Compiler Design
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Lecture – 34
Parser (Contd.)

So, next we have to construct the follow sets for the non terminals.

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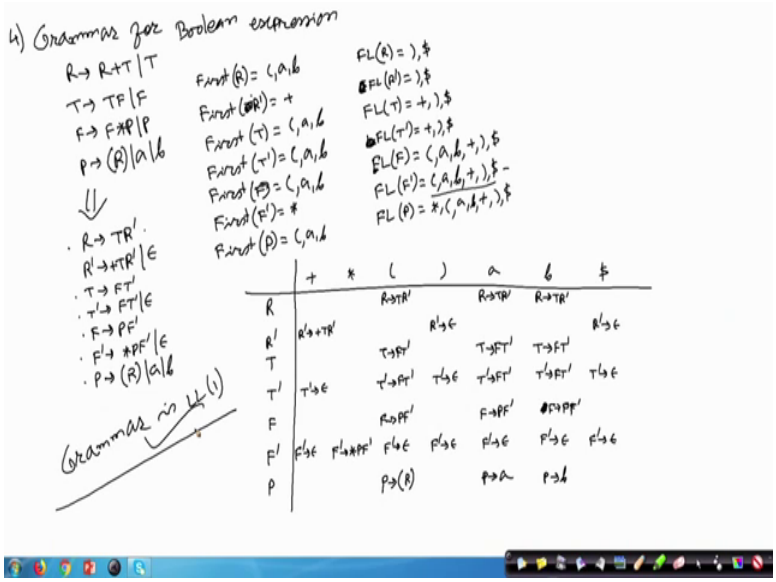

So, the follow set will be like this. So, for I am writing in short follow of R equal to, so these sets are to be computed, follow of R dash. Then follow of T, follow of T dash, then follow of F follow of F dash and follow of P. So, these are the sets that I have to compute.

Now, follow of R, so if you look into the grammar you see that R may be followed by this close parenthesis and the dollar being the start symbol. So, close parenthesis and dollar, they will come to the follow of R. Now follow of R dash, so if you look into this rule, it says whatever is in follow of R is in follow of R dash.

So, this close parenthesis and dollar they will be coming here. Now, follow of P, so it says whatever is in first of R dash, so if you look into this rule it says whatever is in follow of R dash will be in the follow of T, so follow of R dash has got plus. So, this follow of T will have plus here. And then, first of R dash, so R dash can give me epsilon,

so if this R dash is replaced by epsilon in that case, so whatever is in follow of R dash will also be in follow of T. So, that way this follow of R dash has got closed parenthesis and dollar. So, they will also come in the follow set of T.

Now, follow of T dash. So, follow of T dash whatever is in follow of T is in follow of T dash by this rule, T producing F T dash. So, this plus, close parenthesis and dollar they come to the follow of T dash. Now, comes follow of F. So, this says that whatever is in first of P is in whatever is in first of F dash will be in follow of P. So, first of F dash has got star. So, this follow of P, follow of P will have star there. So, before that this follow of F, so how to get this follow of F? So, follow of F, you can say it is given by this first of T dash. So, first of T dash has got this open parenthesis a, b. So, this first of follows whatever this first of T dash has got open parenthesis a, b. So, they can come to the follow of F.

So, this is basically first of T dash. So, open parenthesis a, b, they can come to the follow of this set. Then, then follow of F dash, so follow of F dash tells whatever is in follow of F will be in follow of F dash. So, what is there in follow of [FL]? So, follow of F has got this open parenthesis a, b. So, they will be in the follow of F dash. And this T dash this T dash can give me epsilon. So, whatever is in follow of T is also in follow of F. So, whatever is in follow of T follow of T has got this plus, close parenthesis and dollar. So, they can also come in the follow of F. So, this plus, close parenthesis and dollar, they can come in the follow of F.

Now, this one, so, so whatever is follow of F is equal to follow of F, that is also there in follow of F dash. So, this plus, close parenthesis and dollar so, they will also come here. And then this P, so P is appearing here. So, whatever is in first of F dash is in follow of P. So, first of F dash has got star, so that have been that I have written. Now, it says that this F dash can give me epsilon. So, whatever is in follow of F dash will be in the follow of P. So, follow of F dash has got all the symbols. So, they will all of them will come in the follow of P. So, all of them will come in the follow of P.

Now, we have got this set of rules now I can we can try to make the corresponding table. So, I have got this R, R dash, T, T dash, F, F dash and P and I have got the symbols here that is plus, star, open parenthesis, close parenthesis, then a, b and dollar. Now, we have to go rule by rule. So, first rule it says R producing T R dash. So, I have to look into the

first of T. So, first of T contains open parenthesis a, b, there I have to add this rule. So, open parentheses. So, R producing T R dash, here also R producing T R dash, here also R producing T R dash. So, they have been added. Now, come to the second rule R dash producing plus T R dash. So, that rule will be added here R dash producing plus T R dash.

