What is SLAM?

Estimate the robot's path and the map

$$p(x_{0:T}, m \mid z_{1:T}, u_{1:T})$$

distribution   path   map   given   observations   controls
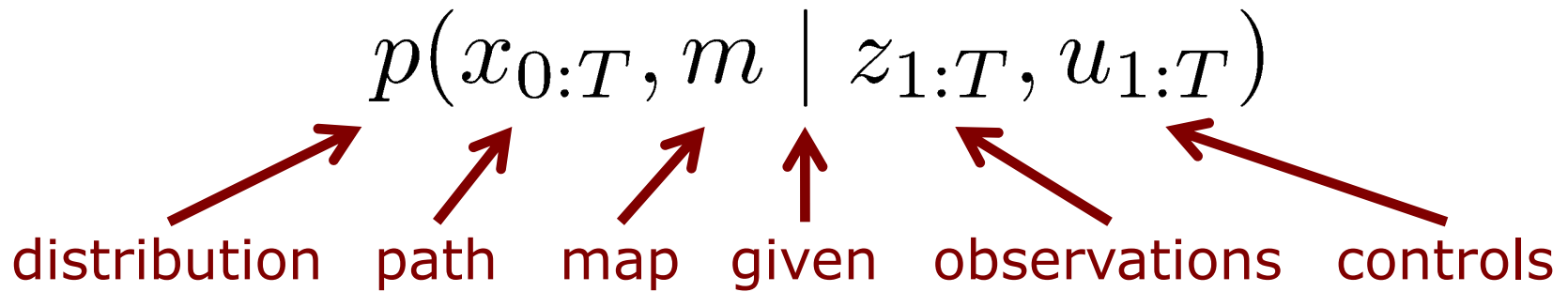
The SLAM Problem

- SLAM is a **chicken-or-egg** problem:
  - → a map is needed for localization and
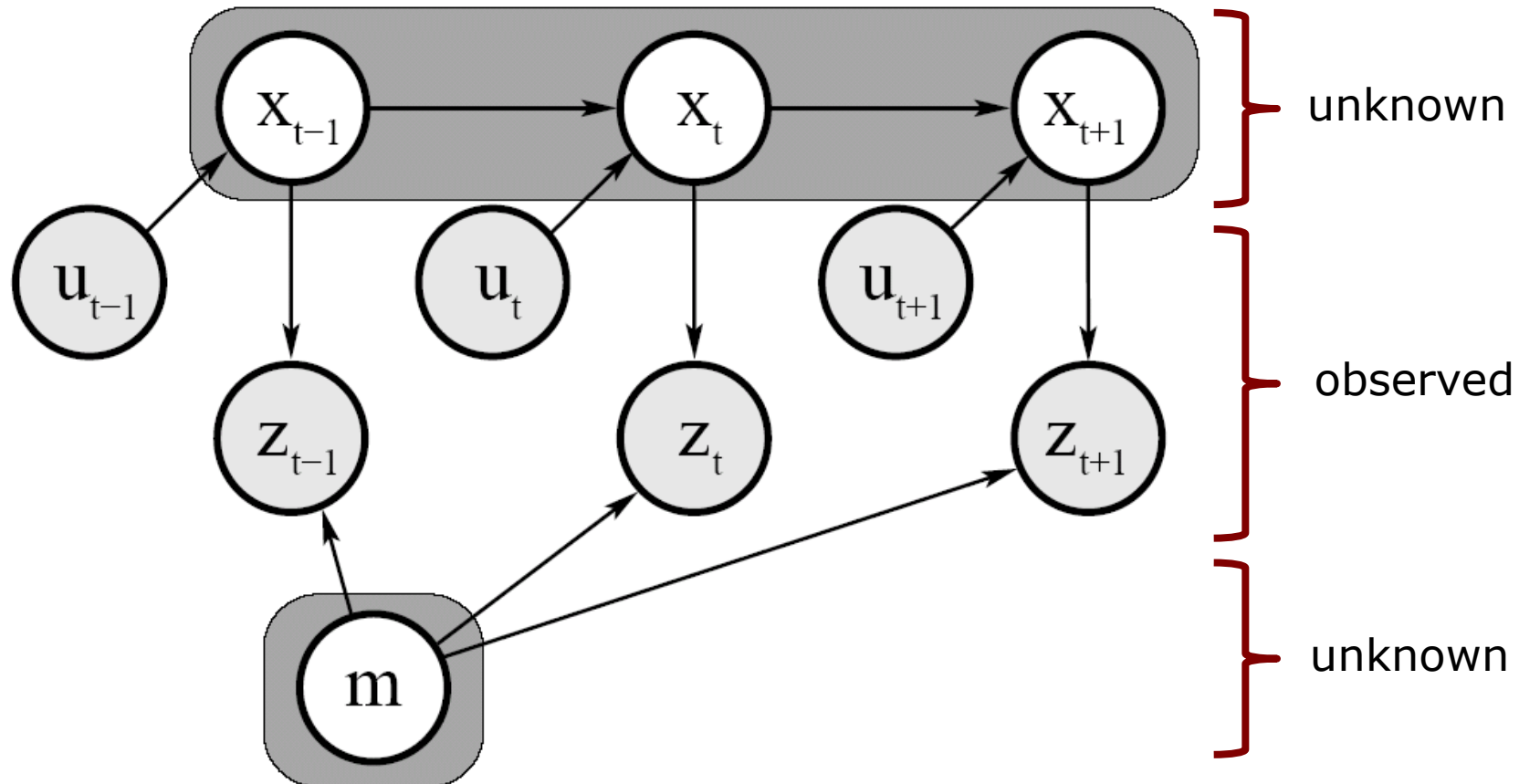 - → a pose estimate is needed for mapping

