LR Parsing

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Outline

Properties of LR Parsing

- bottom-up
- directional (consumes input from left to right)
- related to Earley parsing
- handles left recursion
- handles ε-rules in its more sophisticated form
- fast - parses in linear time
- deterministic

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- The central task of the parser is to find *handles* in the input.
- *Peter goes on a trip with his wife*
- *Peter goes PP with his wife*
- $4 + 3 \times 5$
- $4 + 15$
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The idea (cont.)

- A sequence of tokens can be a handle only if it could have been derived from some non-terminal in that position, which in turn could have been derived. . . and so on, going all the way back up to the start symbol.
- To take that into consideration, LR parsers use a top down component like the Earley parser.

Building an LR Parser

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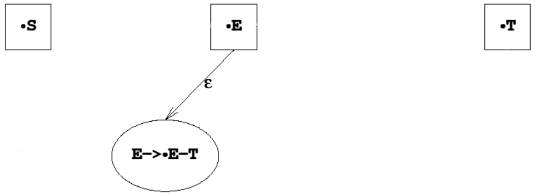

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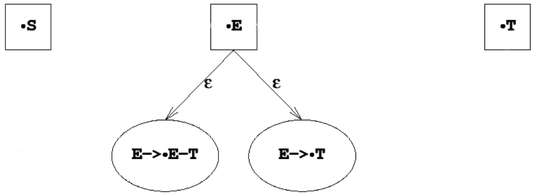

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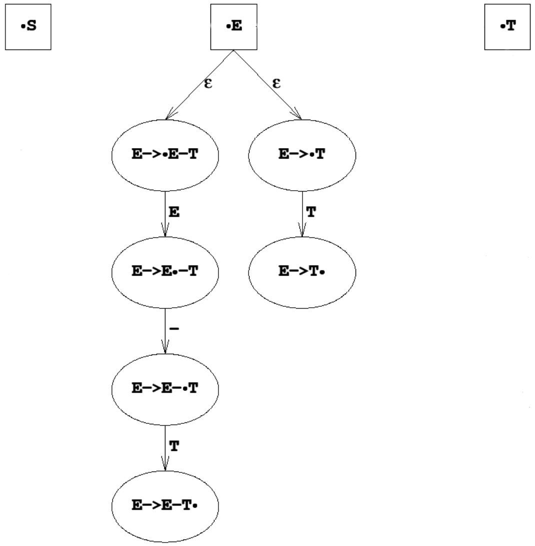

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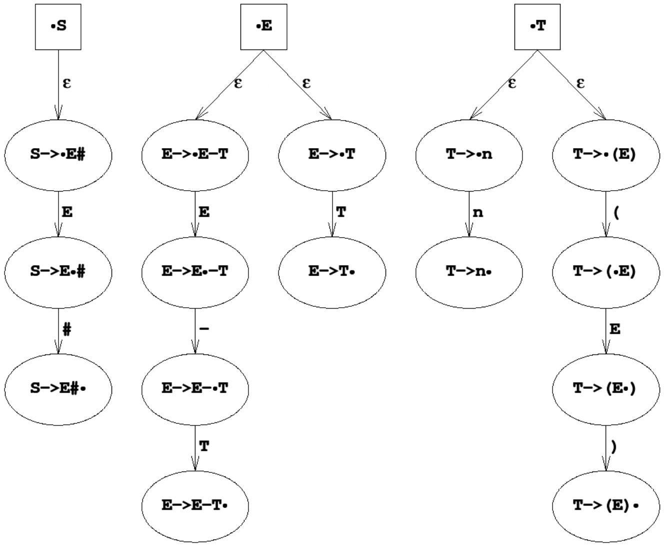

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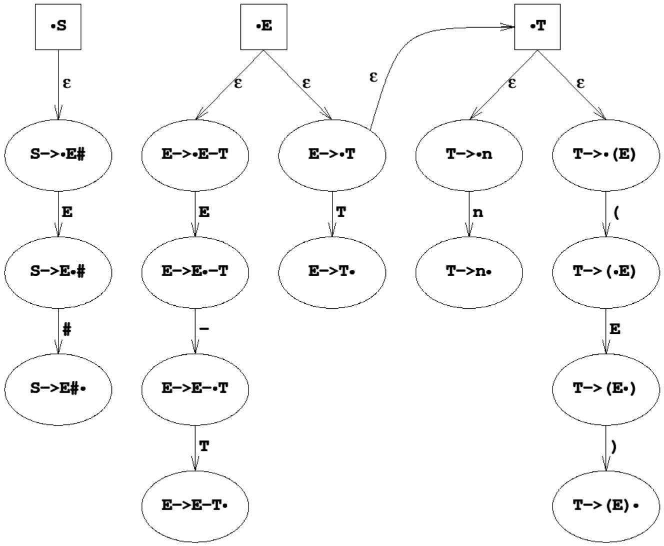

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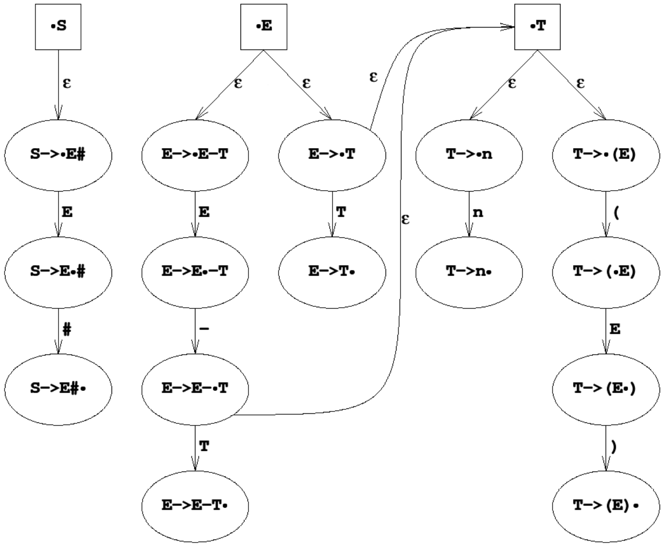

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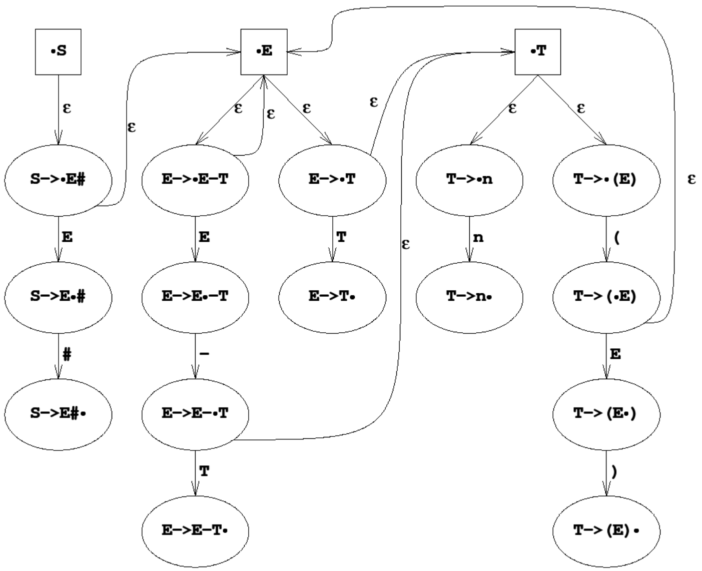

