Lecture 12: Recap

Jesse Hoey
School of Computer Science
University of Waterloo
April 2, 2019

Lecture 2: Agents and Abstraction

- Physical Symbol System Hypothesis
- Dimensions of Complexity
- examples:
  - none
- assignment: none
- Handouts (see OTHER MATERIAL on the website)
  - none

Lecture 3: States and Searching

- Generic frontier-based algorithm
- Selection of a node to expand
  - Blind (breadth-first, depth-first, lowest-cost)
  - Heuristic (best-first, heuristic depth-first, A*)
  - Admissibility
  - Monotonicity
  - Constructing a heuristic
  - Cycle checking and multiple-path pruning
- examples:
  - path finding
  - assignment 1: TSP + 8-puzzle
- Handouts:
  - Search Grid from lecture 3

Lecture 4: CSPs

- Constraint Satisfaction
- Dual Representations: variables ↔ constraints
- backtracking
- Consistency (AC3)
- Variable elimination
- Stochastic methods (local search, simulated annealing)
- examples:
  - scheduling
  - crossword puzzle
  - assignment 1: N-Queens and N-Samurai
- Handouts:
  - Crossword puzzle exercise from lecture 4

Lecture 5: Propositional Logic

- Declarative problem solving
- automated theorem proving
- logical consequence: if the conclusions are true in every model of the premises
- bottom-up and top-down proofs
- conjunctive normal form
- assignment 2: - CNF Resolution (money boxes)
- Handouts:
  - none

Lecture 6: Planning under certainty

- Knowledge base describing actions and effects
- feature based: how features change based on actions
- STRIPS: action preconditions and effects
- forward and backward planning
- planning as constraint satisfaction
- examples:
  - delivery robot
  - assignment: none
- Handouts:
  - none
Lecture 7a: Supervised Machine Learning
- cost/error functions
- decision trees
- information gain
- overfitting
- bias and variance in machine learning
- examples:
  - discussion board
  - assignment 2: newsgroup classification
- Handouts:
  - Discussion Board example

Lecture 7b: Learning as optimization
- Linear/Logistic regression
- stochastic gradient descent
- support vector machines
- neural networks and backprop
- deep neural networks
- assignment: none
- Handouts:
  - Derivation of Backpropagation Equations

Lecture 8a: Reasoning under uncertainty
- Bayesian vs. Frequentist view of probability
- conditional probability
- sum rule, product rule, Bayes’ rule
- Bayesian networks
- variable elimination
- examples:
  - coffee-grumpy-sad
  - Cancer diagnosis
  - bridge on fire
  - assignment 3: bank fraud
- Handouts:
  - Variable elimination examples
  - Grumpy-Sad and Cancer examples for use with aispace Bayes’ Net Applet

Lecture 8b: Reasoning under uncertainty
- time
- HMMs, DBNs
- stochastic simulation
- particle filters
- examples:
  - robot localization
  - assignment: none
- Handouts:
  - Robot Localization Problem
  - Stochastic Simulation examples

Lecture 9a: Learning with uncertainty (complete data)
- Bayesian learning
- Maximum a posteriori learning
- Maximum Likelihood learning
- Naïve Bayes
- examples:
  - Candy bags
  - assignment 3: naïve Bayes newsgroup
- Handouts:
  - Max. Likelihood and EM for Naive Bayes
  - Bayesian Learning (Candy Example)

Lecture 9b: Learning with uncertainty (incomplete data)
- hidden variables
- expectation maximization
- assignment 4: Dunnett’s syndrome
- Handouts:
  - EM exercise for simple Naive Bayes
  - Cancer example decision network
Lecture 10a: Planning under uncertainty

- preferences
- utility
- rationality and expected utility
- decision networks
- variable elimination
- examples:
  - robot pads
  - umbrella
  - cancer diagnosis
  - assignment 4: Monty Hall problem
- Handouts:
  - none

Lecture 10b: Planning under uncertainty

- time
- decision processes
- value iteration: variable elimination applied to MDP
- asynchronous value iteration
- POMDPs (for POMDPs: only the basic model + the fact that a POMDP is an MDP in “belief space”)
- Monte-Carlo Tree Search
- examples:
  - studentbot!
  - tiger problem
  - assignment: none
- Handouts:
  - Coffee/Fridge/MacBook example
  - Decision making
  - Studentbot applet
  - Markov Decision Process Tutorial (up to equation (6)) -

Lecture 10c: Planning under uncertainty

- reinforcement learning
- explore/exploit dilemma
- Model-based/Model-free
- Q-learning
- SARSA
- Q-function approximations (linear, non-linear)
- Deep Q-Network: Experience Replay and Target network
- assignment 4: Monty Hall
- Handouts:
  - Reinforcement Learning Tutorial

Finals: How to Study

- go over sample finals
- go over lecture slides
- go over printed notes (hand-outs - skip the POMDP part in the MDP tutorial)
- review all assignments and solutions
- try out all search, CSP, decision tree, Bayes net, decision net, EM, and Q-learning examples

Lastly

- evaluate.uwaterloo.ca – submit your evaluation today!