Software Validation and Verification – 03/02/2026

Recall: Write your name on every paper sheet **and** motivate all your answers

Exercise 1 [8 points]

Express the following property E as the intersection of E_s and E_l, with E_s a safety property and E_l a liveness property:

$$E = Word(a \, U \, \Box b)$$

Exercise 2 [8 points]

Draw a GNBA that recognize the following ω-regular property E:

$$E = \{\sigma = A_0, A_1, \cdots \mid \forall i \in \mathbb{N}, a \in A_i \text{ or } b \in A_i \text{ and }$$
$$\nexists i \in \mathbb{N} \text{ s.t. } \forall j \geq i.a \in A_j \text{ and }$$
$$\nexists i \in \mathbb{N} \text{ s.t. } \forall j \geq i.b \in A_j\}$$

Exercise 3 [6 points]

Consider the set of LTL formulas $A = \{\phi, \psi, \xi\}$, where:

$$\phi = \neg(a \, U \, b) \qquad \psi = \Diamond(a \wedge \bigcirc \neg b) \qquad \xi = (\neg b) \, U \, (\neg a).$$

For each pair $(x, y) \in A \times A$, discuss whether $Word(x) \subseteq Word(y)$.

Exercise 4 [4 points]

Discuss the validity of the following statement:

> *For any LTL formula ϕ, for any atomic proposition a subformula of ϕ,*
> *if $B \xrightarrow{A} B'$ and $B \xrightarrow{A} B''$ are valid transitions of $\mathcal{G}_\phi$, then $a \in B'$ implies $a \in B''$*

Notation: given an LTL formula ϕ, we write $\mathcal{G}_\phi$ for the GNBA such that $\mathcal{L}_\omega(\mathcal{G}_\phi) = Word(\phi)$ returned by the algorithm from the lecture.

Exercise 5 [6 points]

Consider the following transition systems $\mathcal{T}_1, \mathcal{T}_2, \mathcal{T}_1'$ and $\mathcal{T}_2'$:

- Provide a CTL formula Φ satisfying exactly one between $\mathcal{T}_1$ and $\mathcal{T}_2$;

- Provide a CTL formula Φ' satisfying exactly one between $\mathcal{T}_1'$ and $\mathcal{T}_2'$.