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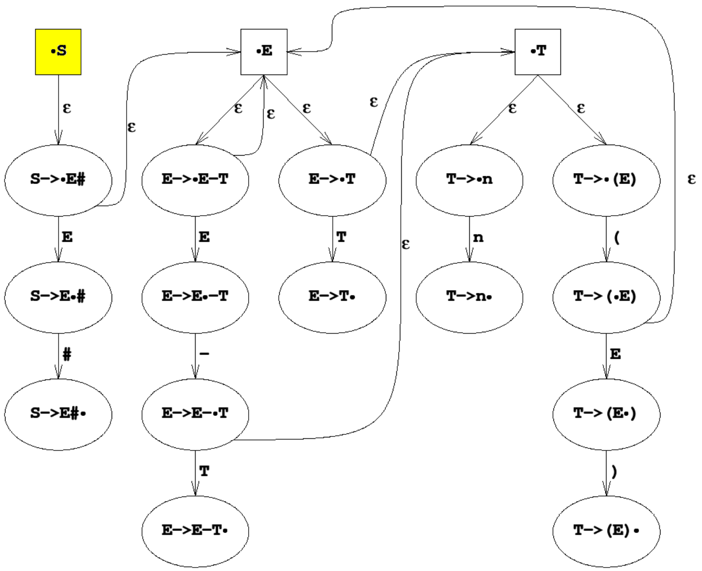

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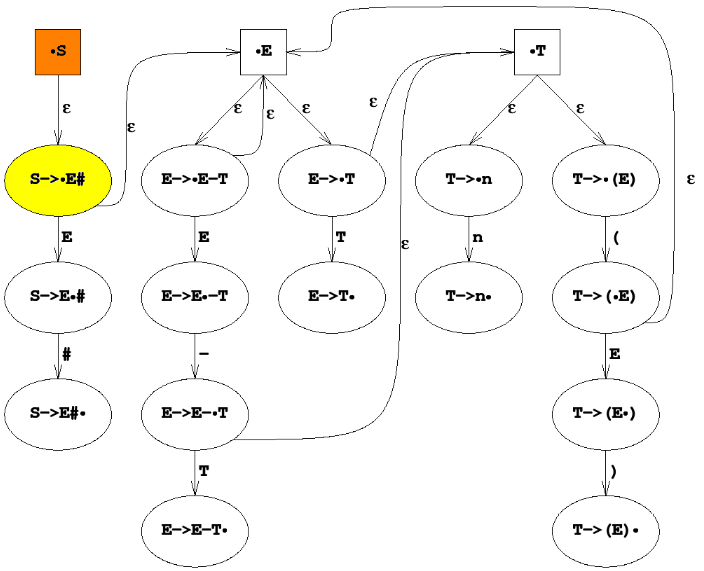

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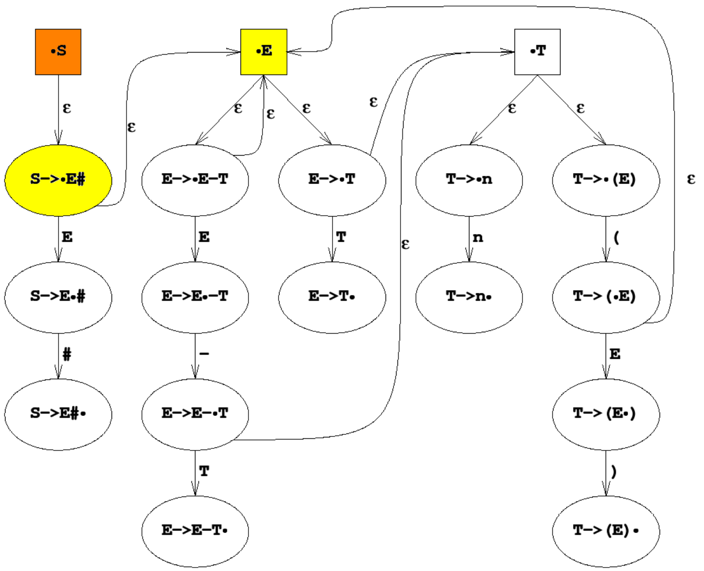

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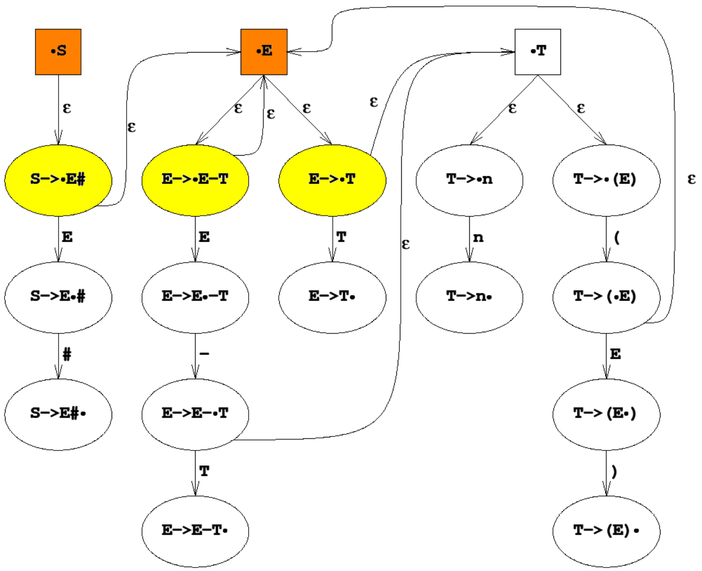

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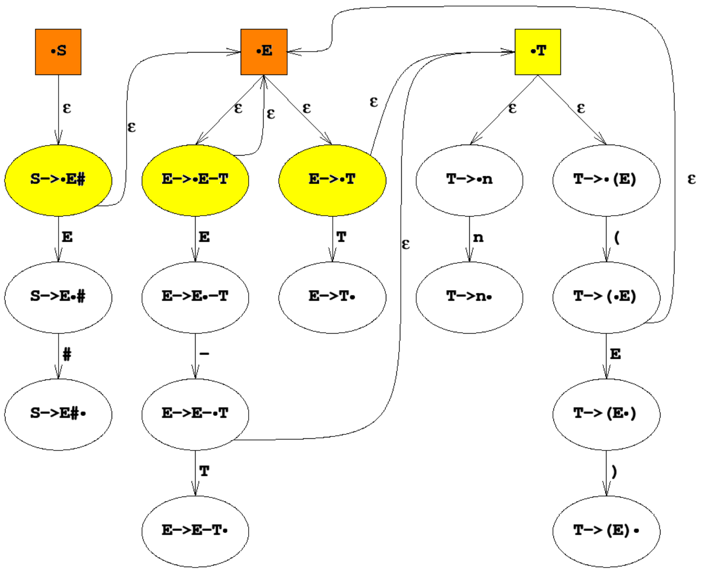

