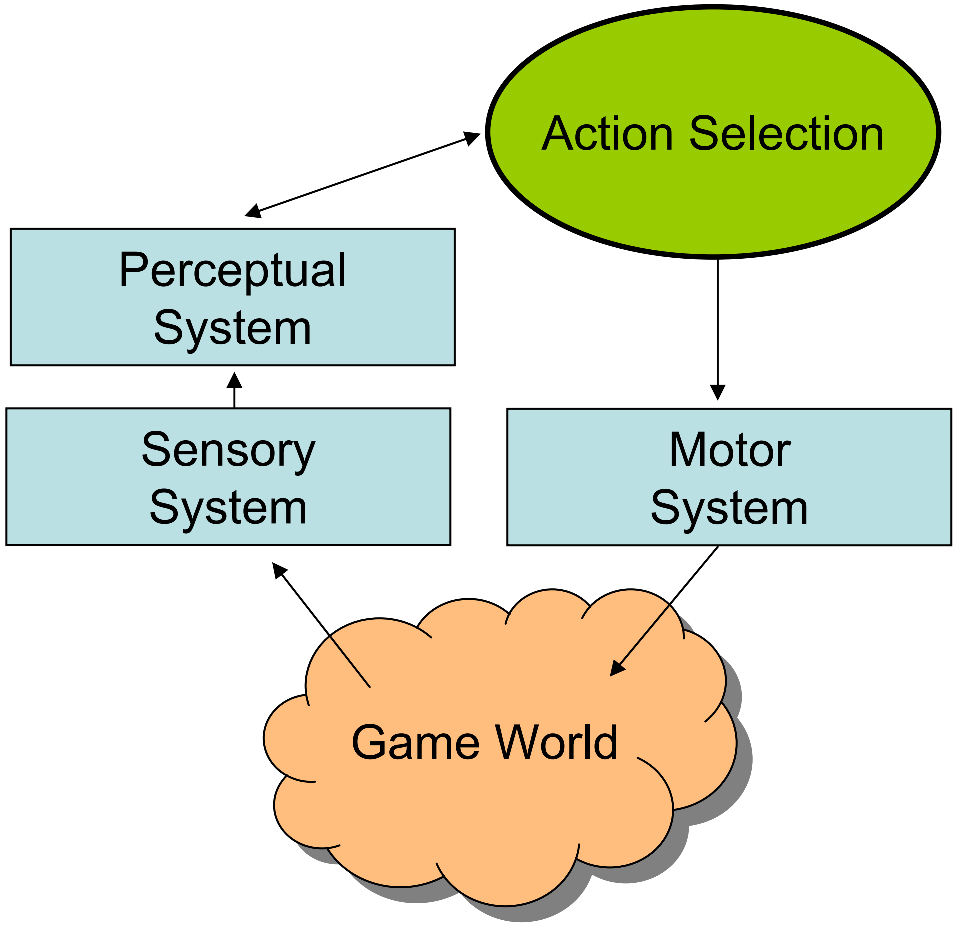
AI Bot Architectures

CS395 GAI

Spring 2005

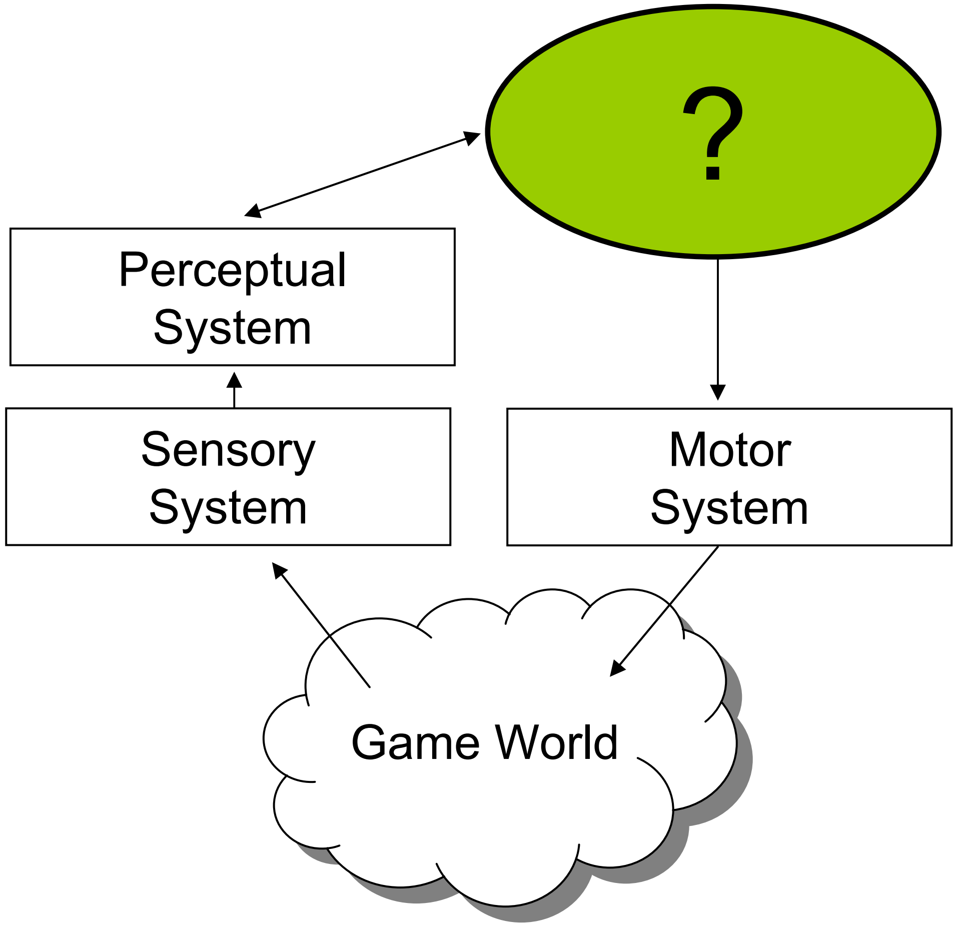
Common Components

- World
- Sensory system
- Perceptual system
- Action selection
- Motor system



AI Bot Architectures

- Scripting
- Behavior-based
- Rule-based
- Goal-based
- Plan-based
- Layered



Types of AI Components

- Reactive
  - Responds directly to environmental factors
  - Ideal for twitch-type response
- Deliberative
  - Contains model of the game environment
  - Perform inference in decision-cycle
- Reflective
  - Learn from experience

