59. PParmlist = parens1 Varspecs parens2
60. PParmlist = PPonly
61. Varspecs = Varspec More_varspecs
62. More_varspecs = comma Varspecs
63. More_varspecs = eps
64. PPonly = parens1 parens2

65. Stmts = Stmt semi Stmts
66. Stmts = eps
67. Stmt = Stasgn
68. Stmt = Fcall
69. Stmt = Stif
70. Stmt = Stwhile
71. Stmt = Stprint
72. Stmt = Strtn

73. Stasgn = Lval equal Expr
74. Lval = Varid
75. Lval = Aref
76. Lval = Deref_id
77. Aref = Varid KKexpr
78. KKexpr = bracket1 Expr bracket2

79. Fcall = Fcnid PPexprs

80. PPexprs = parens1 Exprlist parens2
81. PPExprs = PPonly

82. Stif = kwdif PPexpr BBlock Elsepart
83. Elsepart = kwdelseif PPexpr BBlock Elsepart
84. Elsepart = kwdelse BBlock
85. Elsepart = eps

86. Stwhile = kwdwhile PPexpr BBlock
87. Stprint = kprint PPexprs

88. Strtn = kwdreturn Expr
89. Strtn = kwdreturn

90. PPexpr = parens1 Expr parens2
91. Expr = Rterm
92. Rterm = Term
93. Term = Fact
94. Fact = Basekind
95. Fact = Lval
96. Fact = Addrof_id
97. Fact = Fcall
98. Fact = PPexpr
99. Addrof_id = ampersand id
100.   Oprel = opeq
101.   Oprel = opne
102.   Oprel = Lthan
103.   Oprel = ople
104.   Oprel = opge
105.   Oprel = Gthan
106.   Lthan = angle1
107.   Gthan = angle2
108.   Opadd = plus
109.   Opadd = minus
110.   Opmul = aster
111.   Opmul = slash
112.   Opmul = caret

Added LRE Rules:

113. Q = eps
114. Q = Oprel Rterm Q
115. Q = Opadd Term Q
116. Q = Opmul Fact Q

Left Factoring Rules:
To resolve: 9,10 in one cell
9. Varitem = Vardecl A
117. A = eps
118. A = equal Varinit

To resolve 11,12 in one cell
11. Varitem = ClassDecl VaritemTail
119.VaritemTail = ClassDefTail
120.VaritemTail = eps
121. ClassDefTail = Classmom Interfaces BBclassitems

To resolve 20, 21 in one cell
20. Varspec = id VarspecTail
122. VarspecTail = eps
123. VarspecTail = KKint

To resolve 30,31 in one cell
30. BBexprs = brace1 BBexprsTail
124. BBexprsTail = Exprlist brace2
125. BBexprsTail = brace2

39, 40

41,42
41. Classitems = ClassitemsTail
126. ClassitemsTail = eps
127.ClassitemsTail = ClassgroupTail Classitems
128.ClassgroupTail = Class_ctrl
129.ClassgroupTail = VarlistTail
130.ClassgroupTail = Mdheader Mddecls
131.VarlistTail = Varitem semi Varlist

59,60
59.PParmlist = parens1 PParmlistTail
132.PParmlistTail = Varspecs parens2
133.PParmTail = parens2

67,68
67.Stmt = id StmtTail
134.StmtTail = PPexprs
135.StmtTail = equal Expr

74,75
74.Lval = id LvalTail
136.LvalTail = eps
137..LvalTail = KKexpr

80,81
80.PPExpr = parens1 PPExprTail
138.PPExprTail = Exprlist parens2
139.PPExprTail = parens2

88,89
88.Strtn = kwdreturn StrtnTail
140.StrtnTail = Expr
141.StrtnTail = eps

95,97
95.Fact = id FactTail
142.FactTail = eps
143.FactTail = KKExpr
145.FactTail = PPExpr

Fourth Pass, remove redundant left factored rules

Disappearing Non-Terminals:
Direct:
Vargroup

Varlist
Moreexprs
Classmom
Classitems
Interfaces
Mddecls
Fcndefs
More_varspecs
Stmts
Elsepart

Indirect:
Rule 44: Classgroup → Varlist → eps
Rule 45: Classgroup → Mddecls → eps

1. Pgm = kwdprog Vargroup Fcndefs Main
2. Main = kwdmain BBlock
3. BBlock = brace1 Vargroup Stmts brace2

4. Vargroup = kwdvars PPvarlist
5. Vargroup = eps
6. PPvarlist = parens1 Varlist parens2
7. Varlist = Varitem semi Varlist
8. Varlist = eps
9. Varitem = Vardecl A
10. ~~Varitem = Vardecl equal Varinit~~
11. Varitem = kwdclass Varitemtail
12. ~~Varitem = Classdef~~
13. Vardecl = Simplekind Varspec
14. Simplekind = Basekind
15. Simplekind = Classid
16. Basekind = int
17. Basekind = float
18. Basekind = string
19. Classid = id
20. Varspec = id VarspecTail
21. ~~Varspec = Arrspec~~
22. Varspec = Deref_id