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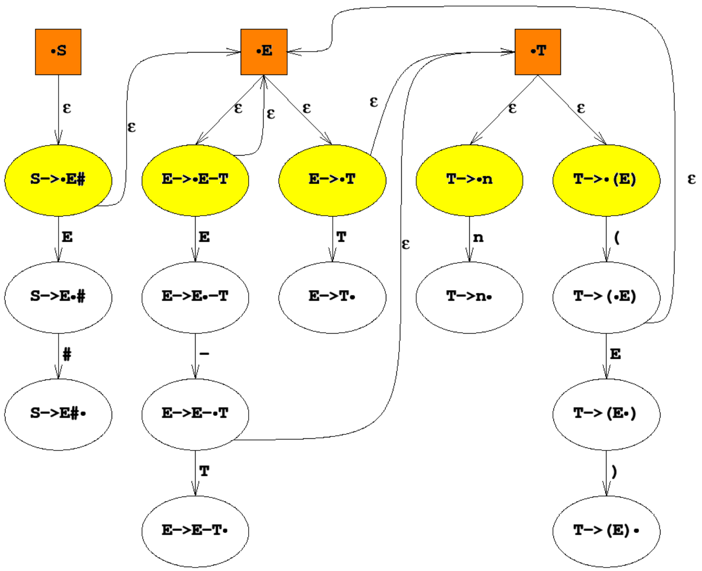

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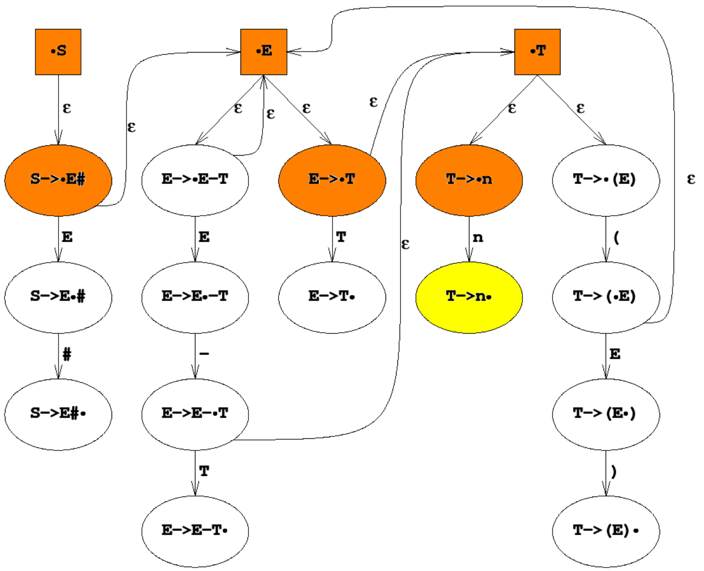

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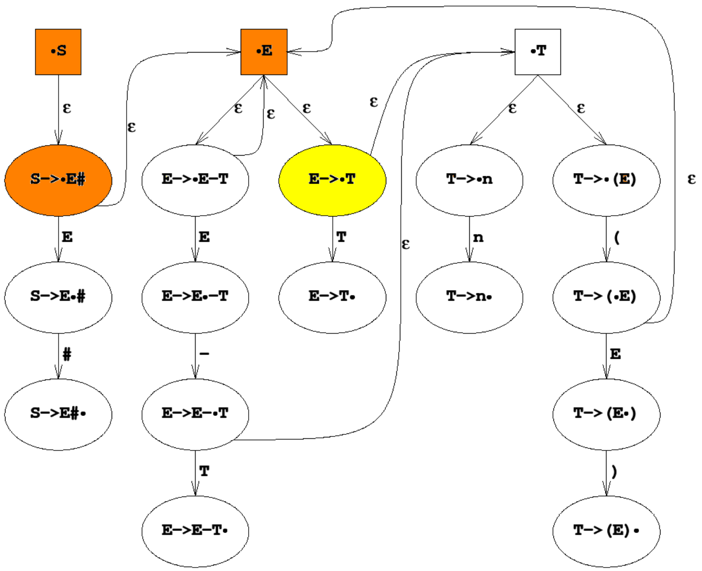

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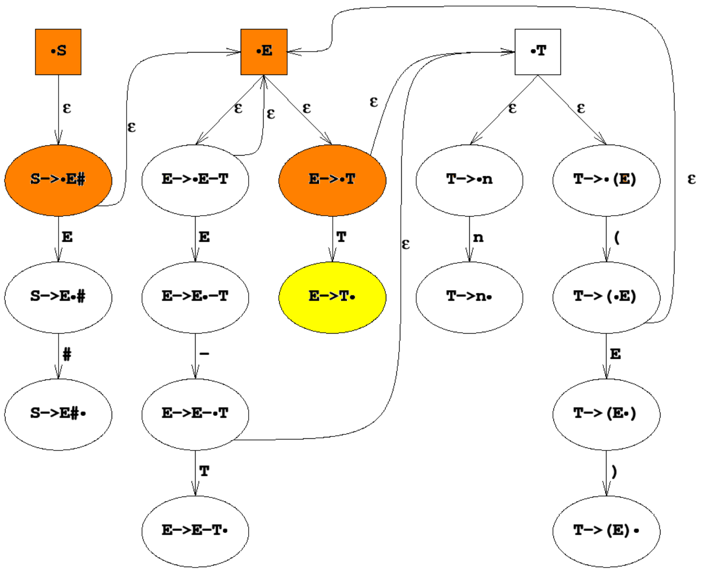

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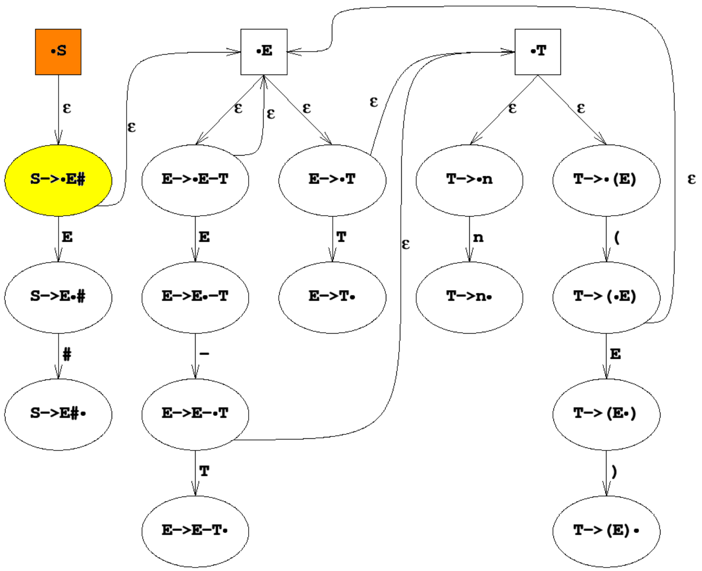

