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United Kingdom 2011

ONLINE CONFERENCE



DESIGN.BUILD.DELIVER
with WINDOWS PHONE

THURSDAY 24 MARCH 2011

Welcome to the
Windows Phone 7
tech days 2011 online conference
XNA Track

Delivered by the XNA UK user group

<http://xna-uk.net>





Video demonstrations



<http://YouTube.com/WP7XNA>

Session_SequenceNumber

XNAAI_1 XNACollisions_1

XNARender_1 XNASunBurn_1





QUESTIONS

Please use the Q&A dialogue box
to share your questions

OR TWEET with
#uktechdays



Practical AI in XNA Games

Paul Foster

Microsoft



[@Paulfo](https://twitter.com/Paulfo)



<http://wotudo.net>



paulfo@microsoft.com



AI defined

- Academic AI
 - ‘...concerns itself with trying to create systems that mimic human thought processes or with applying AI technologies to the solution of real-world problems...’



AI defined

- Video game AI
 - Delivers absorbing game play
- Objectives
 - Not to clever
 - Not to stupid
 - Balanced CPU usage



AI Techniques

- AI Agents
- Path finding
- Fuzzy logic



AI Agents

- Finite State machines
 - Basis for many game AI
 - Simple to code
 - Easy to debug
 - Require little computational overhead
 - Are intuitive
 - Flexible



FSM Patterns

- If-then/switch statements



FSM Patterns

- If-then/switch statements
- State transition table
 - External look up

Current State	Condition	State transition
Runaway	Safe	Patrol
Attack	WeakerThanEnemy	Runaway
Patrol	Threatened AND StrongerThanEnemy	Attack
Patrol	Threatened AND WeakerThanEnemy	Runaway