Scripting

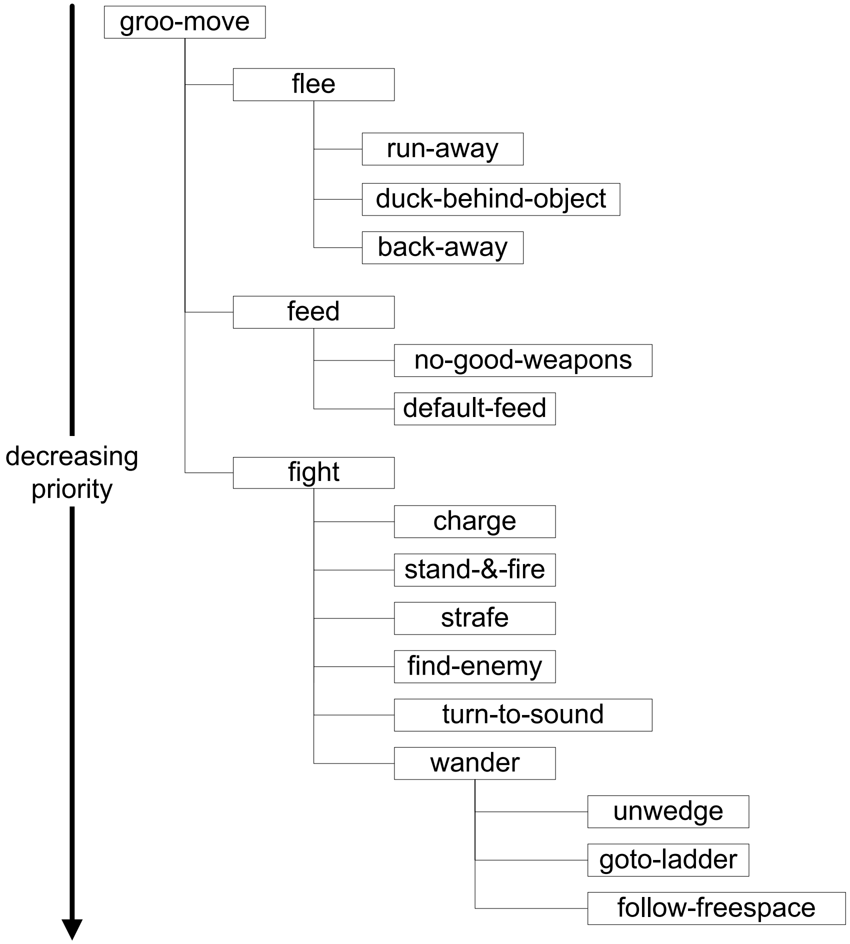
- Commonly called “AI” for marketing purposes
- Game environment is a stage, designer gives the actors directions
- Advantages
  - Tight, absolute control over agent behavior
  - Useful for scenario design
- Disadvantages
  - Static behaviors
    - Threat to replay-ability
  - Very specific to the particular game/map

Behavior-based AI Architectures

- Weak-AI technique
- Borrowed from the robotics community (Brooks)
- Improvement on the authoring of Finite State Machines
  - Design in terms of higher-level behaviors
- Believability vs. intelligence
- Externalizes environment models
  - No internal model of what the bot is actually doing and any given moment