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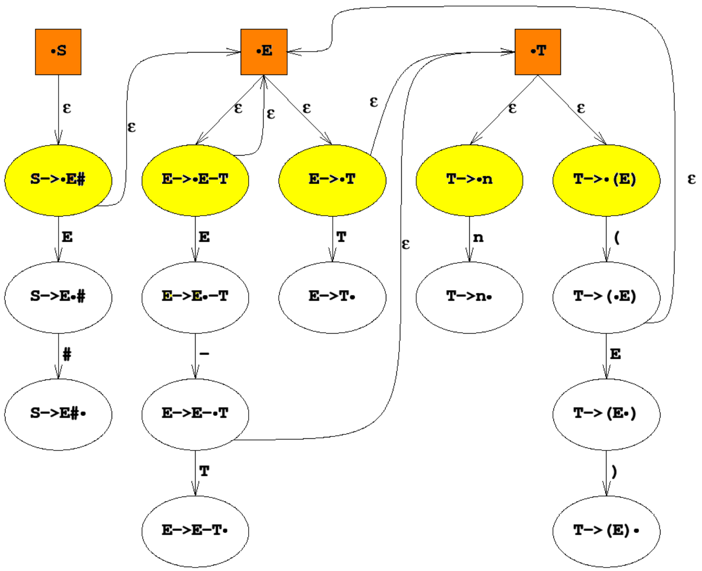

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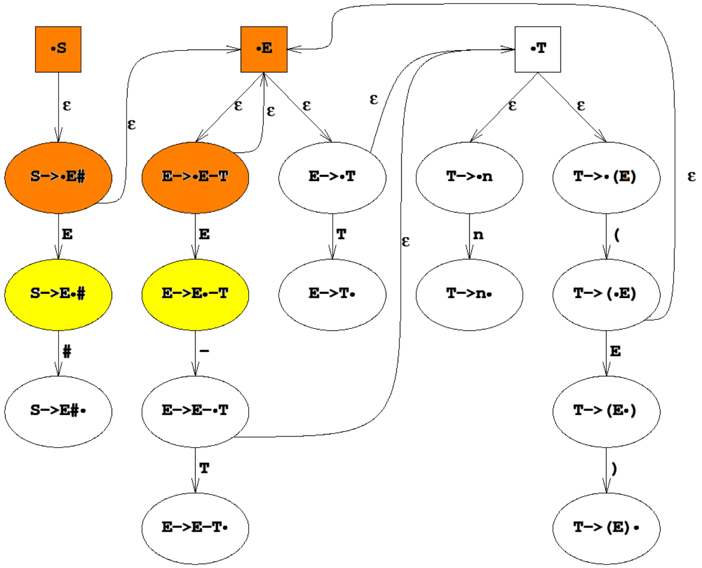

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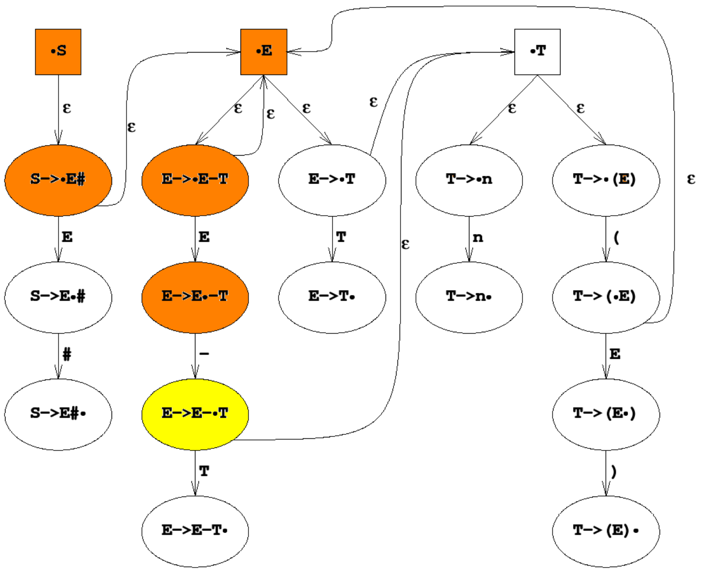

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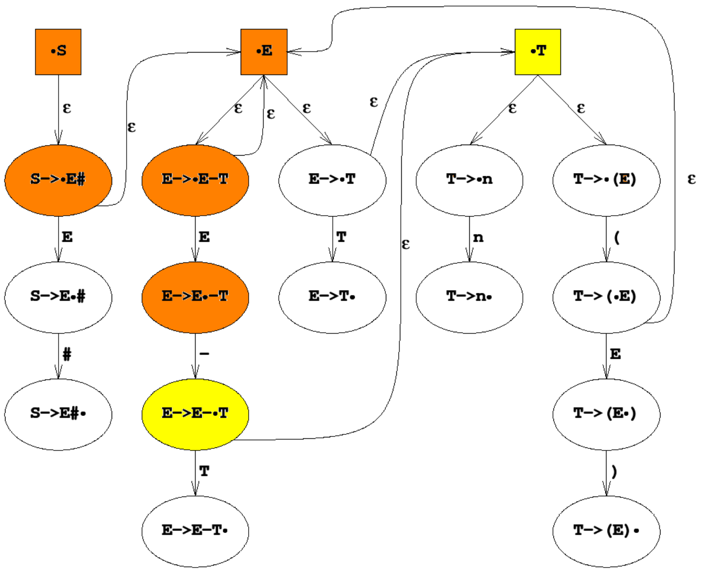

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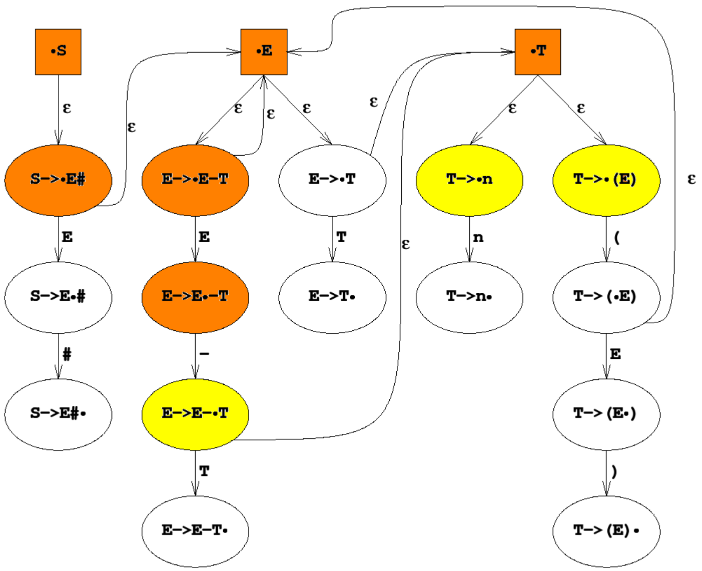

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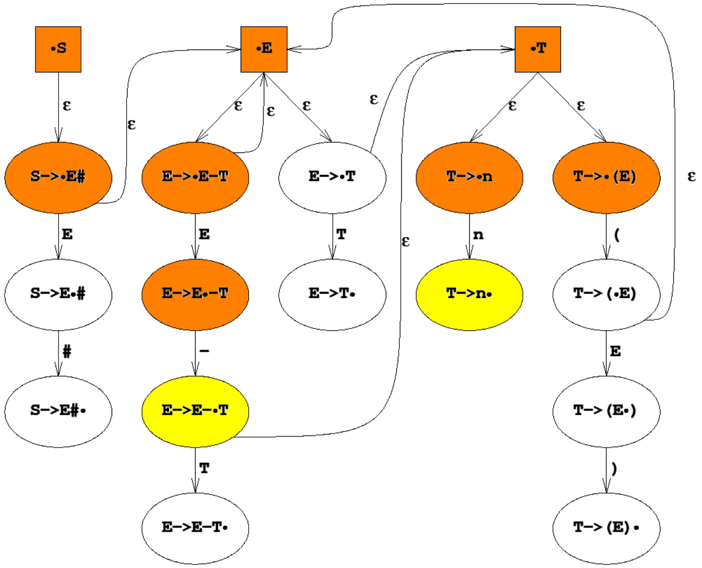

