* What is Intelligence?
  + Reason
  + Acting
  + Making a choice
  + Acting
  + Justified choice
  + Information management/sorting/filtering
  + Apply knowledge
  + Self aware 🡪 consciousness
  + Think 🡪 symbolic problem solver
  + Creativity
  + Learn
  + Conformity to an external standard of truth
  + Abduction(pull facts together, then conclude something more that what the facts support), induction
  + Solve problems that they have never faced before
* Then are the following intelligent?
  + Dog
* Board:
  + Getting it Moving
    - Reactive agents
    - (HW, Search Presentations)
  + PD Control
    - Physics 121
    - Managing error
  + Potential Fields
    - Ski to goal
    - (delta sign) or ds=
    - fields
  + Lab#1
* \* We are not just biochemical machines
* Newton
  + F = ma
  + Stuff stays still
  + Every action has an equal and opposite action
* Board:
  + Potential Fields
    - Attractive (vs. Gravity wells)
    - Repulsion
    - Tangential
  + Rationality!?
  + Frameworks
    - PEAS – symbolic Sym Proc
    - CSA - Brooks
  + Agent Types
    - Group Work
* Search Fun
  + Greedy
    - Sorted by h(n)
    - Heuristic
      * Help us make decision with incomplete information
      * Admissibility: don’t over estimate!
      * How to find?
        + Remove some constraints – you can walk through walls
        + Absolver
        + Combinging
        + Solving subproblems
        + Machine learning
    - Optimal
      * No
    - Complete
      * Infinite spaces
        + No for either a tree search or a graph search
      * Finite spaces
        + Yes for a graph search
        + No for a tree search – it can get stuck
    - Advantages
      * Easy to implement
      * Complete, if it keeps track of where it has already been
    - Disadvantages
      * Not all problems leand themselves to looking ahead exactly one step
      * If no good heuristic is know, thae algorithm quickly becomes naïve
      * Not ver ‘autonomous,” , a lot of human insight required
    - Time and Space Complexity
      * 2^n, n is the depth of the tree
      * O(b^m), where m is the maximum depth of the search space.
  + A\*
    - No other optimal algorithm is guaranteed to expand fewer nodes than A\*. On all problems and using the same h(n).
    - Assumtions:
      * Could be multiple goals
    - Huristic
      * Never overestimates the actual optimal cost
      * Optimal cost to go
    - Tree
      * Poly time – if world and alg are both tree
    - Exponential in both space and time.
      * B^d – b max branching factor, d best case depth
      * D == c\* / e – c\*==true minimum cost path, e == minimum edge cost
      * Worst case
        + B^ floor(c\*/e) + 1
  + IDA\*
    - DFS – but I’m going to only let you go so far…
    - BUT we’ll let the limit be some A\* f(n)
    - Move line by smallest f(n) we know about
      * Move the smallest amount we can to capture the next node
    - Complete
    - Optimality
      * Yes
    - Runtime: O(b^d)
    - Space: O(bd)
    - Good
      * Mem good
    - Bad
      * No good h(n)
      * Cn’t wait
      * On real-valued input, consider using A\* rather than IDA\*
  + Recursive Best-First Search
    - Optimal / complete
    - Linear space
    - Time: b^d
    - Space: bd
    - Only expands one node compared to IDA\*
* Definition of a Rational Agent
  + If it conforms to performance measure that a designer creates. Because we’re the ones defining the performance measure.
* PEAS
  + Environment
    - Usually neutral not out to get you
  + Acutatros
    - don’t have to physical
      * could be a voice
      * a display
* Modeler – Agent
* C = S(x)A
  + A – actions
  + S – States
    - This is the environment
    - All about **nature**
  + C – consequences
  + G – Goal
* Partially Observable
  + Camera – can only see part of the world
* Uncertinty
  + When we don’t know all of the states can see everything, yet have a probable model for what is going on in the world, and have to act anyway … we call this acting under uncertainty.
* Non deterministic world
  + When we have a probablist model that describes how my actions generate consequences we say we’re operating in a non-derterministic world
* I have a map of the US actual size. Its hard to fold.
  + We have to throw away information, otherwise we have the actual thing.
* >
  + set of states that are in order of preference
    - A>B – I like more than B
    - A~B – indifferent
    - A >~B
* Education allows the ability to appreashiate its greatness in all of its forms.
* Preferences Depend on your goals
* Utility
  + Includes strength of preference
  + We can incode the strength of our preference
  + Best state(vs best path)
  + Hill-Climbing
    - Problems
  + Random restart
  + Stochastic
  + Beam Search
  + Genetic Algorithms
  + Gradient Ascent
  + Probability
* Local Search
* Hill – Climbing
  + Look at book
* Socastic
  + Add some randomization
* Random Restart
  + Learn this
  + A flavor of stocatic search
  + Algorithm
    - Random start
    - Find best
    - Remember
    - Start over
    - Return best found
  + How many restarts do you have to do before you found the best?
  + How many times to I have to run to get a 90% confidence?
    - 1 – (1-p)^n > .9 : Solve for n

Beam Search

* + when the amount of computation required to calculate the payoff is high
  + otherwise use Random Restart
* Schedule
* Genetic Algorithms
  + Population
    - One we have worked with, messed with , haven’t tried, pure random start
  + Genome, Chromazome
    - Represented by a vector
  + Fitness
    - How good it is
  + Mutation
    - Introduced randomness
  + Crossover
    - Merging
* Gradient Descent
  + D, sf/sx
  + X <-x +kdf
* X’ <- x + k df/dx | x
* Done
  + Little to no change
  + Hit an end point
  + When the derivative switches signs
  + Doesn’t guarantee optimality
* Probability
  + 1 unit of belief
    - other was to represent probability or in other words to represent uncertainty
  + axioms
  + probability spore
  + measure
  + Radom variable
* Possible
  + Omega – everything…literaly…
* Distinguishable
  + (s,q,p)
* Measurable
  + Book notaion
* P: sigma ->[0,1]
  + Function that take the set of distinguishable events and maps them to a unit of belief
* PMF & CDF
* Joint, Marginal, Conditional
* Bayes Rule
* Joint&Marginal
* Conditional
  + Def&interp
* BayesRule
  + Derivation
  + Terminology
  + Practice
* Exam Review
* Conditional Kids
  + Bayes Rule (Likelihood and prior)
  + Bayes Nets (Conditional independence)
* ChainRule: order doesn’t matter
* Conditional Independence
  + Example
* Bayes Nets
  + Conditional Probability table
  + Computing joint probability

Bayes Nets

* + ChainRule++
  + Conditional Prob Table
  + Practice
  + WHY
    - Smaller in Size
    - Cause and effect
* Canonical Bayes Nets
  + Multiple causes
    - Noisy AND
    - Noisy OR
  + Multiple Effects
    - Naïve Bayes
  + Temporal
    - Markov Processes
* Noisy OR
* Naïve Bayes
* Temporal
  + MDP
* Bayes Filter
* Filters, smoothers, predictors
* Bayes Filter
  + Example
* Grid Filter
* Exam
* Grid Filter
* Bayes Filter
* Bayes Filter
  + Finding examples
  + Continuous spaces
* Kalman Filter
  + P(Xt+1|Xt)
  + P(Zt|Xt)
  + Physics
  + Multivariate Gaussian