PILOT: An Actor-Oriented Learning and Optimization Toolkit for the Swarm

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The Swarm

Are there better programming formalisms than imperative code for programming learning applications on streaming real-time data?
Ptolemy II

- Ptolemy II is an open source platform for modeling and simulation of systems.
- Actor-oriented, hierarchical, heterogeneous design for composing models-of-computation
- **Accessors:** Actors that provide access to sensors, actuators and remote services

[Leonard Ptolemy](image)

[.DataVisualizationDiagram](image)

- **Actor:**
  - Input ports
  - Output ports
  - State

- **Accessor:**
  - Takes in data stream or time-stamped events
  - Runs on a swarmlet host

- **Service Implementation:**
  - Takes in service-specific link e.g., HTTP, CoAP, WebSocket, UDP, ...
  - Runs where ever the service wants

[Lee et al. (2014)]
Models in Ptolemy

Discrete-Event (DE) Semantics

- RobotID: 2
- numClients: 4
- Nparticles: 100
- SpeedLimit: 5.0
- intruderCov: [10.0,0.0;0.0,10.0]
PILOT: Ptolemy Learning, Inference, and Optimization Toolkit

- Actor-oriented toolkit to build models on streaming data
- Bayesian Inference, state estimation, constrained optimization
Robot Sensor Networks: Cooperative Target Localization
The Connected Car

[Wasicek et al. (2015)]
Real-Time Behavior Classification

- aggressive driving
- alert
- HMM classification

Car 1

- low speed
- changing velocity
- cruise
- aggressive

Driver 1
Reactive Jazz Improvisation
Thank You!

• Ptolemy II (and PILOT) are open source and available at: ptolemy.eecs.berkeley.edu
• Demos available online

Optimization and Machine Learning
Control Improvisation
  • Jazz Improvisation
Optimization
  • Constrained Simple Linear Regression
  • Simple Function Minimization
Particle Filter
  • Multi Robot Intruder Tracking
  • Online Robot Trajectory Optimization
  • Online Robot Trajectory Optimization - Distributed Computation
  • Open-Loop Target Localization - Single Robot
  • Open-Loop Target Localization - Two Robots
  • Multi-Observer Particle Filtering
  • Particle Filter Range

Probabilistic Models
  • Channel Fault Model
  • Communication Anomaly Detection Using HMM Estimation
  • Gaussian Mixture Model
  • Gaussian Mixture Model Parameter Estimation
  • Hidden Markov Model
  • Hidden Markov Model Analysis
  • Discrete-Time Markov Chain