Now, it says that R dash producing epsilon is there. So, whatever is in follow of R dash there, I have to add this R dash producing epsilon. So, follow of R dash has got this close parenthesis and dollar there, I have to add R dash producing epsilon and here also I have to put R dash producing epsilon. So, these two are added. Now, come to the third rule T, T producing F T dash. So, whatever is in first of F T dash, that is in first of F. So, I have to add this rule. So, this T producing F T dash has to be added to first of F is open parenthesis. So, T producing F T dash, then a, b. So, T producing F T dash, they are all added there; T producing F T dash has been added.

Now, come to the fourth rule; T producing T dash producing F T dash. So, it says that whatever is in first of F T dash, there I have to add these rules. So, first of F T dash has got first of F. So, there I have to add this rule. So, I have to add the rule T dash producing F T dash here, then here T dash producing F T dash, here also T dash producing F T dash. Now, there is a rule T dash producing epsilon. So, I have to look into the follow set of T dash. So, follow set of T dash has got plus, close parenthesis and dollar. There I have to add this rule T dash producing epsilon, T dash producing epsilon and here also, T dash producing epsilon. So, this is done.

Now, we come to this rule P F producing P F dash. So, whatever now I have to see the first of P. So, first of P has got open parenthesis a, b, there I have to add this rule. So, F producing P F dash, F producing P F dash, then this has got P has got open parenthesis a, b. So, F producing P F dash and here also, F producing P F dash. So, they are added now coming to this rule. So, first contains a star. So, F dash star I should have this rule, F dash producing star P F dash.

Now, this F dash producing epsilon, so, I have to look into the follow set of F dash. So, follow set of F dash has got all these entries. So, there I have to add this rule. So, open parenthesis. So, F dash produces epsilon, then a F dash produces epsilon; b there I add this rule, F dash producing epsilon, then plus F dash producing epsilon. Then, close

parenthesis and dollar. So, dollar also I have to add F dash producing epsilon. So, this has been added. Now, come to this rule P within bracket R. So, this open parenthesis, I have to add this rule. So, there I have to add the rule P producing within bracket R.

Then coming to the second rule, I have to add P producing a here and coming to the third rule I have to put P producing b at this point. So, this is the construction of the predictive parsing table level; one parsing table and here also you see that there is no duplicate definition. And since there is no duplicate definition, so we can say that the grammar is L L 1, so this grammar is L L 1 ok. So, this way, whenever it is, whenever we try to answer the question whether a grammar is L L 1 or not, so the safest way is to do this and if the directly we need to construct the grammar. So, there also we can do it like that.

Next, we will be doing a few exercises on working on this L R parser. So, we have seen the L L parser examples.

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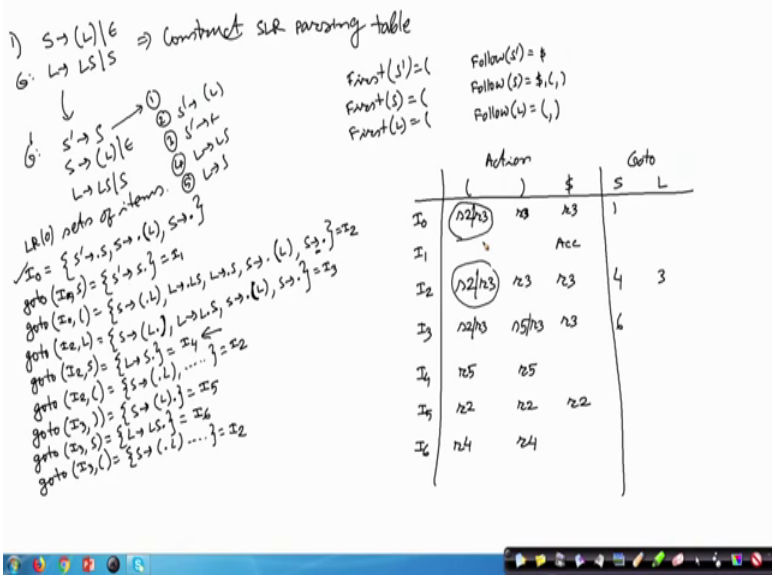

Next, we will see some L R parser examples. So, in that category, the first example that we take is for the grammar a very simple grammar is producing within bracket L or epsilon and this L producing L S or S. The question is to construct the S L R parsing table. Question is to construct the S L R parsing table. Now, this is the grammar G. Now, the first step of this construction you know that we have to augment the grammar by introducing one more start symbol.