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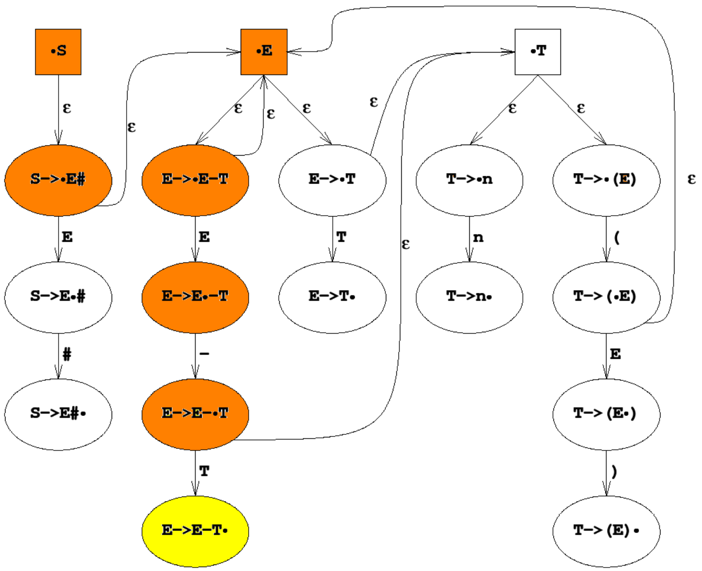

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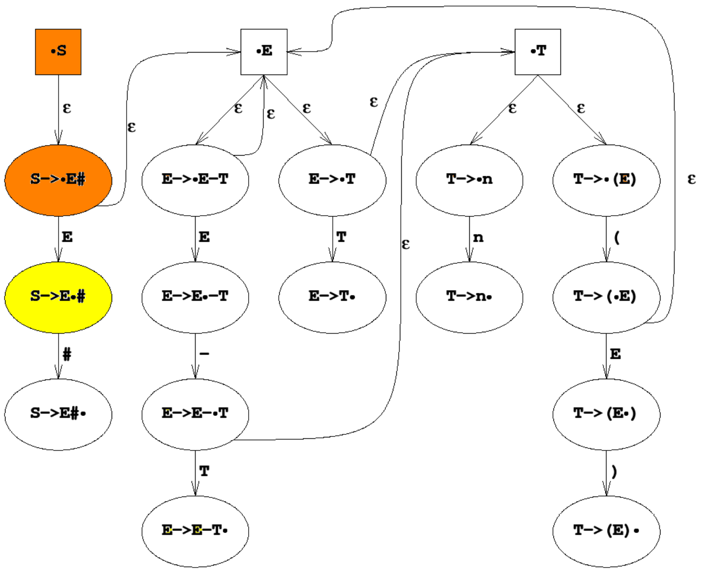

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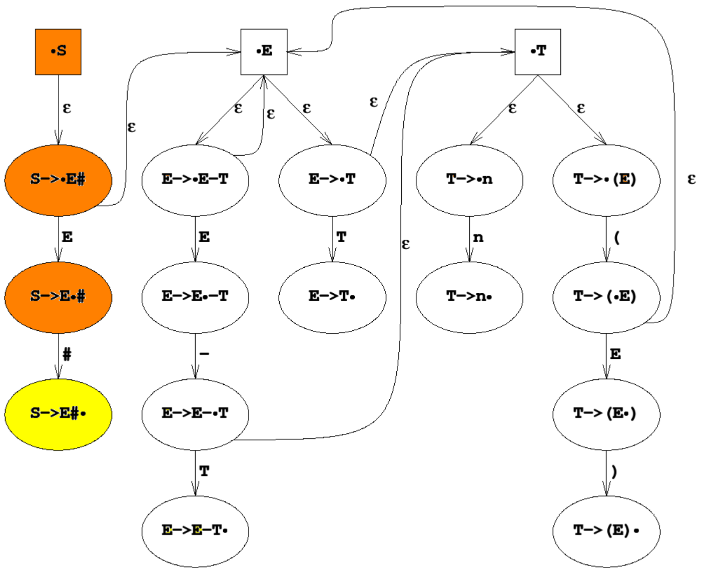
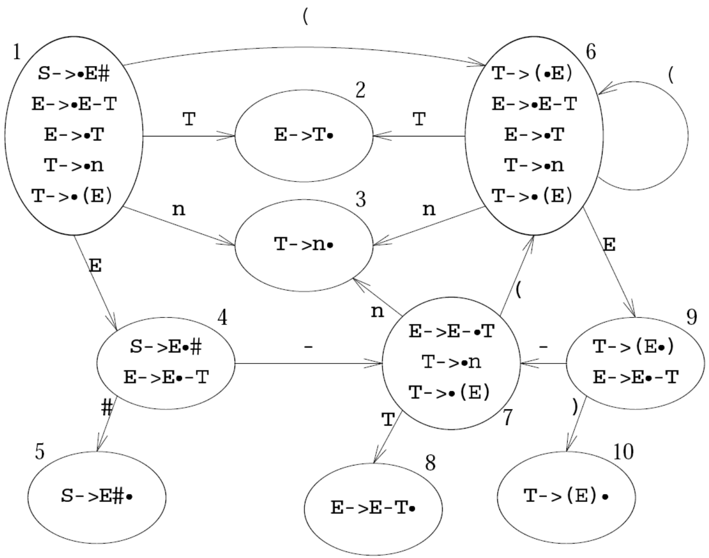


A deterministic handle recognizer



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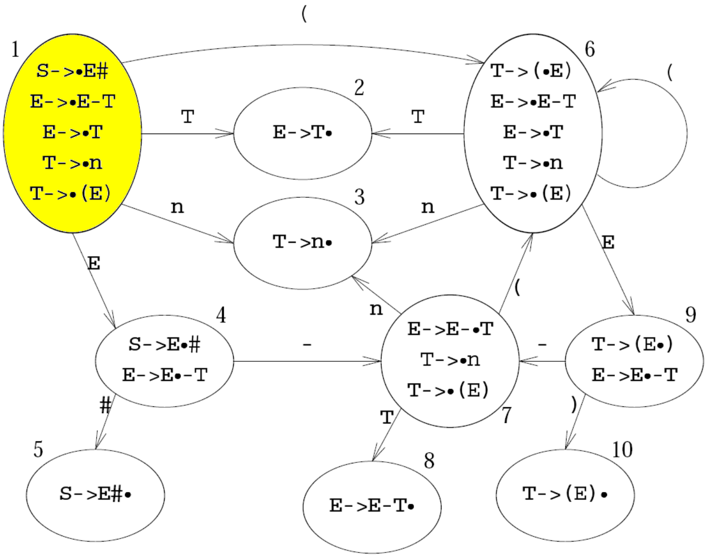

