10 Natural Language Processing (AAC)

The following grammar fragment associates context free syntax rules with lambda calculus rules for semantic composition:

\[
\begin{align*}
S & \rightarrow \text{NP} \ \text{VP} \\
\text{VP}'(\text{NP}') & \rightarrow \lambda y \lambda x \lambda z \text{[give'}(z,y,x)\text{]} \\
\text{VP} & \rightarrow \text{Vditrans} \ \text{NP} \ \text{PPto} \\
(\text{Vditrans}'(\text{NP}')((\text{PPto}'))) & \rightarrow \lambda w \text{[sleep'}(w)\text{]} \\
\text{VP} & \rightarrow \text{Vintrans} \\
\text{Vintrans}' & \rightarrow \text{NP} \rightarrow \text{Sandy} \\
\text{PPto} & \rightarrow \text{to} \ \text{NP} \\
\text{NP}' & \rightarrow \text{Fido} \\
\text{NP} & \rightarrow \text{Kim} \\
\end{align*}
\]

(a) Show the semantics that the grammar above would assign to:

- Kim sleeps
- Kim gives Fido to Sandy

[2 marks]

(b) Extend the grammar to also allow:

- Kim gives Sandy Fido

Show the semantics your grammar gives for this sentence.

[2 marks]

(c) Extend the grammar so the following sentences are all given the semantics reject'(k, f), explaining the reasons for the choices you have made.

- Kim rejects Fido
- Kim turns Fido down
- Kim turns down Fido

[7 marks]

(d) Most native English speakers accept sentences like (d)(i) below as grammatical but find sentences like (d)(ii) ungrammatical. Outline how you would augment the grammar you gave in answer to (c) so that (d)(i) was accepted but (d)(ii) was not.

(i) Kim turns it down
(ii) *Kim turns down it

[3 marks]

(e) What alternative strategy might you use in a large-scale language generation system to ensure that (d)(i) was generated in preference to (d)(ii)? In general, what are the advantages and disadvantages of this approach in comparison with constraining generation by the grammar?

[6 marks]