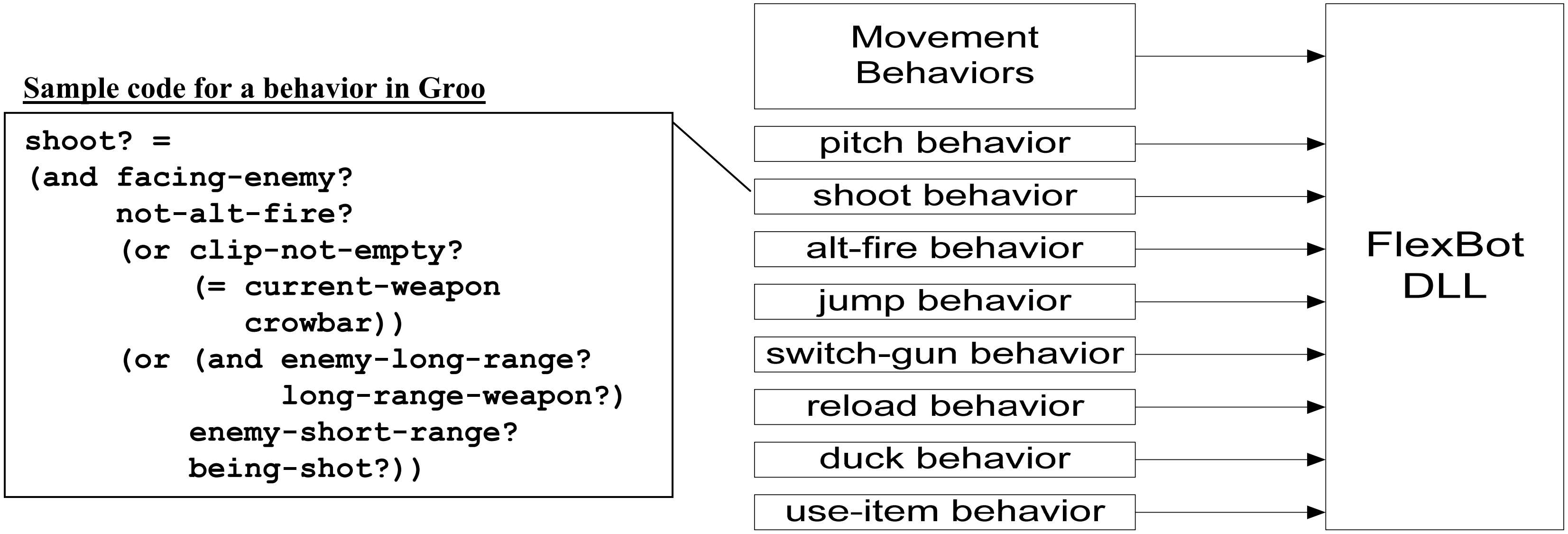
Behavior-based AI Architectures

- Example: FlexBot behaviors for Half-Life
  - Written in the Generic Robot Language (Horswill)
  - Compiles down to FSM (C or Lisp code)
- Very efficient
  - Game engine is the bottleneck not the AI