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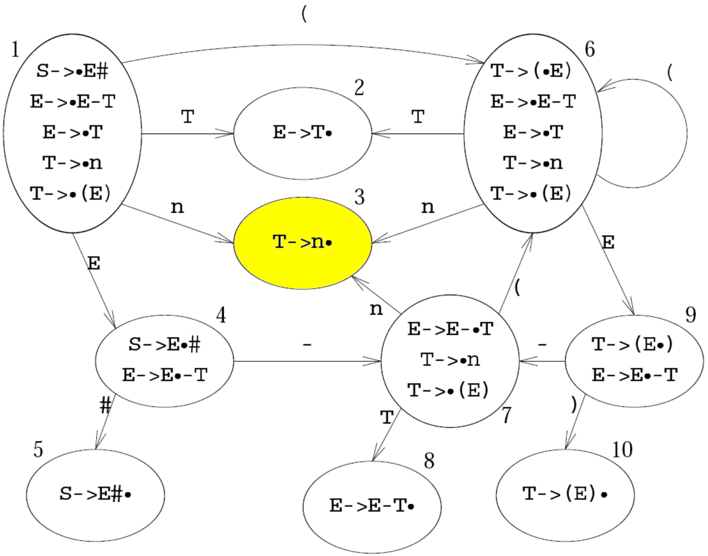

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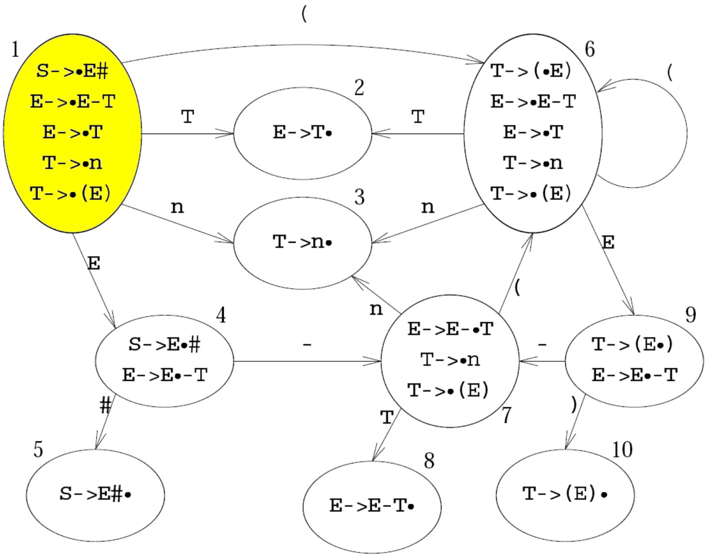

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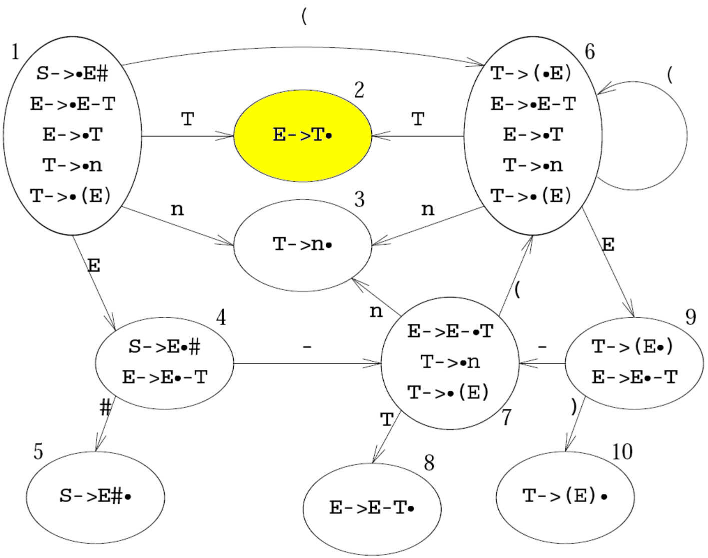

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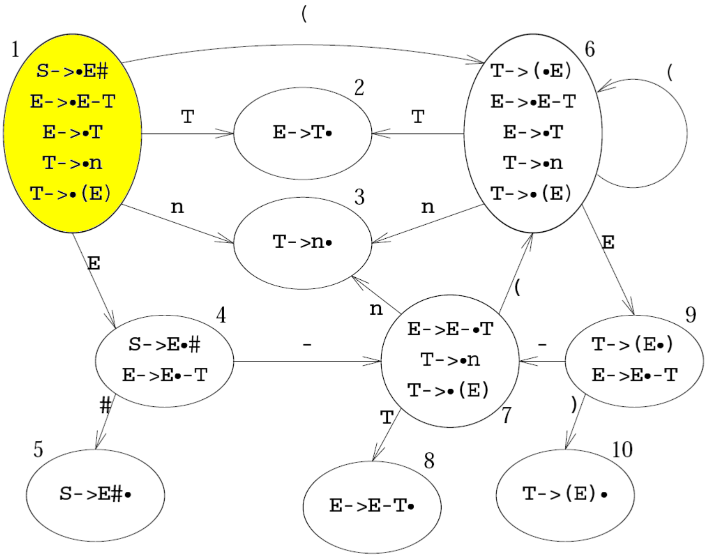

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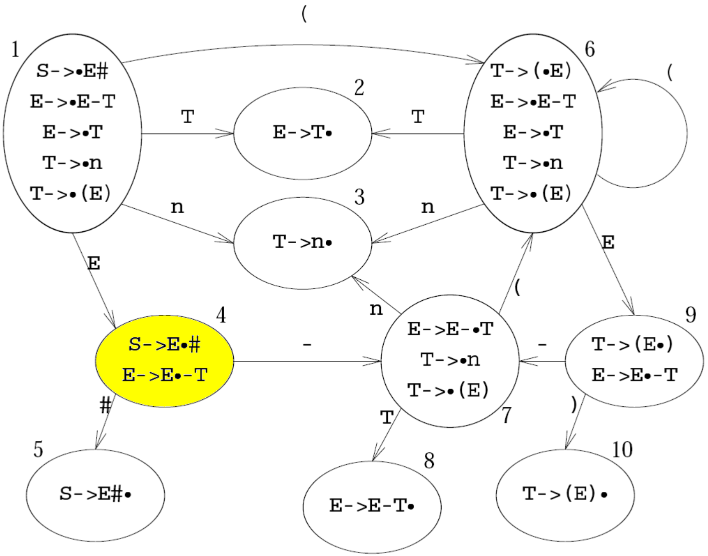

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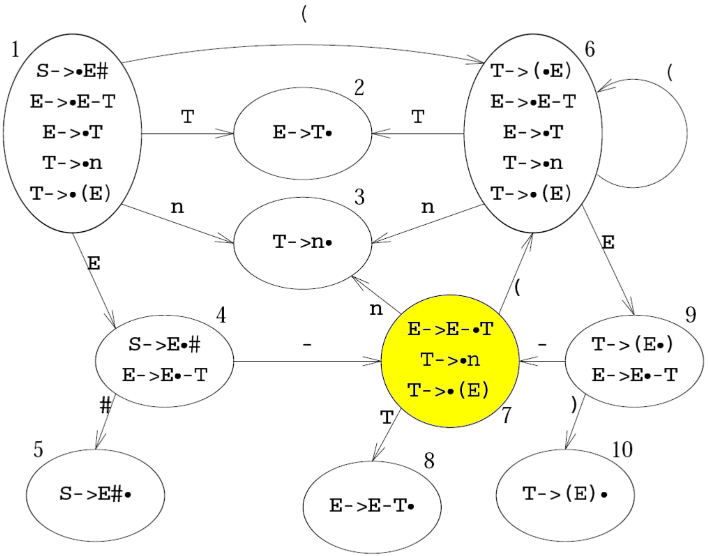

