CTL formulas and models

- “It is possible to get to a state where \textit{Started} holds but \textit{Ready} does not hold.”
- $\text{EF} (\text{Started} \land \neg \text{Ready})$

Exercise: compare to the \textbf{LTL} formula $F (\text{Started} \land \neg \text{Ready})$

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CTL formulas and models (1)

- Examples from slide 91.
- Based on board-work during lecture 4.
- Example models, indicating whether the formula holds.
- Exercise: for failing models, give a counter-example path/trace.

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\textit{Started}

\textit{Ready} \quad \textit{Started} \quad \textit{Done}

Exercise: compare to the \textbf{LTL} formula $F (\text{Started} \land \neg \text{Ready})$
CTL formulas and models (2)

- “If a request \( \text{Req} \) occurs, then it will be eventually acknowledged by \( \text{Ack} \).”
- \( \text{AG} (\text{Req} \Rightarrow \text{AF Ack}) \)

Exercise: compare to the LTL formula \( \text{G} (\text{Req} \Rightarrow \text{F Ack}) \)

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CTL formulas and models (3)

- “DeviceEnabled is always true somewhere along every path starting anywhere: i.e. \text{DeviceEnabled} holds infinitely often along every path.”
- \( \text{AG} (\text{AF DeviceEnabled}) \)

Exercise: compare to the LTL formula \( \text{G} (\text{F DeviceEnabled}) \)

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CTL formulas and models (3)

- “DeviceEnabled is always true somewhere along every path starting anywhere: i.e. DeviceEnabled holds infinitely often along every path.”
- $AG(AF\ DeviceEnabled)$

Exercise: compare to the LTL formula $G(F\ DeviceEnabled)$

CTL formulas and models (4)

- From any state it is possible to get to a state for which “Restart holds.”
- $AG(EF\ Restart)$

Exercise: compare to the LTL formula $G(F\ Restart)$
Misc CTL exercises (1)

▶ AG (Req ⇒ AX(A[¬Req U Ack]))

▶ Is the formula AG (Req ⇒ A[¬Req U Ack]) equivalent?

▶ Easy to construct a counter-example: the second formula requires that Ack is true immediately when Req is true.

Misc CTL exercises (2)

▶ AG (Req ⇒ (¬Ack ⇒ AX(A[Req U Ack])))

▶ Can we simplify the formula?

AG (Req ⇒ (¬Ack ⇒ AX(A[Req U Ack])))
≡ AG ((Req ∧ ¬Ack) ⇒ AX(A[Req U Ack]))
≡ AG ((Req ∧ ¬Ack) ⇒ (A[Req U Ack]))

▶ Exercise: are these equivalence steps correct?

▶ Extended: do we have to assume that our model is left-total?