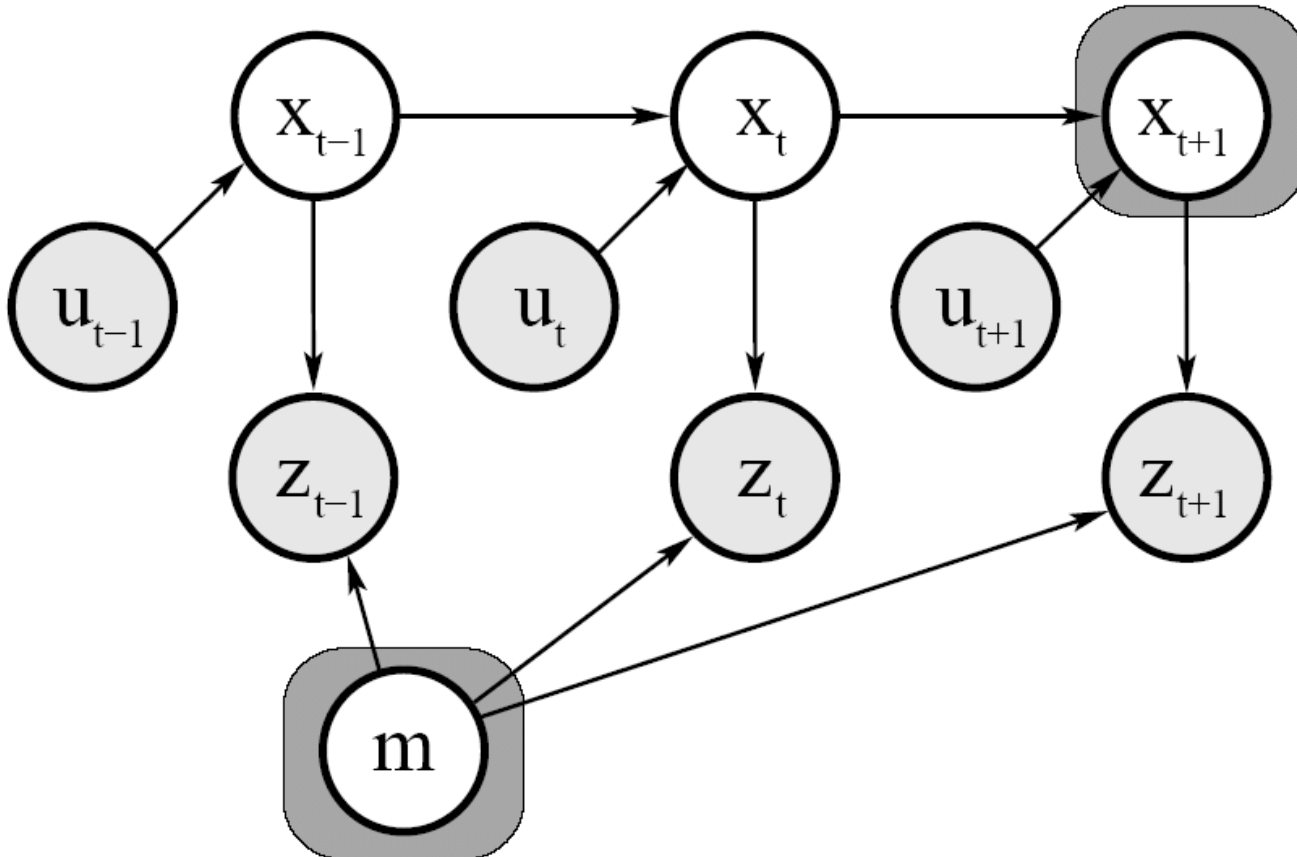# Three Main Paradigms

Kalman filter

Particle filter

Graph-based

Graphical Model of Full SLAM

$$p(x_{0:T}, m \mid z_{1:T}, u_{1:T})$$

Graphical Model of Online SLAM

$$p(x_{t+1}, m \mid z_{1:t+1}, u_{1:t+1})$$

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What You Should Have Learned

- SLAM problem
- Build landmark and grid maps
- EKF SLAM
- SEIF SLAM
- Particle filter-based SLAM
- Graph-based SLAM
- Front-Ends
- Hands-on experience (programing)
- Understand average SLAM papers

Comparison of Approaches

- KF
- EKF
- UKF
- EIF
- SEIF
- FastSLAM
- Grid-Based RBPF SLAM
- Graph-Based GN, LM & SGD

Where Do You See Open Issues?

Open Issues in SLAM

- Dynamic environments
- Systematically changing environments
- Seasonal changes
- Online solutions
- Life-long operation
- Resource-constraint systems
- Failure recovery/zero user intervention
- Exploiting prior knowledge
- Robots sharing maps

Sensor-Related Issues

- Efficient data association
- Sensor-related limitations
- Poorly structured scenes
- Missing light for vision
- Monocular SLAM in large environments

Good Luck for the Exam

(visit the tutors or make an appointment with me if you have questions during the preparation)