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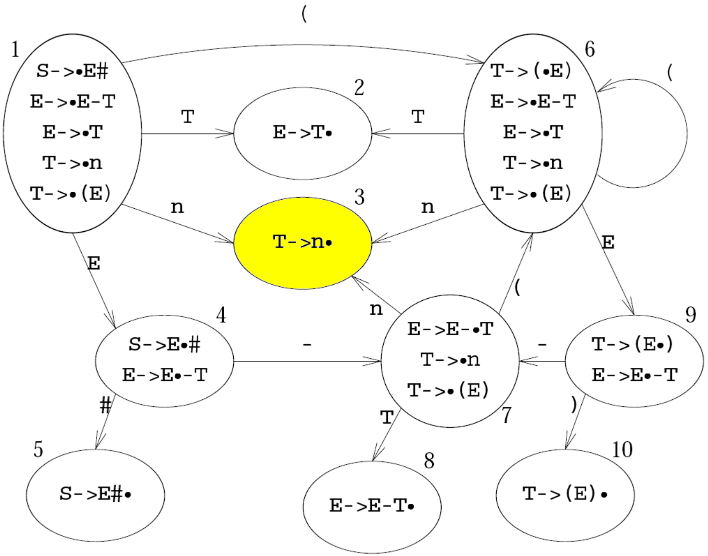

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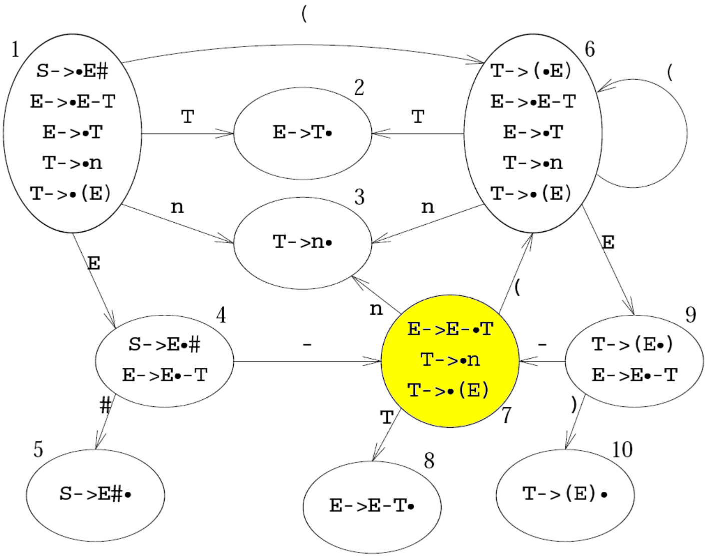

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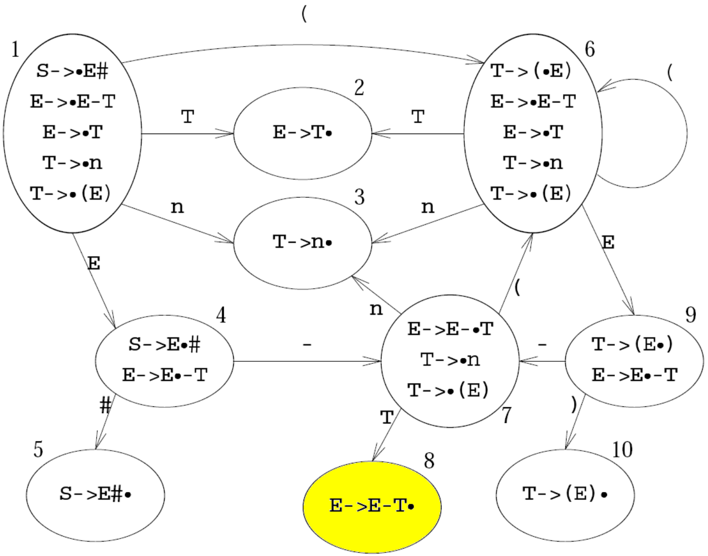

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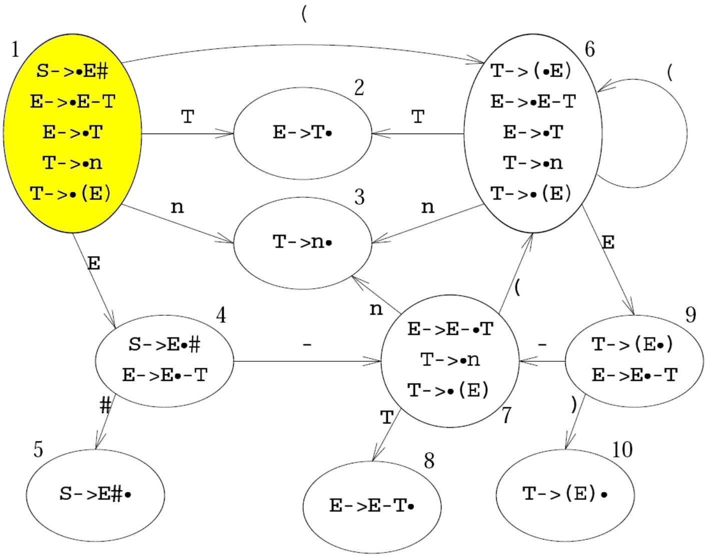

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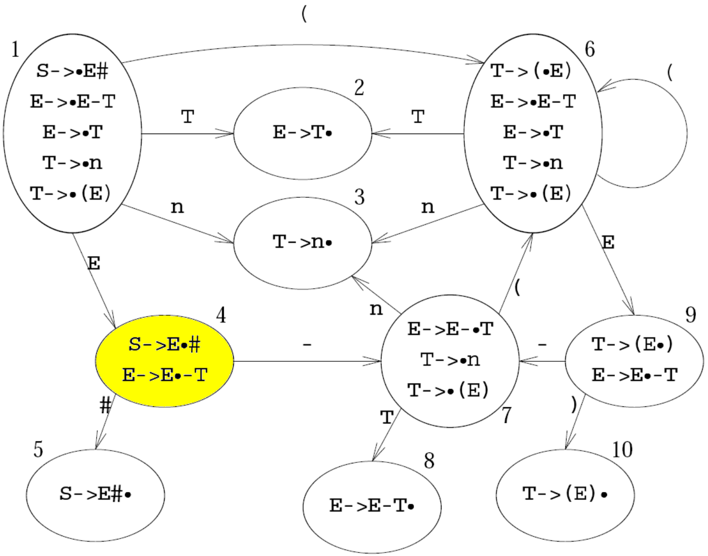

