CS 581 – Advanced Artificial Intelligence

Topic: Summary

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Outline

- What we covered
- Other topics

What We Covered

Deck 2 - Intro

- A general introduction to AI
- A brief history of AI
- Risk and benefits of AI

Deck 3 - Search

- Search powers AI
- UCS
- A*
- Hill climbing
- Simulated annealing
- Genetic algorithms

Deck 4 - Probabilities

- Probability definition and theory
- Joint distribution
- Conditional distribution
- Marginalization
- Bayes rule
- Chain rule
- Marginal independence
- Conditional independence
- MAP query
- Number of independent parameters
- Continuous spaces
- Probability density function
- Uniform distribution
- Gaussian distribution
- Expectation
- Variance

Deck 5 – Bayesian Networks

- Motivation
- BN factorization
- Independencies
- D-separation
- Reasoning/inference
- Variable elimination for probability queries
- Variable elimination for MAP queries
- Irrelevant variables
- Linear Gaussian models

Deck 6 - HMMs

- Definition
- Filtering
- Prediction
- Smoothing
- Most-likely explanation

Deck 7 – MLE & BE

- Maximum likelihood estimation
- Bayesian estimation
- Posterior distribution
- Predictive distribution
- Uniform priors
- Beta priors
- Dirichlet priors

Deck 8 – Naïve Bayes

- Introduction to classification
- Classification metrics
  - Confusion matrix, accuracy, precision, recall, F1, etc.
- Cross validation
- Definition of naïve Bayes
- Parameter estimation for naïve Bayes
- Prediction using naïve Bayes
- Variants – Bernoulli, Gaussian, Multinomial
- How to handle zero probabilities
- How to handle multiplication of thousands of small probabilities
- Text classification

Deck 9 – Logistic Regression

- Gradient optimization
- Definition of logistic regression
- Parameter estimation for logistic regression
- L_2 regularization
- L_1 regularization
- Categorical features

Deck 10 – Neural Networks

- Motivation and definition
- Perceptron
- Logical function examples
- Activation functions
  - Identity, bipolar step, sigmoid, tanh, relu, …
- Backpropagation
- Deep learning
- CNN
- RNN
- LSTM

Deck 11 – Decision Making

- Utility theory
- Influence diagrams
- Which action to take?
- Value of information
- Markov decision processes
- Utility of states, U (later V)
- Utility of state-action pairs, Q
- Policies
- Bellman optimality equations for U and Q
- Value iteration
- Policy iteration
- Multi-armed bandit
- Epsilon greedy
- UCB1

Deck 12 – Reinforcement Learning

- Relationship to and differences from MDPs
- Monte Carlo prediction
- Incremental update
- Temporal difference (TD) prediction
- Monte Carlo control
- TD control (SARSA)
- Briefly
  - N-step TD
  - TD(λ)
  - Approximate methods

Deck 13 – Summary

- Deck 2 – Introduction to AI
- …
- Dec 13 – Summary ☺

Other Topics

Planned but Could not Get to

- Knowledge representation
  - Propositional logic, first-order logic, ontologies

AI Ethics

- Positives of AI are plenty
- Negatives are, unfortunately, just as plenty
- Hollywood made a disservice (surprise☺) by focusing on killer robots; many of the negatives of AI are invisible and are already here
- Issues to consider
  - Safety, privacy, fairness, accountability, transparency, trust, economics, …
- PHIL 381 – AI Ethics

Natural Language Processing

- Language models
  - Bag-of-words, n-grams, word representations, part-of-speech tagging
- Grammar
  - Syntax, semantics, context-free grammar, …
- Parsing
  - Chomsky normal form, dependency parsing
- Machine translation
- Speech recognition
- Text to speech
- Information extraction
- Question answering
- Natural language generation
- …
- CS 585 – Natural language processing
- Online book: https://web.stanford.edu/~jurafsky/slp3/

Computer Vision

- Image formation
- Detection
- Recognition
- Segmentation
- Feature extraction
- Signal processing
- Activity recognition
- Image restoration
- Tagging
- Captioning
- Image generation
- …
- CS 512 – Computer vision
- Online book: http://szeliski.org/Book/

CS595 - ...multimedia

AI(-related) Courses at CS at IIT

- http://bulletin.iit.edu/undergraduate/colleges/computing/computer-science/bs-artificial-intelligence/
- http://bulletin.iit.edu/graduate/colleges/science/computer-science/master-artificial-intelligence/
- http://bulletin.iit.edu/courses/cs/
- 400-level
  - CS 422, CS 429, CS 480, CS 481, CS 482, CS 484
- 500-level
  - CS 512, CS 522, CS 528, CS 529, CS 577, CS 578, CS 579, CS 580, CS 581, CS 582, CS 583, CS 584, CS 585
- Some courses are offered more frequently than others
  - https://docs.google.com/document/d/1kiI3FAEZFC4C1wilkYMJF-KHy-m4BG2jL-pbZNiXehI/edit