CENG424

Logic for Computer Science
Assignment 3

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Question 1

1.

∀u(know(i,u) $\iff$ eq(u,nothing))
Object constants:
i means the person that says the given sentence, **nothing** means nothing.
Relation constants:
know(x,y) means x know(s) y, in this case i know nothing.
eq(x,y) means x is equal to y, in this case u is nothing.

2.

∀u(period(u) $\Longrightarrow$ (mark(u) ∧ (indicate(u,abbreviation) ∨ indicate(u,endofsentence))))
Object constants:
abbrevation respesents an abbreviation.
endofsentence represents end of a sentence.
Relation constants:
period(x) means x is a period, in this case u is a period.
mark(x) means x is a punctuation mark, in this case u is a punctuation mark.
indicate(x,y) means x indicate(s) y, in this case u indicates an abbreviation.

Question 2

1.	$\forall x(P(x) \vee Q(x))$	Premise
2.	$\exists x \neg Q(x)$	Premise
3.	$\forall x(R(x) \implies \neg P(x))$	Premise
4.	$P(a) \vee Q(a)$	Universal Instantiation: 1
5.	$\neg Q(a)$	Existential Instantiation: 2
6.	$R(a) \Rightarrow \neg P(a)$	Universal Instantiation: 3
7.	$P(a)$	Disjunction Elimination: 4,5
8.	$\neg R(a)$	Modus Tolens: 6,7
9.	$\exists y \neg R(y)$	Existential Introduction

Question 3

Set of premises:

$P(a, b, 0.6)$
$P(a, c, 0.4)$
$P(b, d, 0.3)$
$P(b, e, 0.5)$
$P(b, f, 0.2)$
$P(c, g, 0.9)$
$P(c, h, 0.1)$
$P(e, i, 0.9)$
$P(e, j, 0.1)$

The proof using natural deduction:

First, start by choosing path a→b where $P(a, b, 0.6)$.

Possible paths from here are: a→b→d, a→b→e, and a→b→f.

a→b→d: $P(a, d, 0.18)$ by 0.6×0.3 and this path ends at node d, failing to reach node j.

a→b→e: $P(a, e, 0.3)$ by 0.6×0.5 and there are two more possible paths from this node which are a→b→e→i and a→b→e→j.

If node i is chosen after node e,
a→b→e→i: $P(a, i, 0.27)$ by $(0.6 \times 0.5) \times 0.9$ and this path ends at node i, failing to reach node j.

If node j is chosen after node e,
a→b→e→j: $P(a, j, 0.03)$ by $(0.6 \times 0.5) \times 0.1$ and this path ends at node j, which is the desired end node.

a→b→f: $P(a, f, 0.12)$ by 0.6×0.2 and this path ends at node f, failing to reach j.

After these computations, choose path a→c where $P(a, c, 0.4)$.

Possible paths from here are: a→c→g, a→c→h.

a→c→g: $P(a, g, 0.36)$ by 0.4×0.9 and this path ends at node g, failing to reach node j.

a→c→h: $P(a, h, 0.04)$ by 0.4×0.1 and this path ends at node h, failing to reach node j.

As a result of all possible path computations that starts from a, there is only one path that ends at node j which is a→b→e→j. Thus, the probability of the computation ending at node j is $p = 0.03$ from $P(a, j, 0.03)$.