Behavior-based AI Architectures

- Excerpt from a GRL control program

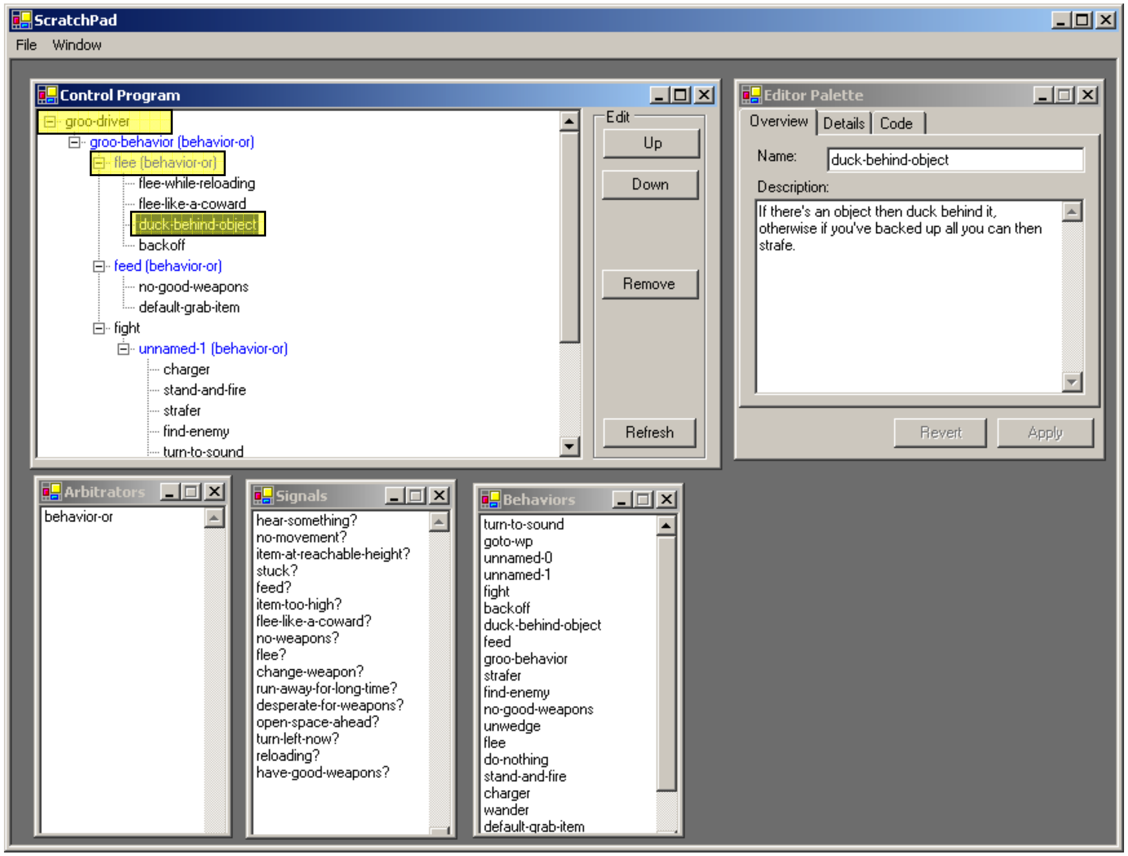


Sample code for a behavior in Groo

```
shoot? =
(and facing-enemy?
     not-alt-fire?
     (or clip-not-empty?
         (= current-weapon
            crowbar))
     (or (and enemy-long-range?
              long-range-weapon?)
         enemy-short-range?
         being-shot?))
```

Behavior-based AI Architectures

- Towards self-explanation in behavior-based control systems



```
groo-driver
  groo-behavior (behavior-or)
    flee (behavior-or)
      flee-while-reloading
      flee-like-a-coward
      duck-behind-object
      backoff
    feed (behavior-or)
      no-good-weapons
      default-grab-item
    fight
      unnamed-1 (behavior-or)
        charger
        stand-and-fire
        strafer
        find-enemy
        turn-to-sound
```

Name: duck-behind-object

Description: If there's an object then duck behind it, otherwise if you've backed up all you can then strafe.

Arbitrators:
behavior-or

Signals:
hear-something?
no-movement?
item-at-reachable-height?
stuck?
feed?
item-too-high?
flee-like-a-coward?
no-weapons?
flee?
change-weapon?
run-away-for-long-time?
desperate-for-weapons?
open-space-ahead?
turn-left-now?
reloading?
have-good-weapons?

Behaviors:
turn-to-sound
goto-wp
unnamed-0
unnamed-1
fight
backoff
duck-behind-object
feed
groo-behavior
strafer
find-enemy
no-good-weapons
unwedge
flee
do-nothing
stand-and-fire
charger
wander
default-grab-item

Rule-based AI Architectures

- Production-rules explicitly define actions to be executed in response to certain conditions
- Advantages
  - Architecture is simple to build
  - Easy for non-programmers to develop rules
- Disadvantages
  - Difficult to organize
    - Lots of independent rules
  - Difficult to debug, identify conflicting rules
  - Sequences of actions must be defined using a series of stateful triggers

Rule-based AI Architectures

- Example: Age of Kings AI “scripting”
- Series of prioritized production rules

```
(defrule
        (building-type-count-total castle less-than 1)
        (can-build castle)
=>
        (build castle)
        (chat-local-to-self "castle"))
```

- http://www.cs.uga.edu/~potter/aok/WDPsample.per

Goal-based Architectures

- Example: SOAR Quakebot (Laird)
  - Production rules suggest actions
  - Suggestions are evaluated vs. goals, and operator is chosen
  - Core implementation does no planning
  - Frequent re-evaluation of actions in the decision cycle

