1 Exercise 1

Show whether each of the following languages is regular or not. That is, if a language is regular, give a FSA that recognizes it; if a language is not regular, show it using the Pumping Lemma (reasoning abstractly about p).

a) \( A = 1^n010^n \), where \( n \geq 0 \).

b) \( B = 1^*010^* \).

c) \( C = 1^*0^n12^n \), where \( n \geq 0 \).

d) \( D = 0^n1^m \), where \( n > m - 3 \).

2 Exercise 2

The following English sentences illustrate a long distance dependency. Based on this dependency, construct a detailed proof showing that English is not a regular language (cf. Relative Clause proof in class). If the proof relies on the claim that some other language is regular or not regular, prove that claim too.

(1) a. John and Mary like to eat and sleep respectively.

b. John, Mary, and Sue like to eat, sleep and dance respectively.

c. John, Mary, Sue, and Bob like to eat, sleep, dance and cook respectively.

d. Etc.
3 Exercise 3

The context-free grammar G1 has the following rules:

S → NP VP
NP → Det N'
N' → (Adj) N' (PP)
N' → N' Conj N'
N' → N
VP → V_{trans} NP (PP)
VP → V_{intrans} (PP)
PP → P NP
Det → the | some | its |
N → men | women | architecture | Barcelona | pigeons | tapas (=food)
Adj → tall | proud | old
V_{trans} → visited | like(s/d) | hate | bought | ate
V_{intrans} → slept
P → from | in | near
Conj → and | or

i. For each of the following sentences, specify whether this grammar generates a tree. If it does, draw the tree. If it doesn’t, say how you would amend the grammar (while keeping it as close as possible to a grammar for English) and then draw the corresponding tree. What empirical generalization do these data suggest for English conjunction?

The men and women visited Barcelona.
Women from Barcelona like the city and hate its pigeons.
The men bought and ate tapas.
The women liked Barcelona and its architecture.
The tall and proud women live in or near Barcelona.

ii. Take the original G1 grammar above (not your modified G1). How many times is the following sentence ambiguous according to G1? Draw all the trees that G1 generates for the sentence and explain their corresponding meaning (unambiguously) in your own words. (Sometimes two trees may yield indistinguishable readings.)

Some old men and women from Barcelona slept.

4 Exercise 4 (Optional, extra points)

Show whether the following language is regular or not.

\[ E = 010^n110^m, \text{ where } n \geq 0, m \geq 0, \text{ and } m \neq n. \]