CS 6601: Final Study Guide

Note: R&N = *AI, A Modern Approach*, by Russell & Norvig

- Adversarial search (R&N Chapter 5)

    - Observable games (e.g. isolation)
    - Minimax
    - Alpha-beta pruning

        - Performance improvement

    - Utility and evaluation functions

        - Sensitivity

    - Optimization tricks

        - Move-ordering
        - Symmetry

    - Iterative deepening
    - Multiplayer games
    - Probabilistic games
    - Partially observable games (e.g. poker)

- Search (R&N Chapter 3, uninformed and informed)

    - Uninformed

        - Breadth-first search
        - Depth-first search
        - Depth-limited search
        - Iterative deepening depth-first search

    - Informed

        - Uniform-cost search
        - Greedy search
        - A* search
        - Heuristics

            - Consistency/admissibility
            - Dominance

- - - Derivation by relaxation

  - Bidirectional
  - Tridirectional
  - Tree vs. graph search
  - Completeness, space/time complexity, path optimality

- Agent design (R&N Chapter 2)

  - Rationality
  - PEAS

    - Performance
    - Environment

      - Observability
      - Deterministic/stochastic
      - Episodic/sequential
      - Static/dynamic
      - Discrete/continuous
      - Single/multi-agent

    - Actuators
    - Sensors

      - Uncertainty

  - Agent types

    - Reflex
    - Reflex with state
    - Goal-based
    - Utility-based
    - Learning

- Random algorithms (part of R&N Chapter 4)

  - Hill-climbing
  - Beam search
  - Iterative improvement
  - Simulated annealing
  - Genetic algorithms
  - Local vs. global maximum
  - Local stochastic search

- Constraint satisfaction problems (R&N Chapter 6)

- Variables, domains, constraints
- Standard search
- Backtracking
- Heuristics

  - Minimum remaining values
  - Least constraining value

- Forward-checking
- Arc consistency
- Path consistency
- Problem re-structuring

- Probability (R&N Chapters 13 and 14a, 14b)

  - Independence/dependence
  - Discrete/continuous variables
  - Joint distribution
  - Central Limit Theorem
  - Conditional probabilities

    - Bayes' Rule
    - Chain Rule
    - Conditional independence

  - Bayesian networks

    - How to construct
    - Local independence
    - Inference

      - Exact (calculation)

        - Enumeration
        - Variable elimination

      - Inexact (sampling)

        - Rejection sampling
        - Stochastic simulation
        - MCMC simulation

  - Decision/utility theory

    - Expected value

- Machine learning (part of R&N Chapter 18)

    - Classification problems
    - Gaussian distribution

        - Central limit theorem

    - Maximum likelihood estimate
    - Decision boundaries
    - Distance metrics: Euclidean vs. Mahalanobis
    - Training and testing

        - Cross-validation, LOOCV
        - Over/underfitting

    - Accuracy

        - Precision/recall

    - *k* nearest neighbors
    - Naive Bayes
    - Mixture of Gaussians
    - No free lunch

    - Separability

        - Linear vs. nonlinear

    - Decision trees

        - Entropy
        - Information gain
        - C4.5
        - Random forests
        - Decision "stumps"

    - Boosting
    - Clustering (i.e. unsupervised learning)

        - k-means
        - Inter/intra-class variance
        - Descriptive length
        - Gaussian mixture models
        - Expectation Maximization

    - Neural Networks

- - Single-layer perceptron
    - Multilayer perceptron
    - Backpropagation
  - Support Vector Machines
- Reasoning over time (R&N Chapter 15)
  - Dynamic Time Warping
    - Sakoe-Chiba bands
  - Hidden Markov Models
    - Sequence decoding
      - Viterbi
    - Probability estimation
      - Forward-backward
    - Training
      - Baum-Welch
    - Improvements
      - N-gram models
      - State tying
      - Pruning, beam search
      - Context-Free Grammars
      - Segmentally-boosted HMMs
- Complex decisions (R&N Chapter 17 and 21)
  - Utility functions
  - Policy (vs. path)
  - Finding optimal policy
    - Bellman equation
    - Value iteration
    - Policy Iteration
    - Q-learning
    - SARSA
    - Local consistency vs. global optimality

- Partially-observed Markov Decision Processes

  - Belief state
  - Particle filter

- Logic (R&N Chapters [7](#), [8](#) and [9](#))

  - Propositional knowledge
  - First-order logic

    - Operators
    - Existential quantifiers

  - Knowledge base
  - Entailment
  - Inference

    - Soundness vs. completeness
    - Enumeration
    - Logical equivalence

  - Validity vs. satisfiability
  - Forward/backward chaining
  - Horn clauses
  - Conjunctive Normal Form
  - Resolution

    - Proof by contradiction

  - Universal/existential instantiation
  - Reduction
  - Unification

- Planning (R&N Chapter [11](#) plus [this](#))

  - STRIPS planner

    - States
    - Conditions
    - Operators
    - Goals
    - Actions
    - Plan

  - Partially-ordered plans
  - Conditional planning

- Monitoring

  - Execution vs. action monitoring

- Replanning

  - Clobbering
  - Demotion/promotion