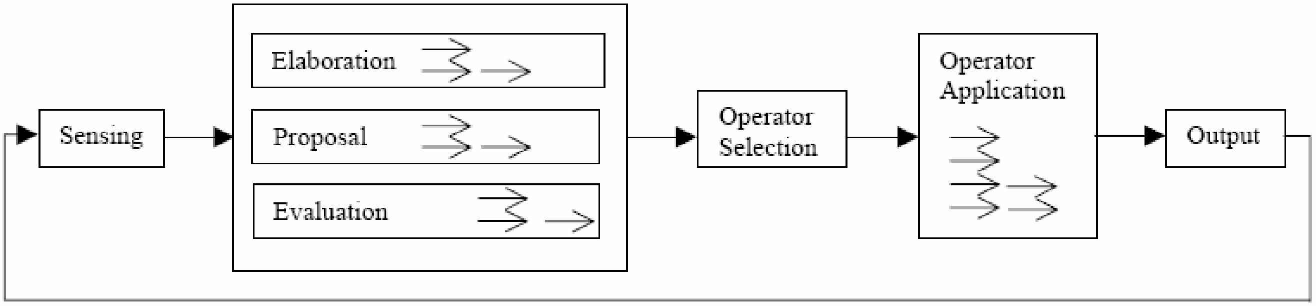
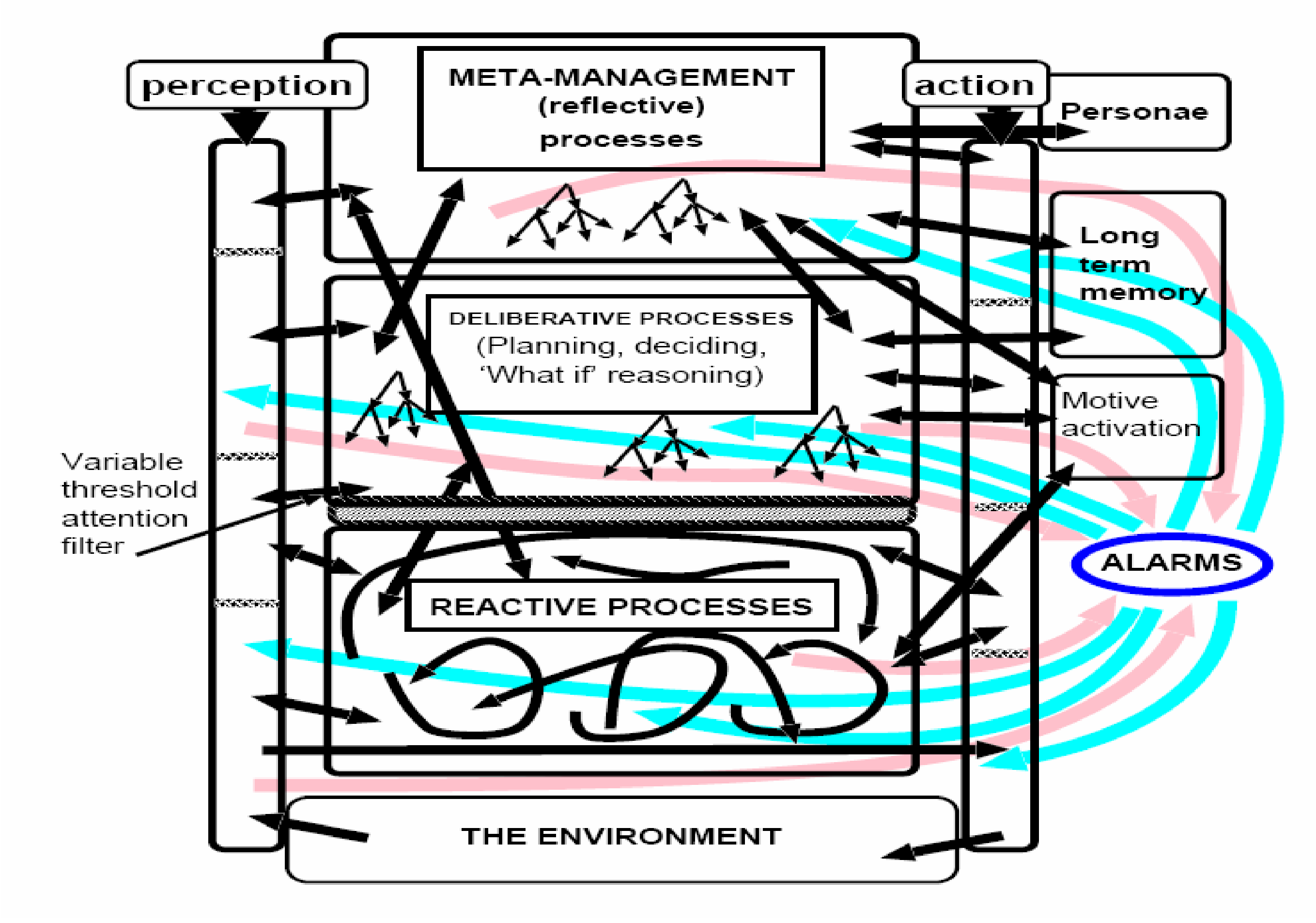


