1. (from Chris Brew) The three procedural languages of the EU are English, French and German. There are twenty other official languages. You want to make sure that it is possible to translate from any of these languages to any other. Having a separate translation team for each language results in a need for 506 teams ($23 \times 22 = 506$, one for each source-target pair). How many expert translation teams do you need if you adopt a policy that all documents will be first be translated from the source language into English, French or German, then translated back out into the target language? How many would you need if you managed to agree that there should be just one procedural language (for example, German) and that all translations would either begin, end or pass through German?

2. Take the following German and English sentence pairs and do the following (you might find a German-English dictionary helpful, although it is not strictly necessary):

   (1) a. Das Kind ist mir ans Herz gewachsen.
       I have grown fond of the child.
   b. Sie ist bloß ein Kind.
       She is but a child.
   c. Sie nahm das Kind mit.
       She took the baby with her.

   (a) Describe precisely how the bag of words method derives a translation for Kind.
   (b) Describe how the expectation-maximization (EM) algorithm derives a translation for but. Address why we have to use several iterations when calculating alignments between words.
   (c) How will phrase-based translation improve upon the translation models here?

3. When translating from English into the Native American language Mam (in Guatemala), a translator reported the following terms used among siblings (in phonetic transcription here):
   - [ntź?ica] = ‘older sibling’
   - [witzin] = ‘younger sibling’

   Both words are used for males and females.
(a) In terms of hyponymy/hypernymy, describe the relationship between the English word *sibling* and these words.

(b) Draw a Venn diagram showing how the English words *brother* and *sister* overlap with the Mam words *ntz?ica* and *witzin*.

(c) You come across the text: *Maxwell is the brother of Santiago*, but it gives no indication of who is older. If you had to translate this into Mam and were being forced to preserve this age ambiguity, how would you do it?

4. (from Jason Baldridge) Go to one of the following online chatbots:
   - Eliza http://www-ai.ijs.si/eliza/eliza.html
   - Elbot http://www.elbot.com/
   - Jabberwacky http://www.jabberwacky.com/
   
   Have a conversation with at least 5 turns with at least two (2) of the chatbots. Write down both conversations (include them in your homework submission). For each conversation, identify instances where each of the four Gricean maxims (Quantity, Quality, Relevance, Manner) were violated by the chatbot during the conversation, saying what the maxim is and how it was violated. Which of the chatbots do you think best obeyed the Gricean maxims?