LIN 177 Homework 4

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1.

2. (a) The phones are [p,b,t,d,k,g]
   (b) The phones are [æ,a]
   (c) The phones are [ɹ]
   (d) The phones are [j,w,i,ɪ,e,æ,u,ʊ,o,a,ə,ʌ]

3. (a) One minimal property is

```
phone(X), sib(X), not(voi(X)).
```

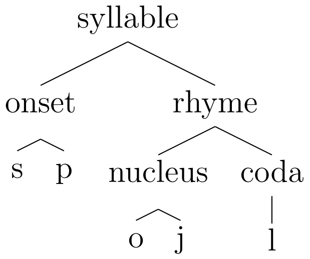
   (b) One minimal property is

```
phone(X), str(X), not(bck(X)), not(ctr(X)).
```

   (c) One minimal property is

```
phone(X), lab(X), not(cnt(X)).
```

4. The structure is:



5. - We can solve this with some combinatorics.

     We want to find how many sequences of 6 phones or less there are. We can break this down to finding the number sequences of 0, 1, 2, 3, 4, 5, and 6 phones and summing them.

     So we need to find the permutations with replacement, as it's possible to have more than one phone in a sequence.

     Since there are 34 possible phones we want to find the following sum:

$$\begin{aligned}\sum_{i=0}^{6} 34^i &= 34^0 + 34^1 + 34^2 + 34^3 + 34^4 + 34^5 + 34^6 \\ &= 1 + 34 + 1156 + 39304 + 1336336 + 45435424 + 1544804416 \\ &= 1591616671\end{aligned}$$

So, there are 1591616671 possible sequences with 6 phones or less.

- Using the query:

  ```
  findall(X, (syllable(X), length(X, Len), Len =< 6), _Y), length(_Y, YLen).
  ```

  The result is:

  ```
  YLen = 20608.
  ```

  So there are 20608 English syllables according to `syllable.swipl`.

- 20608 is 0.00129% of the 1591616671 possible syllables.
- This percentage is important because it means the vast majority of sounds that can be made are not English syllables. It shows that English is a very small language in the scheme of things.

6.

```
%% Start with some facts.

%% List all of the possible phones in Senufo
phone(a).
phone(e).
phone(i).
phone(k).
phone(o).
phone(p).
phone(t).
phone(u).

%% List all the consonants.
consonant(k).
consonant(p).
consonant(t).

%% List all the vowels.
vowel(a).
vowel(e).
vowel(i).
vowel(o).
vowel(u).

%% Now the rules

%% A ‘syllable‘ is an ‘onset‘ followed by a ‘nucleus‘.
syllable(Syl) :-
    onset(On),
    nucleus(Nu),
    append(On, Nu, Syl).

%% An ‘onset‘ is just a ‘phone‘ that is a ‘consonant‘.
onset([X]) :-
    phone(X),
    consonant(X).

%% A ‘nucleus‘ is just a ‘phone‘ that is a ‘vowel‘.
nucleus([X]) :-
    phone(X),
    vowel(X).
```

Some output from running this:

```
?- findall(X, syllable(X), Y).
Y = [[k, a], [k, e], [k, i], [k, o], [k, u], [p, a], [p, e], [p|...], [...|...]|...].
```