Solutions for selected exercises of Chapter 5

1. **Exercise on literal listener:** Test the predictions of `literalListener` for the various utterances.

```
literalListener("terrible")
literalListener("bad")
literalListener("okay")
literalListener("good")
literalListener("amazing")
```

Notice that we can visually inspect the assumed semantics in this way. The LL returns the normalized semantics, but we still see that no utterance is ever completely false in any sate. (That's important for understanding why the speaker might select 'almost-false' utterances for politeness reasons.)

2. **Exercises on speaker function:**

I. Describe the kind of speaker assumed by the above function call (`speaker(1, 0.99)`)?

That's a kind of "honest Olaf" who cares almost exclusively about conveying the true state of affairs.

II. Change the call to the speaker to make it so that it only cares about making the listener feel good.

```
speaker1(1,0)
```

Notice that the speaker's choice of utterance is independent of the true state when $\phi = 0$.

III. Change the call to the speaker to make it so that it cares about both making the listener feel good and conveying information.

```
speaker1(1,0.5)
```

IV. Change the value of lambda and examine the results.

The higher λ, the more impact social meaning has on the speaker's choice. Test this by setting $\phi = 0.5$.

3. **Exercises on pragmatic listener:**

I. Examine the marginal posteriors on `state`. Does this make sense? Compare it to what the `literalListener` would believe upon hearing the same utterance.

The marginal state interpretation of the pragmatic listener after hearing 'good' is higher than that of the literal interpretation because the pragmatic listener takes into account the possibility that the speaker cares about social utility and therefore uses "good" even for world states where this utterance has a low truth value (where it would be rather uninformative).

This generally seems to make sense.

II. Examine the marginal posterior on `phi`. Does this make sense? What different utterance would make the `pragmaticListener` infer something different about `phi`? Test your knowledge by running that utterance through the `pragmaticListener`.

The pragmatic listener infers that the speaker is more likely to care at least to some extent about social utility than not. This seems reasonable and intuitive enough. the reason why it comes out of the model is that speakers with $\phi < 0.5$ are generally more likely to want to say "good" because they would not only use it for the state 4 where, by informativity, it would be most applicable.

III. In Yoon, Tessler, et al. (2016), the authors ran an experiment testing participants' intuitions as to the kind of speaker they were dealing with (i.e., inferred phi). Modify `pragmaticListener` so that she knows the speaker (a) wants the listener to feel good, (b) wants to convey information to the listener, and (c) both, and test the models on the utterance "good".

We can manipulate the pragmatic speaker function by commenting in/out various lines, as shown below:

```
var pragmaticListener = function(utterance) {
  Infer({model: function(){
    var state = uniformDraw(states)
    var phi = uniformDraw([0.1, 0.3, 0.5, 0.7, 0.9])
//     var phi = 0   // assumed knowledge of "polite Polly"
//     var phi = 0.5 // assumed knowledge of "mixed Molly"
//     var phi = 1   // assumed knowledge of "honest Olaf"
    var S1 = speaker1(state, phi)
    observe(S1, utterance)
    return { state, phi }
  }})
}
```

Assuming a “polite Polly” the pragmatic listener will believe that any state is equally likely. This is because a “polite Polly” produces utterances with the same probability in each world state.
Assuming a “mixed Molly” we see a preferred state interpretation in state 3, where this is a preferred utterance due to a mixture of politeness and informativity.
Assuming a “honest Olaf” we get something like scalar implicature reasoning, inferring that the state where an informative speaker is most likely to generate ‘good’ is state 4.

IV. The authors also ran an experiment testing participants’ intuitions if they knew what state of the world they were in. Modify pragmaticListener so that she knows what state of the world she is in. Come up with your own interesting situations (i.e., choose a state and an utterance) and show the model predictions. Are the predictions in accord with your intuitions? Why or why not?

If the pragmatic listener knows that the true state is 1, the inference after ‘good’ is that the speaker is most likely polite. However, intuitively, this inference seems a bit weak. (Can you make it stronger somehow?)

3. **Exercises on hyperpragmatic speaker:**

I. What does the pragmatic listener infer when she hears “not amazing”? How does the pragmatic listener interpret the other “indirect” utterances?

We can use code from the previous code box to visualize this:

```
var listenerPosterior = pragmaticListener("not_amazing")

display("expected state = " +
        expectation(marginalize(listenerPosterior, "state")))
viz(marginalize(listenerPosterior, "state"))

display("expected phi = " +
        expectation(marginalize(listenerPosterior, "phi")))
viz.hist(marginalize(listenerPosterior, “phi"))
```

We see that the pragmatic listener believe that the true state is likely low (1 or 2) and that the speaker most likely cares abut social AND epistemic utility. That much seems intuitive enough.

II. Write a purely informative `speaker2`, who only cares about conveying state, but knows that the pragmatic listener will reason about both `phi` and `state`. Does it make different predictions from the model defined above?

```
var speaker2_onlyState = function(state) {
  Infer({model: function(){
    var utterance = sample(utterancePrior)
    var L1 = marginalize(pragmaticListener(utterance), "state")
    factor(alpha2 * L1.score(state))
    return reshapeUtt(utterance)
  }})
}
```

III. Write a purely self-presentational `speaker2`, who only cares about conveying `phi`, but knows that the pragmatic listener will reason about both `phi` and `state`. Does it make different predictions from the model defined above?

```
var speaker2_onlyPhi = function(phi) {
  Infer({model: function(){
    var utterance = sample(utterancePrior)
    var L1 = marginalize(pragmaticListener(utterance), "phi")
    factor(alpha2 * L1.score(phi))
    return reshapeUtt(utterance)
  }})
}
```

IV. Write an alternative `speaker2` who, like `speaker1`, is actually both kind and informative (as opposed to the self-presentational speaker model above). Does it make different predictions from the model defined above?

```
var speaker2_both = function(state, phi) {
  Infer({model: function(){
    var utterance = sample(utterancePrior)
    var L1 = marginalize(pragmaticListener(utterance), "state")
    var utility = {
      epistemic: L1.score(state),
      social: expectation(L1, valueFunction)
    }
    var speakerUtility = phi * utility.epistemic +
                         (1 - phi) * utility.social
    factor(alpha * speakerUtility)
    return utterance
  }})
}
```