

CSC-325
Artificial Intelligence
Dr. Adam Wyner

Practical 3

Mar 3, 2023.

Last day to sign-off: Mar 10, 2023.

The practical has parts (1)-(4), all of which must be completed to complete the practical. Each part is worth one mark.

Your work, solution, and code should be your own. If you discuss how to address the problem, use words and narratives.

To get signed off, you should:

- Show your code and solutions to a lecturer/demonstrator;
- Explain your code and solutions to a lecturers/ demonstrators.

1. Suppose have the following DCG:

```
s --> foo,bar,wiggle.  
foo --> [choo].  
foo --> foo,foo.  
bar --> mar,zar.  
mar --> me,my.  
  
me --> [i].  
my --> [am].  
zar --> blar,car.  
blar --> [a].  
car --> [train].  
wiggle --> [toot].  
wiggle --> wiggle,wiggle.
```

Write down the ordinary Prolog rules that correspond to these DCG rules; that is, write down the rules that use difference lists, since these correspond to DCG rules. What are the first three responses that Prolog gives to the query `s(X,[])` ?

2. In this exercise, you take a basic DCG and revise it so that it can generate a parse tree (see Lecture 6). The basic DCG is:

```
s --> np, vp.  
np --> det, n.  
vp --> v, np.  
det --> [the].  
det --> [a].  
n --> [woman].  
n --> [man].  
v --> [hires].
```

The form of the queries is:

```
?- s(Tree,S,[]).
```

Where S is the input, [] is used for the difference list, and Tree is the output parse tree. For example, your grammar should take the following query and produce the parse Tree.

```
?- s(Tree, [the,woman,hires,the,man],[])  
Tree = s(np(det(the), n(woman)), vp(v(hires), np(det(the), n(man))))
```

You should produce parse trees for:

```
A man hires a woman.  
A woman hires the woman.
```

You might be asked to parse additional input with the same vocabulary.

3. Take the answer for the parse tree grammar from exercise 2 above and augment the grammar to accept the following (A)-(C).

A. Subject-verb agreement. It is common in languages that the subject and verb of the sentence *agree in number*: if the subject is in a plural form, then the verb is in a plural form; if the subject is in a singular form, then the verb is in a singular form. See examples below. In the grammar above, we have singular nouns and verbs in the singular form. The task is to add plural noun forms (*women, men*) and a plural verb form (*hire*). The grammar should accept the following as grammatical:

The women hire the man
The woman hires a woman
A man hires the women

But should not be accepted as grammatical, i.e., are not accepted by the parser:

A man hire the woman
The women hires the men

B. No object-verb agreement. While there is subject-verb number agreement, there is no object-verb number agreement; that is, all of the following are grammatical:

A man hires the woman
A man hires the women
The men hire the woman
The men hire the women

C. Determiner-common noun number agreement. In addition, note that the indefinite determiner *a* can only combine with singular nouns, the definite determiner *the* can combine with singular or plural nouns, and two can only combine with plural nouns. The following are grammatical:

A man hires the woman
The man hires the woman
The men hire the woman
Two women hire a man

While the following are not grammatical:

A women hire the man
A women hires the man
Two man hires the man
Two man hire the man

Change the DCG for the parse tree grammar from exercise 2 so that it correctly handles these sentences. Produce parse trees such as:

?- s(Tree, [the,women,hire,the,man],[]).

Tree = s(np(det(the), n(women)), vp(v(hire), np(det(the), n(man))))

You need to demonstrate solutions to the previous sentences.

You might be asked to parse additional input with the same vocabulary.

4. In Lecture 6, we showed how to make the analysis more modular by separating the grammar and the lexicon. The sample grammar there was:

```
s --> np, vp.  
np --> det, n.  
vp --> v, np.  
vp --> v.  
  
det --> [Word], {lex(Word,det)}.  
n --> [Word], {lex(Word,n)}.  
v --> [Word], {lex(Word,v)}.  
  
lex(the, det).  
lex(a, det).  
lex(woman, n).  
lex(man, n).  
lex(hires, v).
```

This contrasts with the approach in Question 3 above.

A. To the grammar above that separates the grammar and lexicon, you should introduce all the distinctions from Question 3; that is, subject-verb agreement, no object-verb agreement, and determiner-common noun number agreement. The grammar should accept all the grammatical sentences in Question 3 and none of the ungrammatical sentences.

B. In addition, your grammar should address the distinction between transitive and intransitive verbs, where a transitive verb has a direct object and a intransitive verb does not. For example, while *The woman hires a man* is grammatical, *The woman hires* is not grammatical; this shows that the verb *hire* is a transitive verb. On the other hand, some verbs are intransitive, e.g., *The woman falls* is grammatical, while *The man falls a man* is not grammatical.

Modify the grammar and lexicon for 4A above to distinguish between transitive and intransitive verbs.

The grammar should accept:

```
The woman falls  
The men fall  
A man falls  
Two women fall  
A woman falls
```

But, it should not accept:

The women falls
A man fall
A man falls the woman
A woman falls the men

Examples of input and output:

?- s(Tree,[the,women,hire,the,man],[]).
Tree = s(np(det(the), n(women)), vp(v(hire), np(det(the), n(man))))

?- s(Tree,[the,women,fall],[]).
Tree = s(np(det(the), n(women)), vp(v(fall)))

The grammar should accept all the grammatical sentences above and none of the ungrammatical sentences.

You might be asked to parse additional input with the same vocabulary.