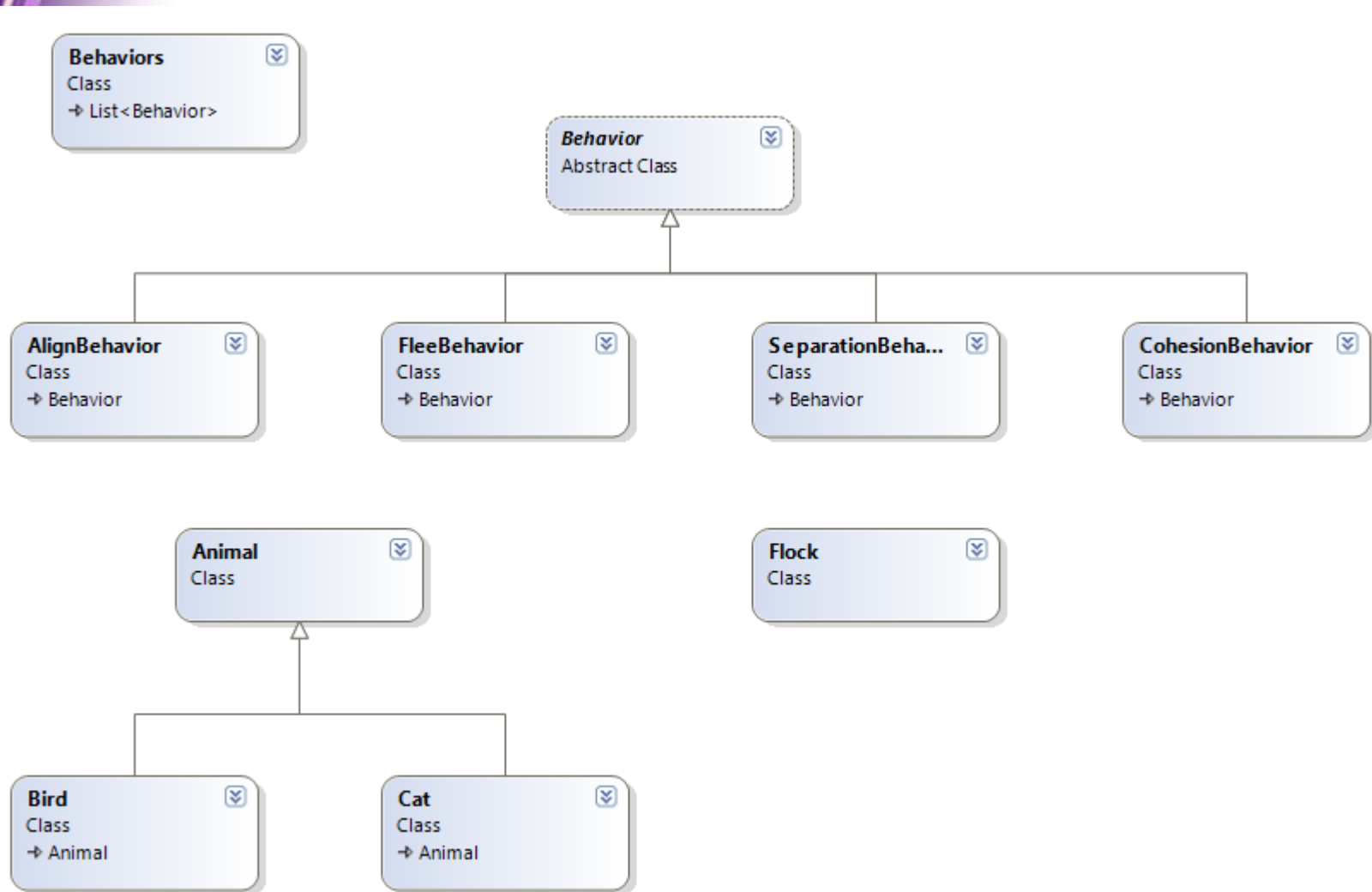


FSM Patterns

- If-then/switch statements
- State transition table
 - External look up
- State design pattern
 - Distinct state objects/functions
 - Embedded transition rules



Pluggable behaviours sample



Demonstration XNAAI_1

<http://youtube.com/WP7XNA>

Flocking Example

Sample available from App Hub



C# Iterators

- C# Iterators produce
 - Finite State Machine
 - Provide readable code with Yield Return
- But is it practical to use them to produce your AI FSM?



