CS-411

Assignment-9

1) Explain how first order logic overcomes shortcomings of propositional logic.

→ In first order logic user can use quantifiers as it expresses generalization, specialization & pattern, while propositional logic do not use quantifiers so cannot express generalization, specialization & pattern. Moreover, talking about propositional logic we are allowed to use and, or, etc, while for first order logic we are allowed to use forall & exist over variables which makes the logic more expressive.

2) Express universal ~~quantifiers~~ quantification in terms of existential quantification

⇒ The two quantifiers are actually intimately connected with each other through negation. Asserting that everyone dislikes parsnips is the same as asserting there does not exist someone who likes them,

$$\forall x \neg Likes(x, Parsnips) \iff \neg \exists x\ Likes(x, Parsnips).$$

As $\forall$ is really a conjunction over the universe of objects & $\exists$ is a disjunction, it should not be surprising that they obey De Morgan's rules.

$$\forall x \neg P \equiv \neg \exists x P$$
$$\neg \forall x P \equiv \exists x \neg P$$
$$\forall x P \equiv \neg \exists x \neg P$$
$$\neg \forall x \neg P \equiv \exists x P$$

3) Translate the following into first-order logic.

a) Some students took CS411 in Spring 2020.
$\exists x$ Student(x) $\wedge$ Takes(x, CS411, Spring 2020).

b) Some students wear a hoodie with UIC logo on it.
$\exists x \exists y$ Student(x) $\wedge$ wears(x,y) $\wedge$ Hoodie(y) $\wedge$ Printed on(y, UIC logo).

c) Something that glitters is not always gold, whereas gold always glitters.
$\exists x$ (glitters(x) $\wedge \neg$ gold(x)) $\wedge \forall y$ (gold(y) $\rightarrow$ glitters(y))

d) No one can win with everyone all the time.
$\forall x \exists y \exists t$ ($\neg$ Win(x,y,t))

e) All CS courses are difficult, except two.
$\exists x \exists y$ CS Course(x) $\wedge$ CS Course(y) $\wedge \neg(x=y) \wedge \neg$ Difficult(x) $\wedge$
$\neg$ Difficult(y) $\wedge$ ($\forall z$ CS Course(z) $\wedge \neg(y=z) \wedge \neg(x=z) \rightarrow$ Difficult(z))