

MAU22C00 Assignment 0, Due Friday 22 September 2023  
Solutions

1. Insert parentheses in the expression “not  $p$  and  $q$  or  $p$ ” to make each of the following truth tables correct:

| $p$ | $q$ | not $p$ and $q$ or $p$ |
|-----|-----|------------------------|
| F   | F   | F                      |
| F   | T   | T                      |
| T   | F   | F                      |
| T   | T   | F                      |

| $p$ | $q$ | not $p$ and $q$ or $p$ |
|-----|-----|------------------------|
| F   | F   | F                      |
| F   | T   | T                      |
| T   | F   | T                      |
| T   | T   | T                      |

| $p$ | $q$ | not $p$ and $q$ or $p$ |
|-----|-----|------------------------|
| F   | F   | T                      |
| F   | T   | T                      |
| T   | F   | T                      |
| T   | T   | T                      |

| $p$ | $q$ | not $p$ and $q$ or $p$ |
|-----|-----|------------------------|
| F   | F   | T                      |
| F   | T   | T                      |
| T   | F   | F                      |
| T   | T   | F                      |

*Solution:*

- (a)  $((\text{not } p) \text{ and } (q \text{ or } p))$  works:

| $p$ | $q$ | $(\text{not } p)$ | $(q \text{ or } p)$ | $((\text{not } p) \text{ and } (q \text{ or } p))$ |
|-----|-----|-------------------|---------------------|----------------------------------------------------|
| F   | F   | T                 | F                   | F                                                  |
| F   | T   | T                 | T                   | T                                                  |
| T   | F   | F                 | T                   | F                                                  |
| T   | T   | F                 | T                   | F                                                  |

- (b)  $((\text{not } p) \text{ and } q) \text{ or } p$  works:

| $p$ | $q$ | $(\text{not } p)$ | $((\text{not } p) \text{ and } q)$ | $((\text{not } p) \text{ and } q) \text{ or } p$ |
|-----|-----|-------------------|------------------------------------|--------------------------------------------------|
| F   | F   | T                 | F                                  | F                                                |
| F   | T   | T                 | T                                  | T                                                |
| T   | F   | F                 | F                                  | T                                                |
| T   | T   | F                 | F                                  | T                                                |

- (c)  $((\text{not } (p \text{ and } q)) \text{ or } p)$  works:

| $p$ | $q$ | $(p \text{ and } q)$ | $((\text{not } (p \text{ and } q)))$ | $((\text{not } (p \text{ and } q)) \text{ or } p)$ |
|-----|-----|----------------------|--------------------------------------|----------------------------------------------------|
| F   | F   | F                    | T                                    | T                                                  |
| F   | T   | F                    | T                                    | T                                                  |
| T   | F   | F                    | T                                    | T                                                  |
| T   | T   | T                    | F                                    | T                                                  |

(d) Either  $(\text{not } (p \text{ and } (q \text{ or } p)))$  or  $(\text{not } ((p \text{ and } q) \text{ or } p))$  will work:

| $p$ | $q$ | $(q \text{ or } p)$ | $(p \text{ and } (q \text{ or } p))$ | $(\text{not } (p \text{ and } (q \text{ or } p)))$ |
|-----|-----|---------------------|--------------------------------------|----------------------------------------------------|
| F   | F   | F                   | F                                    | T                                                  |
| F   | T   | T                   | F                                    | T                                                  |
| T   | F   | T                   | T                                    | F                                                  |
| T   | T   | T                   | T                                    | F                                                  |

| $p$ | $q$ | $(p \text{ and } q)$ | $((p \text{ and } q) \text{ or } p)$ | $(\text{not } ((p \text{ and } q) \text{ or } p))$ |
|-----|-----|----------------------|--------------------------------------|----------------------------------------------------|
| F   | F   | F                    | F                                    | T                                                  |
| F   | T   | F                    | F                                    | T                                                  |
| T   | F   | F                    | T                                    | F                                                  |
| T   | T   | T                    | T                                    | F                                                  |

2. The ambiguous grammar

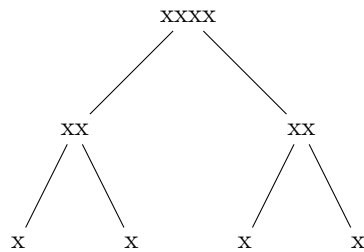
```
%start start
```

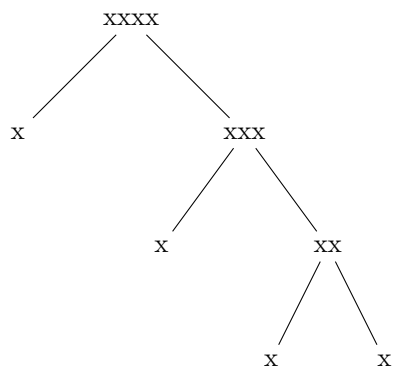
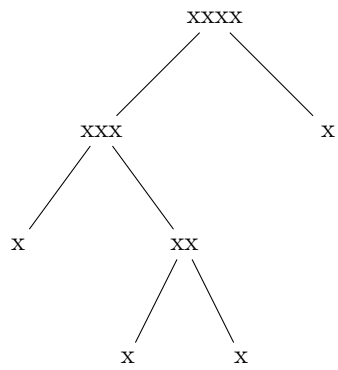
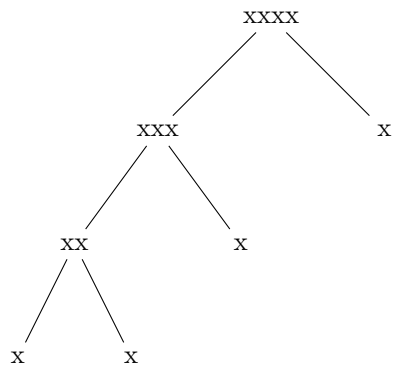
```
%%
```

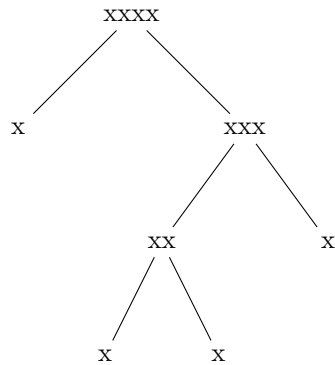
```
start : x | start start ;
```

can generate `xxxx` in multiple ways. How many? Draw a parse tree for each.

*Solution:* Each of the following parse trees is possible:







So there are five possible parsings.

3. What language does the following grammar generate?

```
%start expression
```

```
%%
```

```
expression : expression ;
```

*Solution:* There is no way to generate any list of tokens with this grammar so the language is the empty language, i.e. the empty set of lists of tokens.