So, by augmentation, so this is the grammar G given to us we get the grammar G dash which is which has got an additional symbol is just producing S and then, we have got the rest of the rules are there S producing within bracket L or epsilon and L producing L S or S. Now, I have to construct the L R 0 sets of items, so this is the first step. Second step is to construct the L R 0 sets of items. This is the second thing to do and for that matter what we do we have to first the set is I 0. So, the set I 0 will have only one item in it which is S dash, initially you will have only one item in it S dash producing dot S

And then, by the closure rule we know that we have to construct the closure and for constructing closure. So, I have to look for productions where left hand side is S because there is an item here where S producing dot S. So, I have to look for productions which has got left side as S and then apply the closure rule. So, this will give me this particular thing as another item and since S producing epsilon is there. So, that will give me S producing dot. So, this is the third grammar rule, this is third item. So, these are the three items that I have constructed.

Now, what are the other L R 0 items? So, for that I have to see the goto parts. So, wherever there is a dot before any grammar symbol of any item, so I have to do a goto on that. So, we do it like this. So, we construct the set goto I 0 S; goto I 0 S will give me S dash producing S dot. No other item has got dot before this before s. So, this is the thing and after in this in this items. So, if even if you take closure nothing is going to happen because dot is at the end. And this is a new item that we have got. So, let us name the item as I 1 ok. So, that is the item I 1.

Next, I have to construct other possible goto items. So, to goto I 0 open parenthesis. So, I 0 open parenthesis, so this will give me S producing open parenthesis dot L close parenthesis. And since there is a dot before L, so, by closure I will get all these items L producing from this rule, I will get L producing dot L S and I will get a L producing dot S.

And then, and then since I have got this L producing dot L S um, so this particular rule, so that can that will give me again the same items. But this S producing dot S, so this can give me two more items; one is S producing by this rule ok, S producing dot within bracket L and another item is S producing dot. So, this is another new item that I have got. Let us name the new item as I 2.

Now, from I 0, I cannot have anymore gotos. From I 1 also, there is there is no dot before any grammar symbol. So, I 1 also does not give any goto. From I 2, from I 2, I have to see whether I can get something new. So, goto I 2, L goto I 2 L gives me S producing within bracket L dot. So, this is one item and then another item that I get is L producing L dot S. So, this is another item. So, there is no other item where there is a dot before L. So, nothing else comes, only thing is that now I have got this dot S. So, I have to look for grammar rules and from there, I will get the new items S producing within bracket dot within bracket L, then S producing dot. So, these two items will come.

So, this is again a new item we have not yet generated. So, this is thus the item I 3 ok. Now, goto I 2, I 2 L, I have done. So, I 2 s, so goto I 2 S will give me L producing S dot. There is no other item where I have got a dot before L. So, that is new item I 4. Now, goto I 2 then this open parenthesis goto I 2, open parenthesis. So, this will give me S producing open parenthesis dot L. And then, since there is a dot before L, so, it will giving me all these rules again, all these items again. So, all those items will be coming here. So, this essentially gives me back I 2. So, goto I 2, open parenthesis is I 2 only.

Now, go to I 2. So, I 2, I do not have anything as I believe. So, this is open parenthesis is done. Now, I have to look for this item I 3 goto I 3, then this close parenthesis. So, that gives me S producing that gives me the item S producing within bracket L and that dot come here. So, that is a new item that I have got and that is I 5.

Now, I 3 S goto I 3 s. So, that will give me this L producing L S dot, L producing L S dot and that is a new item. So, this is item I 6. Now, goto I 3 S, I have done I 3 open parenthesis. So, I 3 open parenthesis, so this will give me the item S producing open parenthesis dot L ok. And this as soon as this is there, so I will get all these things, so etcetera. So, that is same as I 2 ok.

Now, for the remaining items I 4, I 5 and I 6, so there is no grammar symbol after the dot ok. So, it they cannot give any more items. So, I have constructed the set L R 0 sets of items, I 0 to I 6, there are seven things, seven cases. The next part of this parsing table construction is to get the follow sets for the grammar symbol but for getting follow sets, we also have to get the first sets. So, again we do the first and follow computations. So, first of S dash, first of and first of L, so this is to be computed, first of S dash is same as first of S and first of S is open parenthesis. So, this is there, open parenthesis is there.

And first of L by this rule L producing S, so, you see it has got the same as the first of S. So, that is the first computation.

Now, the follow computation follow of S dash, then follow of S and follow of L ok. Now, follow of S dash since S dash is the start symbol of the grammar. So, dollar is definitely there. Then, for the follow of S you see that whatever is in follow of, whatever is in follow of S dash is in follow of S. So, whatever is in follow of S dash, so that is in follow of S.

