## Logic Tutorial 1 Solutions

- 1. p: the sun shines today, q: the sun shines tomorrow,  $p \to \neg q$ .
- 2. p: Robert was Jealous of Yvonne, q: Robert was in a good mood,  $p \vee \neg q$ .
- 3. p: barometer falls. q: it will rain, r: t will snow,  $p \to (q \lor r)$ .
- 4. p: a request occurs, q: the request is eventually acknowledged, r: the requesting process makes progress,  $p \to (q \lor \neg r)$
- 5. p: the cause of cancer is determined, q: a new cancer drug is found, r: cancer is cured,  $\neg(p \land q) \rightarrow \neg r$ .
- 6. q: You can ride the roller coaster,r: You are under 4 feet tall,s: You are older than 16 years old. $(r \land \neg s) \to \neg q$ .
- 7. p: You can access the internet from campus, q: you are a Computer Science major, r: You are a freshman.  $p \to (q \lor \neg r)$ .

Q: When we have a logical statement of the form  $p \rightarrow q$ , where p and q are propositions corresponding to real world events, does the truth of the statement  $p \rightarrow q$  necessarily imply that the event p \*caused\* the event q? If not, could you provide an example where the statement  $p \rightarrow q$  can be true without p necessarily causing q.

It could simply be the case, for example that a common cause (what is called a confounder) causes both p and q to be true, so that whenever p is true q is also true, without necessarily p causing q to be true.

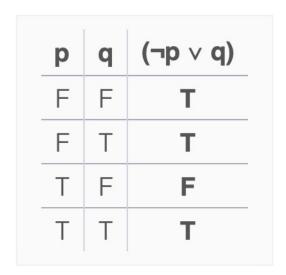
For example,

p: This week, the weekly ice-cream sales are 3x the average.

q: This week, the heat-strokes are 5x the weekly average.

Both p and q could be true during peak summer, yet without one causing the other.

р	q	(p → q)
F	F	Т
F	Т	Т
Т	F	F
Т	Т	Т



• Both the truth tables are identical in each row, and what this means is that the two propositions are *equivalent*, in that one can substitute one for the other in any larger compound proposition without altering its truth value.

p	q	(p → q)
F	F	Т
F	Т	Т
Т	F	F
Т	Т	Т

$(\neg q \rightarrow \neg p)$	q	p
Т	F	F
Т	Т	F
F	F	Т
Т	Т	Т

- Here again  $\neg q \rightarrow \neg p$  is equivalent to  $p \rightarrow q$ .
- In fact,  $\neg q \rightarrow \neg p$  is called the *contrapositive* of  $p \rightarrow q$ .