23. Varid = id
24. Arrspec = Varid KKint
25. KKint = bracket1 int bracket2
26. Deref_id = Deref id
27. Deref = aster

28. Varinit = Expr
29. Varinit = BBexprs
30. BBexprs = brace1 BBexprsTail
31. ~~BBexprs = brace1 brace2~~
32. Exprlist = Expr Moreexprs
33. Moreexprs = comma Exprlist
34. Moreexprs = eps

35. Classdecl = kwdclass Classid
36. Classdef = Classheader BBclassitems
37. BBClassitems = brace1 Classitems brace2
38. Classheader = Classdecl Classmom Interfaces
39. Classmom = colon Classid
40. Classmom = eps
41. Classitems = ClassitemsTail
42. ~~Classitems = eps~~
43. Classgroup = Class_ctrl
44. Classgroup = Varlist
45. Classgroup = Mddecls
46. Class_ctrl = colon id // in {public, protected, private}
47. Interfaces = colon Classid Interfaces
48. Interfaces = eps

49. Mddecls = Mdheader Mddecls
50. Mddecls = eps
51. Mdheader = kwdfcn Md_id PParmlist Retkind
52. Md_id = Classid colon Fcnid

53. Fcndefs = Fcndef Fcndefs
54. Fcndefs = eps
55. Fcndef = Fcnheader BBlock

56. Fcnheader = kwdfcn Fcnid PParmlist Retkind

57. Fcnid = id
58. Retkind = Simplekind   //Asked professor during lab and said he needed to correct
    it from Retkind = Kind
59. PParmlist = parens1 PParmlistTail
60. ~~PParmlist = PPonly~~
61. Varspecs = Varspec More_varspecs
62. More_varspecs = comma Varspecs
63. More_varspecs = eps
64. PPonly = parens1 parens2

65. Stmts = Stmt semi Stmts
66. Stmts = eps
67. Stmt = id StmtTail
68. ~~Stmt = Fcall~~
69. Stmt = Stif
70. Stmt = Stwhile
71. Stmt = Stprint
72. Stmt = Strtn

73. Stasgn = Lval equal Expr
74. Lval = id LvalTail
75. ~~Lval = Aref~~
76. Lval = Deref_id
77. Aref = Varid KKexpr
78. KKexpr = bracket1 Expr bracket2

79. Fcall = Fcnid PPexprs
80. PPexprs = parens1 PPexprsTail
81. ~~PPExprs = PPonly~~

82. Stif = kwdif PPexpr BBlock Elsepart
83. Elsepart = kwdelseif PPexpr BBlock Elsepart
84. Elsepart = kwdelse BBlock
85. Elsepart = eps

86. Stwhile = kwdwhile PPexpr BBlock
87. Stprint = kprint PPexprs

88. Strtn = kwdreturn StrtnTail

89. Strtn = kwdreturn

90. PPexpr = parens1 Expr parens2
91. Expr = Rterm
92. Rterm = Term
93. Term = Fact
94. Fact = Basekind
95. Fact = id FactTail
96. Fact = Addrof_id
97. Fact = Feall
98. Fact = PPexpr
99. Addrof_id = ampersand id
100.   Oprel = opeq
101.   Oprel = opne
102.   Oprel = Lthan
103.   Oprel = ople
104.   Oprel = opge
105.   Oprel = Gthan
106.   Lthan = angle1
107.   Gthan = angle2
108.   Opadd = plus
109.   Opadd = minus
110.   Opmul = aster
111.   Opmul = slash
112.   Opmul = caret

    Added Rules
113.   Q = eps
114.   Q = Oprel Rterm Q
115.   Q = Opadd Term Q
116.   Q = Opmul Fact Q

117.   A = eps
118.   A = equal Varinit

119.   VaritemTail = ClassDefTail
120.   VaritemTail = eps
121.   ClassDefTail = Classmom Interfaces BBclassitems

122.   VarspecTail = eps
123.   VarspecTail = KKint

124.   BBexprsTail = Exprlist brace2
125.   BBexprsTail = brace2

126.   ClassitemsTail = eps
127.   ClassitemsTail = ClassgroupTail Classitems
128.   ClassgroupTail = Class_ctrl
129.   ClassgroupTail = VarlistTail
130.   ClassgroupTail = Mdheader Mddecls
131.   VarlistTail = Varitem semi Varlist

132.   PParmlistTail = Varspecs parens2
133.   PParmTail = parens2

134.   StmtTail = PPexprs
135.   StmtTail = equal Expr

136.   LvalTail = eps
137.   LvalTail = KKexpr

138.   PPExprTail = Exprlist parens2
139.   PPExprTail = parens2

140.   StrtnTail = Expr
141.   StrtnTail = eps

142.   FactTail = eps
143.   FactTail = KKExpr
144.   FactTail = PPExpr