So, dollar is there and you see from rule, you see whatever is in first of S is in follow of L. So, first of S has got this open parenthesis. So, follow of L has got this open parenthesis and follow of L from this rule, you see close parenthesis is also there. So, close parenthesis is 3 in the follow of L. And by this rule, L producing S whatever is in follow of L is in follow of S. So, this open parenthesis and close parenthesis, they also come in the follow of S.

So, this finishes the follow set computation. Next, I have to find out the parsing table. Now, for making the parsing table, we have to the parsing table. We will have two part; the action part and the goto part. So, this is the action part and this is the goto part. So, in the action part, I will have the grammar similar terminals, the we have got two terminal symbols open parenthesis close parenthesis and the dollar that is always there. Now, as the rows, I will have this items I 0, I 1, I 2 we can also write only the states 0, 1, 2, 3. So, also you can write this I 3, I 4 like that, so I 4, I 5 and I 6, so these are the items.

Now, in this I 0, so you see this rule L S producing dot within bracket L. So that means, I if I if I get this open parenthesis, I should do a shift operation and that is shift by and that will be a shift and the I have to consult the goto part. So, goto dot you know I 0 open parenthesis is I 2, I 0 open parenthesis is I 2. So, this is shift 2. So, this is the rule that we get from this item I 0. Now, I 0 does I 0 also has got one rule which is S producing dot. So, I have to see the follow of S and then I have to add it, I have to do the reduction by S producing epsilon for them ok.

So, follow of S has got this dollar, open parenthesis and close parenthesis there I have to tell the reduction rules. So, this is reduction by rule number 3. So, this is our rule number 1, this is rule number 1. Then rule number 2 is S dash producing within bracket L. Rule number 3, S dash producing epsilon. Rule number 4 is L producing L S and rule number

5 is L producing S. So, always we will follow this convention. So, this is reduction by rule number 3, this is also reduction by rule number 3 and here also, there is another action which is reduction by rule number 3. And, so, you see already we have got a shift reduce conflict here that is I do not know getting an open parenthesis whether I should shift it or I should reduce by rule number 3. So, that is the problem.

And the goto part it will have the grammar non terminals S and L. So, one I 0 s, so I 0 S is I 1. So, I will write one here, there is nothing like I 0 L. So, nothing comes to the other one. So, that finishes the processing of I 0. So, I 0 is over. Now, this one I 2, so I 1, I mean the item I 1. So, in item I 1, so I have got this S dash producing dollar. So that means, so, this S dash producing dollar. So, S dash producing S dot and then I have to look into the follow of S dash and there I have to say accept. So, this is the accept.

Now, goto I, now the set I 2, so, the set I 2 has got here. There is a dot before open parenthesis. So, I should be doing a shift operation I 2 open parenthesis. So, this should be a shift. And I 2 I 2, this open parenthesis is I 2 only. So, this is shift 2 and again I have got this rule S producing dot. So, this reduce by 3 will also come, reduce by 3 and here I will get this reduce by 3 and here also there will be reduce by 3. Now, I 2 has got transition on L and S both; I 2 L is 3. So, I 2 L is 3 and I 2 S is 4. So, we have to add them here.

Now, comes item I 3. In item I 3, so, there is a dot before this close parenthesis. So, I have to do a shift on I 2, sorry I 3 close parenthesis. So, this will do a shift and I 2 I there close parenthesis is I 5. So, this is shift 5 ok. So, this will be shift 5. And then, this I 3 and then I have got this one I 3 has I 3 has got this rule also this item the dot before open parenthesis. So, I 3 open parenthesis, so this will be shift this is also be a shift and this I 3 open parenthesis is I 2. So, this is shift 2.

And then, I have got is S producing dot. So, all the reductions will come as we had earlier. So, this will be reduction by 3, this will be reduce by 3, this will be reduce by 3. And this, I 3 S, I 3 S is 6. So, this is 6 and I 3 L does not have any transition. So, it is not possible. Now, come to I 4, so this 1 I 4 L producing S. So, I have to look into follow set of L. So, follow set of L has got open parenthesis and close parenthesis. So, there I have to apply this rule, this L producing S, that is rule number 5. So, this will be reduced by rule number 5 and this will also be reduced by rule number 5.

Now, come to I 5, it has got this particular rule that is rule number 2 and I have to look into the follow set of S. So, follow set of S has got dollar, open parenthesis, close parenthesis. So, there I have to add like reduce by rule number 2, reduce by rule number 2, reduce by rule number 2. Now, come to I 6. So, I 6 has got L S dot. That is rule number 4 and there I have got this follow set of L is open parenthesis and close parenthesis.

So, I have to reduce by rule number 4 and reduce by rule number 4. So, this way you can construct the S L R parsing table for this particular grammar. So, it has got shift reduce conflicts in it. So, naturally we have got the grammar is not S L R ok, but we can try to resolve this conflict somehow by adding some domain knowledge on this grammar ok. So, we will continue with the examples in the next class.