Figure 4. The Soar Decision Cycle

Plan-based Architectures

- Classical planners
  - Most frequently used for path planning
- HTN’s

Layered AI Architectures



(Sloman, Scheutz)

Useful Techniques

Techniques used to augment various architectures

Bayesian Networks

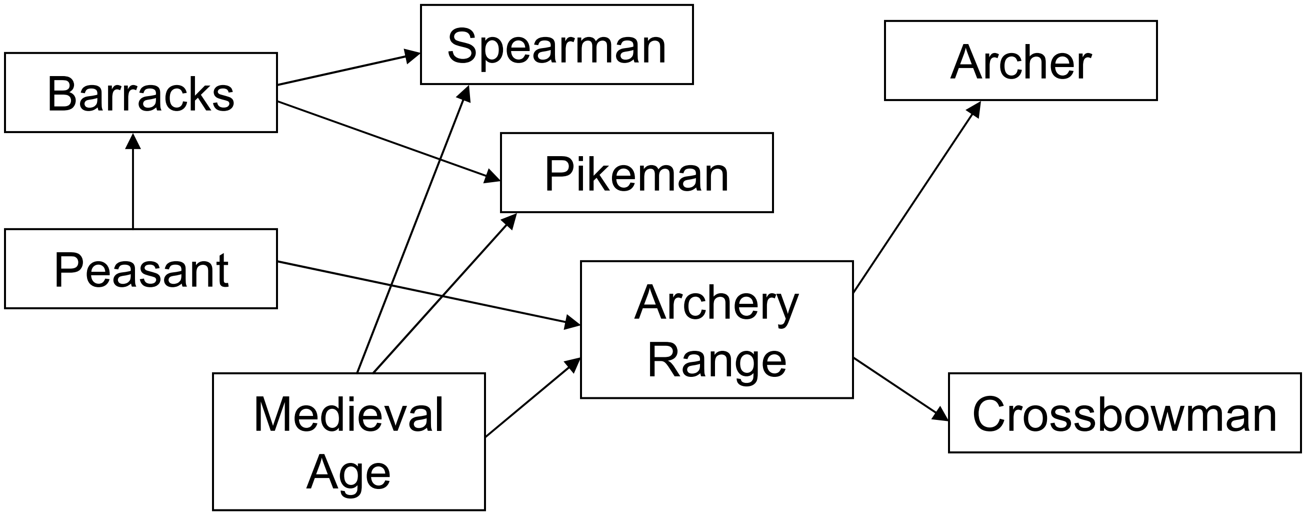
- Bayes’ Theorem
  - P(A|B) = P(B|A)P(A) / P(B)
  - P(A|B) “the probability of A given that what I know is B”
- Example
  - “the probability that it rained yesterday, given that your lawn is wet”
  - P(B|A) = the probability that the lawn would be wet if it actually rained yesterday
  - P(A) = the probability of rain, all other things being equal
  - P(B) = the probability of your lawn being wet, all other things being equal

Bayesian Networks

- Combination of prob. propositions in a graph structure called a “belief network” or a “Bayesian network”
- Model underlying cause-and-effect relationships between game phenomenon
- Dealing with uncertainty in the perceptual system
  - Infer likely facts about other players based on partial or incomplete observations

Bayesian Networks

- Example: using a Bayes network in a RTS to infer the existence or nonexistence of some technologies by the presence or absence of others



(Paul Tozour, *AI Game Programming Wisdom*)

Level-of-Detail for AI

- Path-planning
  - Waypoints
  - Voronoi diagrams

Learned Heuristics

- Initial frontier for reflective systems
- “Stench-of-death” tiles in RTS
- Influencing decision probabilities in Black & White