Advanced information, computation, communication I
EPFL - Fall semester 2021-2022

Week 1

September 24, 2021

1 Open Questions

Exercise 1. Determine the truth values (i.e., T or F) of the following propositions:

- ☐ $19 - 4 = 12$ if and only if 3 is a prime number.
- ☐ If $1 + 1 = 5$, then $1 + 1 = 3$.
- ☐ If the moon is a star, then so is the sun.
- ☐ If 5 is a prime number, then the earth is flat.
- ☐ $0 > 1$ if and only if $2 > 1$.
- ☐ Either Toronto is the capital of Canada or Hamburg is the capital of Germany.

Exercise 2. Construct a truth table for each of these compound propositions:

1. $p \oplus (p \vee q)$
2. $p \wedge (q \oplus u)$
3. $(p \wedge q) \oplus (p \wedge u)$
4. $(p \leftrightarrow q) \oplus (p \rightarrow q)$

Exercise 3. Without using truth tables, show the following logical equivalences:

1. $\neg p \leftrightarrow q \equiv p \leftrightarrow \neg q$
2. $p \oplus (q \wedge u) \not\equiv (p \oplus q) \wedge (p \oplus u)$.
3. $p \oplus q \equiv (p \vee q) \wedge (\neg p \vee \neg q)$.
4. $\neg(p \oplus q) \equiv (\neg p) \oplus q$.
5. $p \leftrightarrow q \equiv \neg(p \oplus q)$.

Exercise 4. Find a compound proposition with three variables p, q, u that is

1. True if and only if p is true, q is false, and u is false;
2. True if and only if exactly one of the variables is true;
3. True if and only if at least two of the variables are true.

Exercise 5. (Rosen, exercise 38, sec. 1.2) Five friends have access to a chat room. Is it possible to determine who is chatting if the following information is available:

- Either Kevin or Heather, or both, are chatting.
- Either Randy or Vijay, but not both, are chatting.
- If Abbey is chatting, so is Randy.
- Vijay and Kevin are either both chatting or neither is.
- If Heather is chatting, then so are Abbey and Kevin.

Explain your reasoning.

Exercise 6. (Rosen, exercise 36, sec. 1.2) The police have three suspects for the murder of Mr. Cooper: Mr. Smith, Mr. Jones, and Mr. Williams. Smith, Jones, and Williams each declare that they did not kill Cooper. Smith also states that Cooper was a friend of Jones and that Williams disliked him. Jones also states that he did not know Cooper and that he was out of town the day Cooper was killed. Williams also states that he saw both Smith and Jones with Cooper the day of the killing and that either Smith or Jones must have killed him. Can you determine who the murderer was if

1. one of the three men is guilty, the two innocent men are telling the truth, but the statements of the guilty man may or may not be true?
2. innocent men do not lie?

2 Exam Questions

Exercise 7. The negation of the statement "if it rains, the ground is wet" is

- ◯ if the ground is not wet, it does not rain.
- ◯ it rains and the ground is not wet.
- ◯ if the ground is wet, it does not rain.
- ◯ if it rains, the ground is not wet.

Exercise 8. Let C and D be two sets. The statement $\neg((D \subseteq C) \wedge (C \subset D))$

- ◯ is a tautology.
- ◯ is a contingency.
- ◯ is a contradiction.
- ◯ is not a compound proposition.

Exercise 9. Tick the equivalent sentence of the following newspaper headline:

"UK minister refuses to rule out ignoring law preventing no-deal Brexit"

- ◯ UK minister does not accept not to rule in not acknowledging law not approving no-deal Brexit.
- ◯ UK minister accepts to rule in acknowledging law approving no-deal Brexit.
- ◯ UK minister does not accept to rule out ignoring law tolerating Brexit with deal.

◯ UK minister refuses to rule in acknowledging law approving no-deal Brexit.

Exercise 10. (From 2016 midterm exam)

(*français*) Soit p et q deux propositions. Considérons les deux propositions composées ci-dessous.

(*English*) Let p and q be two propositions. Consider the two compound propositions below.

$$((q \to p) \wedge \neg q) \to \neg p \qquad \big(((\neg q) \to (\neg p)) \wedge p\big) \to q$$

◯ { Une seule des propositions composées est une tautologie, l'autre est une contingence.
One of the compound propositions is a tautology, the other is a contingency.

◯ { Les deux propositions composées sont des contingences.
Both compound propositions are contingencies.

◯ { Une seule des propositions composées est une contradiction, l'autre est une contingence.
One of the compound propositions is a contradiction, the other is a contingency.

◯ { Une seule des propositions composées est une tautologie, l'autre est une contradiction.
One of the compound propositions is a tautology, the other is a contradiction.

Exercise 11. (From 2016 mock final exam)
The compound proposition $((\neg p \wedge q) \to (r \oplus q)) \vee (\neg s \leftrightarrow p)$ is

◯ a tautology.

◯ a contingency.

◯ a contradiction.

◯ incorrectly formatted.