Assignment4: Propositions and Inference

Problem1:

Consider the following knowledge base:

$a \leftarrow b \wedge c.$
$a \leftarrow e \wedge f.$
$b \leftarrow d.$
$b \leftarrow f \wedge h.$
$c \leftarrow e.$
$d \leftarrow h.$
$e.$
$f \leftarrow g.$
$g \leftarrow c.$

1- Give a model of the knowledge base.

2- Give an interpretation that is not a model of the knowledge base.

3- Give two atoms that are logical consequences of the knowledge base.

4- Give two atoms that are not logical consequences of the knowledge base.

Problem2:

Consider the knowledge base KB:

$a \leftarrow b \wedge c.$
$b \leftarrow d.$
$b \leftarrow e.$
$c.$
$d \leftarrow h.$
$e.$
$f \leftarrow g \wedge b.$
$g \leftarrow c \wedge k.$
$j \leftarrow a \wedge b.$

1- Show how the bottom-up proof procedure works for this example. Give all logical consequences of KB.

2- f is not a logical consequence of KB. Give a model of KB in which f is false.

3- a is a logical consequence of KB. Give a top-down derivation for the query ask a.

Problem3:

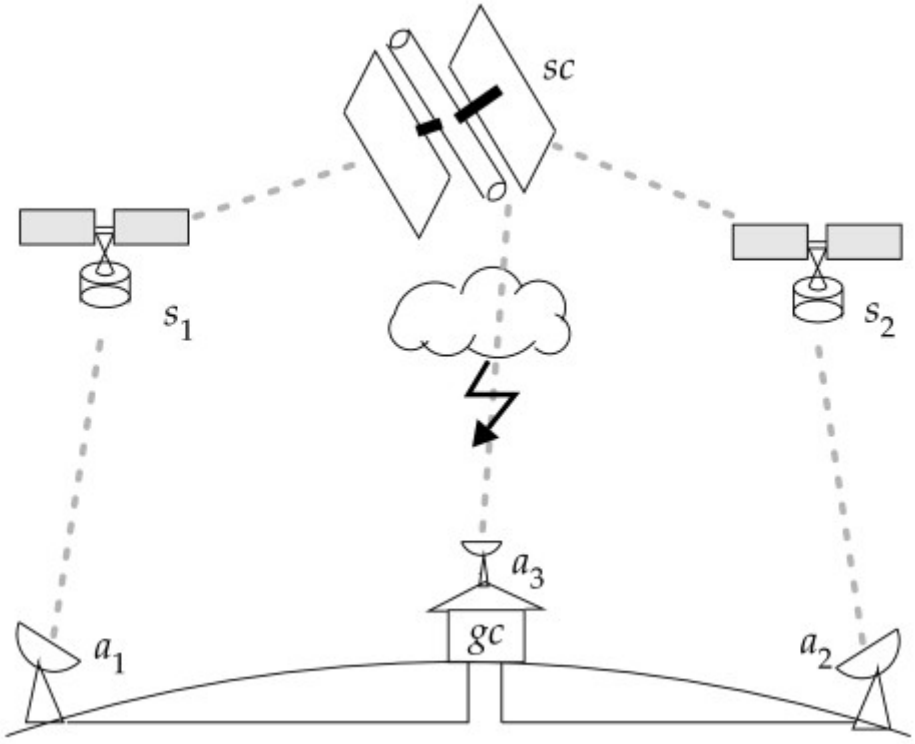
Consider the following knowledge base and assumables aimed to explain why people are acting suspiciously:

$goto\_forest \leftarrow walking.$
$get\_gun \leftarrow hunting.$
$goto\_forest \leftarrow hunting.$
$get\_gun \leftarrow robbing.$
$goto\_bank \leftarrow robbing.$
$goto\_bank \leftarrow banking.$
$fill\_withdrawal\_form \leftarrow banking.$
$false \leftarrow banking \wedge robbing.$
$false \leftarrow wearing\_good\_shoes \wedge goto\_forest.$

assumablewalking,hunting,robbing,banking.

1- Suppose get_gun is observed. What are all of the minimal explanations for this observation?
2- Suppose get_gun ∧ goto_bank is observed. What are all of the minimal explanations for this observation?
3- Is there something that could be observed to remove one of these as a minimal explanation? What must be added to be able to explain this?
4- What are the minimal explanations of goto_bank?
5- What are the minimal explanations of goto_bank ∧ get_gun ∧ fill_withdrawal_form?

Problem4:



The above figure shows a simplified redundant communication network between an unmanned spacecraft (sc) and a ground control center (gc). There are two indirect high-bandwidth (high-gain) links that are relayed through satellites (s1,s2) to different ground antennae (a1,a2). Furthermore, there is a direct, low-bandwidth (low-gain) link between the ground control center's antenna (a3) and the spacecraft. The low-gain link is affected by atmospheric disturbances – it works if there are no disturbances (no_dist) – and the spacecraft's low-gain transmitter (sc_lg) and antenna 3 are ok. The high-gain links always work if the spacecraft's high-gain transmitter (sc_hg), the satellites' antennae (s1_ant,s2_ant), the satellites' transmitters (s1_trans,s2_trans), and the ground antennae (a1,a2) are ok.

To keep matters simple, consider only messages from the spacecraft going through these channels to the ground control center.

The following knowledge base formalizes the part of the communication network we are interested in:

send_signal_lg_sc ← ok_sc_lg ∧ alive_sc.
send_signal_hg_sc ← ok_sc_hg ∧ alive_sc.

get_signal_s1 ← send_signal_hg_sc ∧ ok_s1_ant.
get_signal_s2 ← send_signal_hg_sc ∧ ok_s2_ant.
send_signal_s1 ← get_signal_s1 ∧ ok_s1_trans.
send_signal_s2 ← get_signal_s2 ∧ ok_s2_trans.
get_signal_gc ← send_signal_s1 ∧ ok_a1.
get_signal_gc ← send_signal_s2 ∧ ok_a2.
get_signal_gc ← send_signal_lg_sc ∧ ok_a3 ∧ no_dist.

Ground control is worried, because it has not received a signal from the spacecraft (no_signal_gc). It knows for sure that all ground antennae are ok (i.e., ok_a1, ok_a2, and ok_a3) and satellite s1's transmitter is ok (ok_s1_trans). It is not sure about the state of the spacecraft, its transmitters, the satellites' antennae, s2's transmitter, and atmospheric disturbances.

1- Specify a set of assumables and an integrity constraint that model the situation.

2- Using the assumables and the integrity constraints from part (a), what is the set of minimal conflicts?

3- What is the consistency-based diagnosis for the given situation? In other words, what are the possible combinations of violated assumptions that could account for why the control center cannot receive a signal from the spacecraft?

4- Explain why NASA may want to use abduction rather than consistency-based diagnosis for the domain.

5- Suppose that an atmospheric disturbance dist could produce static or no signal in the low-bandwidth signal. To receive the static, antenna a3 and the spacecraft's low-bandwidth transmitter sc_lg must be working. If a3 or sc_lg are not working or sc is dead, there is no signal. What rules and assumables must be added to the knowledge base so that we can explain the possible observations no_signal_gc, get_signal_gc, or static_gc? You may ignore the high-bandwidth links. You may invent any symbols you need.