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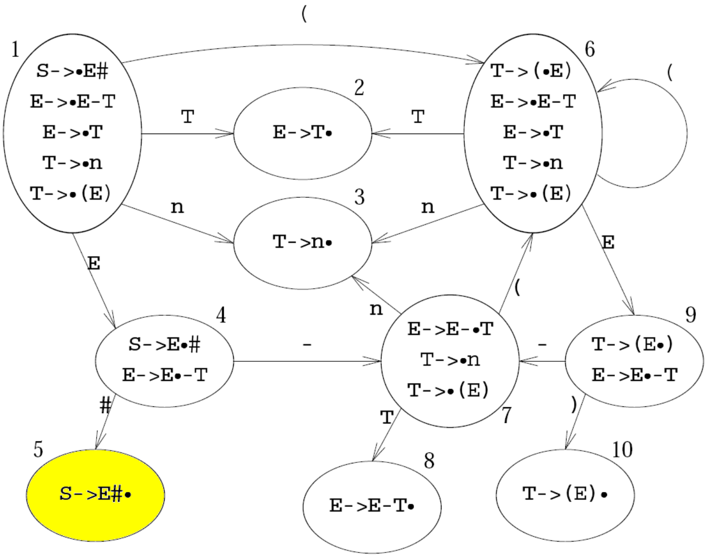
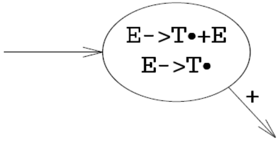
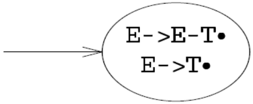


Conflicts caused by non-LR(0) grammars



shift/reduce conflict
(on +)



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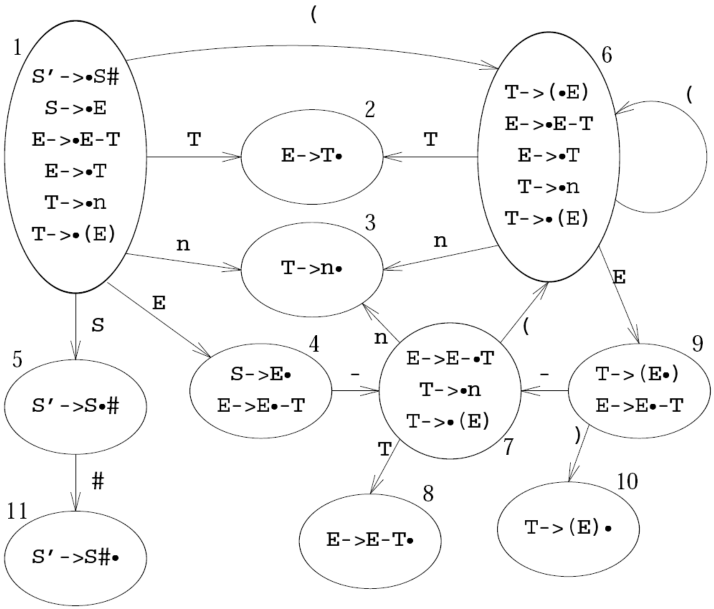
(always)

An inadequate handle recognizer



Lookahead

- The 0 in $LR(0)$ stands for 0 symbols lookahead.
- Grammars which are not $LR(0)$ may still be $LR(1)$, or $LR(k)$ with some higher k.
- LR parsers can be built for such grammars by introducing lookahead.
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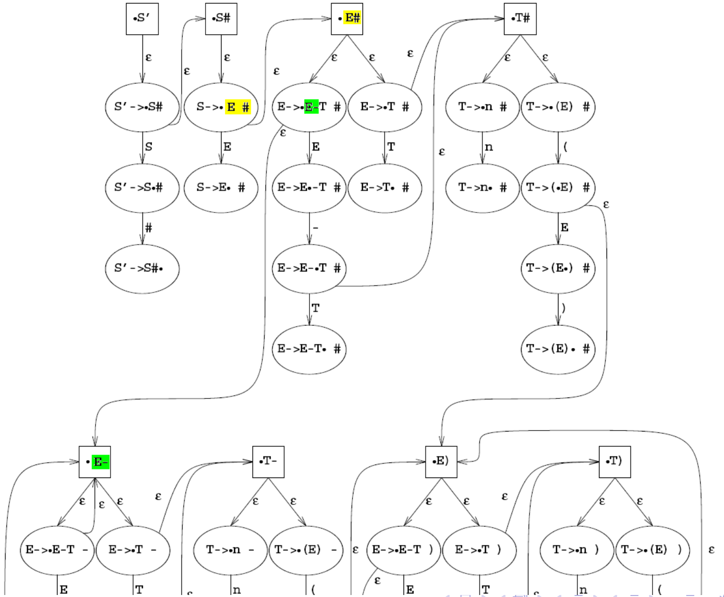
A non-deterministic handle recognizer with lookahead



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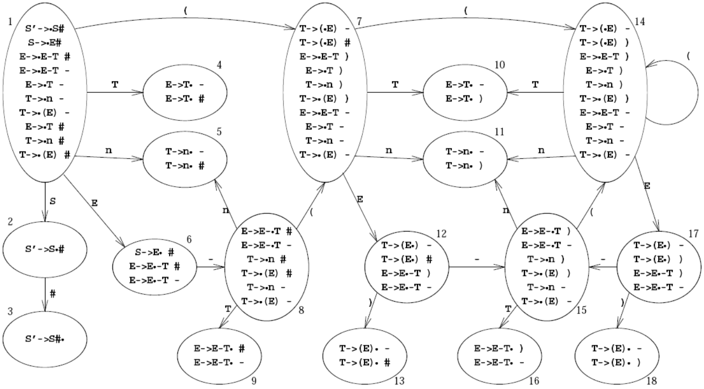

A table representation of our LR(1) parser

	n	-	(	)	#	S	E	T
1	s5	e	s7	e	e	s2	s6	s4
2	e	e	e	e	s3			
3/acc								
4	e	r4	e	e	r4			
5	e	r5	e	e	r5			
6	e	s8	e	e	r2			
7	s11	e	s14	e	e		s12	s10
8	s5	e	s7	e	e			s9
9	e	r3	e	e	r3			
10	e	r4	e	r4	e			
11	e	r5	e	r5	e			
12	e	s15	e	s13	e			
13	e	r6	e	e	r6			
14	s11	e	s14	e	e		s17	s10
15	s11	e	s14	e	e			s16
16	e	r3	e	r3	e			
17	e	s15	e	s18	e			
18	e	r6	e	r6	e			

Limitations of $LR(k)$ parsing

- Although an $LR(2)$ parser is more powerful than an $LR(1)$ in that it can handle some grammars that the other cannot, the emphasis is on *some*. (Grune + Jacobs)

Some more properties of $LR(k)$ parsing

- Any $LR(k)$ grammar with $k > 1$ can be transformed into an $LR(k-1)$ grammar, thus to $LR(1)$, but not always to $LR(0)$.
- A language that has an $LR(1)$ grammar is called *deterministic*.
- Many programming languages are $LR(1)$. Well-known exceptions are C++, Perl and Python.

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References

Dick Grune & Ceriel Jacobs (1990). *Parsing Techniques.* Amsterdam. pp. 200-213

Content, examples and all diagrams taken from there.