PS2: Practice problems

1 Logic

1.1 Propositional sentences

For each of the sentences below, indicate whether it is valid, unsatisfiable, or neither. If neither, provide an interpretation that makes it true and one that makes it false.

0. $S \rightarrow F$

1. $S \rightarrow S$

2. $B \vee D \vee (B \rightarrow D)$

1.2 English to propositional logic

We'd like to formalize the sentence: *A person who is radical (R) is electable (E) if he/she is conservative (C), but is otherwise not electable.* For each of the logical sentences below, indicate whether it is a successful formalization of the English sentence. If it is not, explain why not.

0. $(R \wedge E) \leftrightarrow C$

1. $R \rightarrow (E \leftrightarrow C)$

2. $R \rightarrow ((C \rightarrow E) \vee \neg E)$

1.3 Quantifiers

Consider a finite domain $U = \{a, b, c\}$. For each of the sentences below, provide a sentence without any quantifiers that is equivalent to it in any interpretation with universe U.

0. $\forall x.P(x)$

1. $\exists x.\forall y.Q(x, y)$

1.4 English to FOL

Formalize each of these sentences in first-order logic.

0. All countries that border Ecuador are in South America.

1. No two adjacent countries have the same map color.

2. There is a barber who shaves all men, and only those men, who do not shave themselves.

For extra fun, figure out whether the last one is satisfiable, and provide a proof.

2 Planning

2.1 Monkey and bananas

A monkey wants bananas, but is too short to grab them. Help him make a plan!

There are three locations. The monkey is at L1, a box is at L2 and the bananas are hanging at L3. The monkey can **move** to any location if he is not elevated. The monkey can **climb up** on top of the box if he is at the same location as the box; if he climbs on the box, he will be elevated. The monkey can **climb down** from the box if he is on it, and then he will no longer be elevated. The monkey can **push** the box to any location if he and the box are at the same location to start with and he is not elevated. The monkey can **grab** the bananas if he is at the same location as the bananas and is elevated, at which point, he will have the bananas.

Write STRIPS or PDDL-like action schemas (syntax isn't important) for the monkey's operations above.

2.2 Regression

The monkey has the goal: $\text{Holding}(\text{Monkey}, \text{Bananas}) \wedge \text{At}(\text{Monkey}, \text{L1})$.

- Which actions are *relevant* to this goal?
- Which actions are both *relevant* and *applicable*?
- For each of the actions that are both relevant and applicable, provide the regression of the goal under that action.

2.3 Graphplan

If you have a goal $G_1 \wedge G_2 \wedge \ldots \wedge G_n$, then one heuristic function to use might be $\sum_i \text{lc}(G_i)$, where $\text{lc}(G_i)$ is the level cost of G_i in the plan graph. Is this heuristic admissible? Why or why not?