This work is to be done before Exam 1.

Assigned Reading on the Syntax of Expressions

Read Sections 2.1 and 2.2 on pp. 28 – 33 of Sethi (up to and including the figure at the top of p. 33).

Homework Exercises on the Syntax of Expressions  [Not for credit]

A. Do problems 2.1, 2.2, 2.3, 2.7, and 2.8 on pp. 49 – 50 of Sethi.

B. Do the following exercises on infix, prefix, and postfix syntax, and abstract syntax trees:

1. In a certain language expressions are written in infix syntax. The language has binary, prefix, and postfix operators that belong to the following precedence classes:

<table>
<thead>
<tr>
<th>binary ops</th>
<th>prefix ops</th>
<th>postfix ops</th>
<th>associativity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Class:</td>
<td># ~</td>
<td>~</td>
<td>[none]</td>
</tr>
<tr>
<td>2nd Class:</td>
<td>@</td>
<td>[none]</td>
<td>$</td>
</tr>
<tr>
<td>3rd Class:</td>
<td>% ^</td>
<td>@</td>
<td>[none]</td>
</tr>
</tbody>
</table>

   1st class operators have highest precedence and 3rd class operators have lowest precedence.

   (a) Say which operator is applied last in the following expression, and then draw the abstract syntax tree of the expression. [To help you, subscripts have been attached to each operator to indicate its precedence class and whether that class is left- or right-associative, even though this information can also be obtained from the above table.]

   (@3R a #1R u) @2L w $2L %3R (5 ^3R b ~1R c) ^3R d

   (b) Rewrite the expression in prefix syntax.

   (c) Rewrite the expression in postfix syntax.

2. Draw the AST of the following postfix syntax expression, and rewrite the expression in prefix syntax. A subscript has been attached to each operator that shows the operator's arity. [The operators in this question and the next are not related to the operators in question 1.]

   a b $2 @1 3 u *1 v w $2 ~2 5 @1 ^3 #2

3. Draw the AST of the following prefix syntax expression, and rewrite the expression in postfix syntax. A subscript has been attached to each operator that shows the operator's arity.

   ^3 x y #2 ^3 ~2 u v *1 w #2 ^1 5 a b
Solutions
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Section A
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2.1 (a) \( + * a b c \) (b) \( * a + b c \) (c) \( + * a b * c d \)
    (d) \( * * a + b c d \) (e) \( / + / b 2 \text{ SQRT} - * / b 2 / b 2 * a c a \)

2.2 (a) \( a b * c + \) (b) \( a b c + * \) (c) \( a b * c d * + \)
    (d) \( a b c + * d * \) (e) \( b 2 / b 2 / b 2 / * a c * - \text{ SQRT} + a / \)

2.3 (a) \( + \) (b) \( * \) (c) \( + \)
    \[ / \ / \ * \ c \ a + \ / \ / \ \ * \ * \ \]
    \[ / \ / \ a b \ / \ b c \ / \ / \ a b c d \]
    (d) \( * \)
    \[ / \ / \ * \ d \ / \ a + \ / \ b c \]
2.8 stack

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7

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7 7

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7 7

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49

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49 4

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remaining input

7 7 * 4 2 * 3 * -

7 * 4 2 * 3 * -

* 4 2 * 3 * -

4 2 * 3 * -

2 * 3 * -
Section B

1. (a) % is applied last.

1. (b) % $ @ @ # a u w ^ ^ 5 ~ b c d

1. (c) a u # @ w @ $ 5 b c ~ ^ d ^ %
prefix syntax:  # @ $ a b ^ 3 ~ * u $ v w @ 5
postfix syntax: $x\ y\ u\ v\ \sim\ w\ *\ 5\ -\ a\ \#\ ^\ b\ \#\ ^$