Exercise 1: LTL Properties

Given the following LTL properties over $AP = \{a, b, c\}$:

$\varphi_1 = a \land \Box b$

$\varphi_2 = a \lor b$

$\varphi_3 = \neg(a \lor \Box b)$

$\varphi_4 = (\Diamond c) \lor \Box a$

$\varphi_5 = \Diamond \Box a$

$\varphi_6 = \Box \Diamond c$

For each of the LTL properties $\varphi_i$, complete the following tasks:

(a) Give a trace $\tau \in (2^{AP})^\omega$ that satisfies $\varphi_i$.

(b) Give a trace $\tau \in (2^{AP})^\omega$ that violates $\varphi_i$.

(c) State whether or not the transition system below satisfies $\varphi_i$.

(d) Formalize $\text{Words}(\varphi_i)$ (i.e. the set of all traces satisfying $\varphi_i$) using set comprehension.

For example for $\varphi = \Diamond a$ we can formalize $\text{Words}(\varphi) = \{A_0A_1 \cdots | \exists i. a \in A_i\}$.

Exercise 2: Stating properties in LTL

Suppose we have two users, Betsy and Peter, and a single printer device. Both users perform several tasks, and every now and then they want to print their results on the printer. Since there is only a single printer, only one user can print a job at a time.

Suppose we have the following atomic propositions for Peter at our disposal:

$\text{Peter.request}$ indicates that Peter requests usage of the printer.

$\text{Peter.use}$ indicates that Peter uses the printer.

$\text{Peter.release}$ indicates that Peter releases the printer.

For Betsy, analogous predicates are defined. Specify in LTL the following properties:
(a) Mutual exclusion, i.e., only one user at a time can use the printer.

(b) Finite time of usage, i.e., a user can print only for a finite amount of time.

(c) Absence of individual starvation, i.e., if a user wants to print something, the user is eventually able to do so.

(d) **Bonus:** Absence of blocking, i.e., if a user requests access to the printer, the user does not request forever.

(e) **Bonus:** Alternating access, i.e., users must strictly alternate in printing.