Formal methods in control

Lecture: Jie Fu
What is formal methods

• Formal methods
  – Formal synthesis
  – Formal logic

• Formal logic: A logic language to specify task specifications.

Control theory:
  set-point,
  tracking a reference trajectory.
Formal logic specifications

- **Always Avoidance** other UAV and pedestrians.
- visit regions in a given order.
- **Always eventually** land.
- If signal red, then return to service region 1.

Interaction with uncertain, dynamic/Stochastic environment.
Topics

• How to specify tasks for robot systems using formal logic?
  – Automata theory
  – Logic
  – Finite transition systems

• Abstraction: How to reason about logic in continuous systems?
  – Abstraction-based planning
  – Abstraction-based control design
  – Discretization-based methods, variable grids (Guest lecture)
Topics

• Trajectory planning under temporal logic constraints.

• Control design.
  – Stochastic environment: Probabilistic model checking, Markov decision processes, stochastic optimal control.
  – Dynamic environment: Game theoretic analysis.
  – Deductive verification.

• Technical for scalability and other related topics.
  – Distributed control synthesis.
  – Sampling-based methods and approximate dynamic programming.