Demonstration XNAAI_2

<http://youtube.com/WP7XNA>

C# Iterators Example

Sample available from wotudo.net

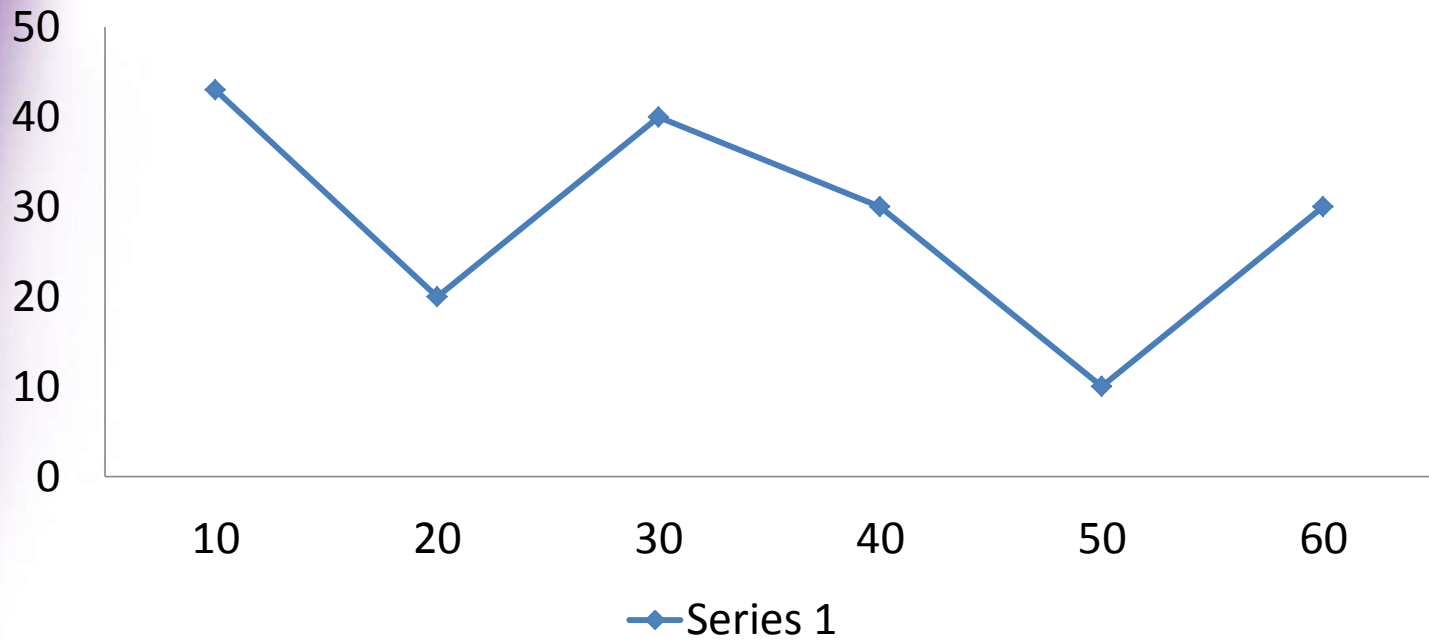


Practical path finding

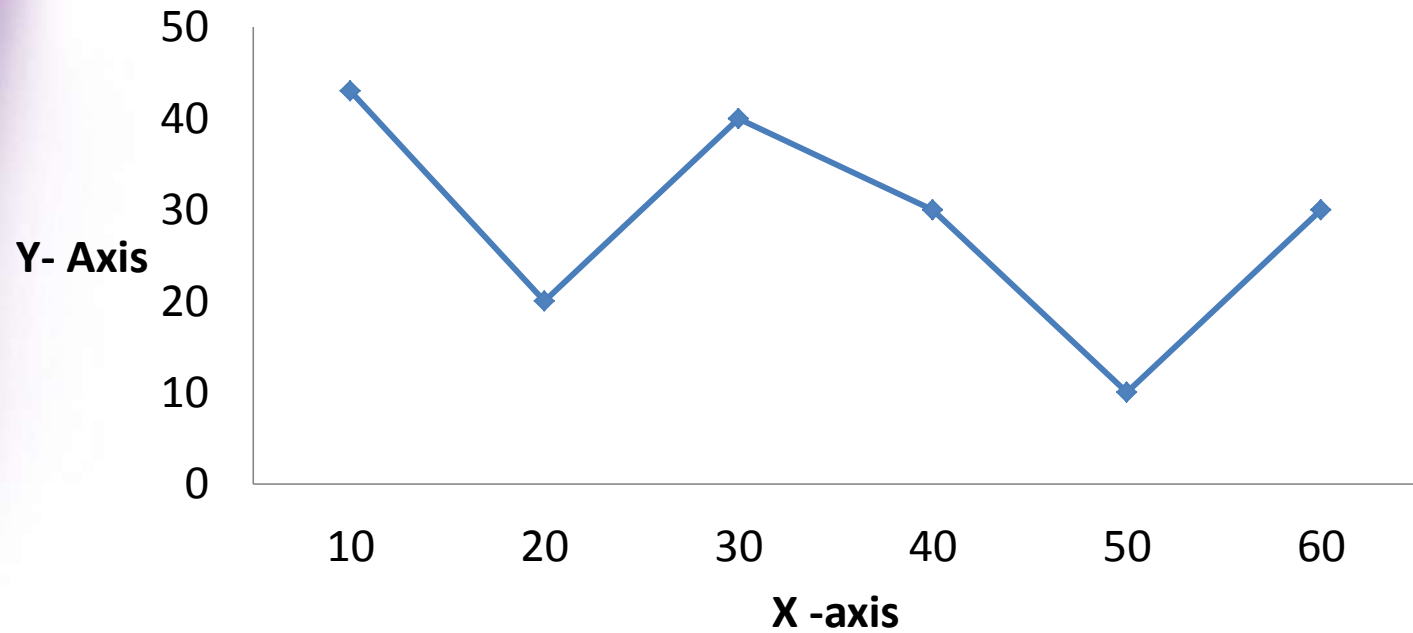
- Path finding allows AI agents to navigate worlds
- Search dynamic or predefined maps for routes
- Use edge costs to identify terrain features
- Add meta-data to nodes to define features



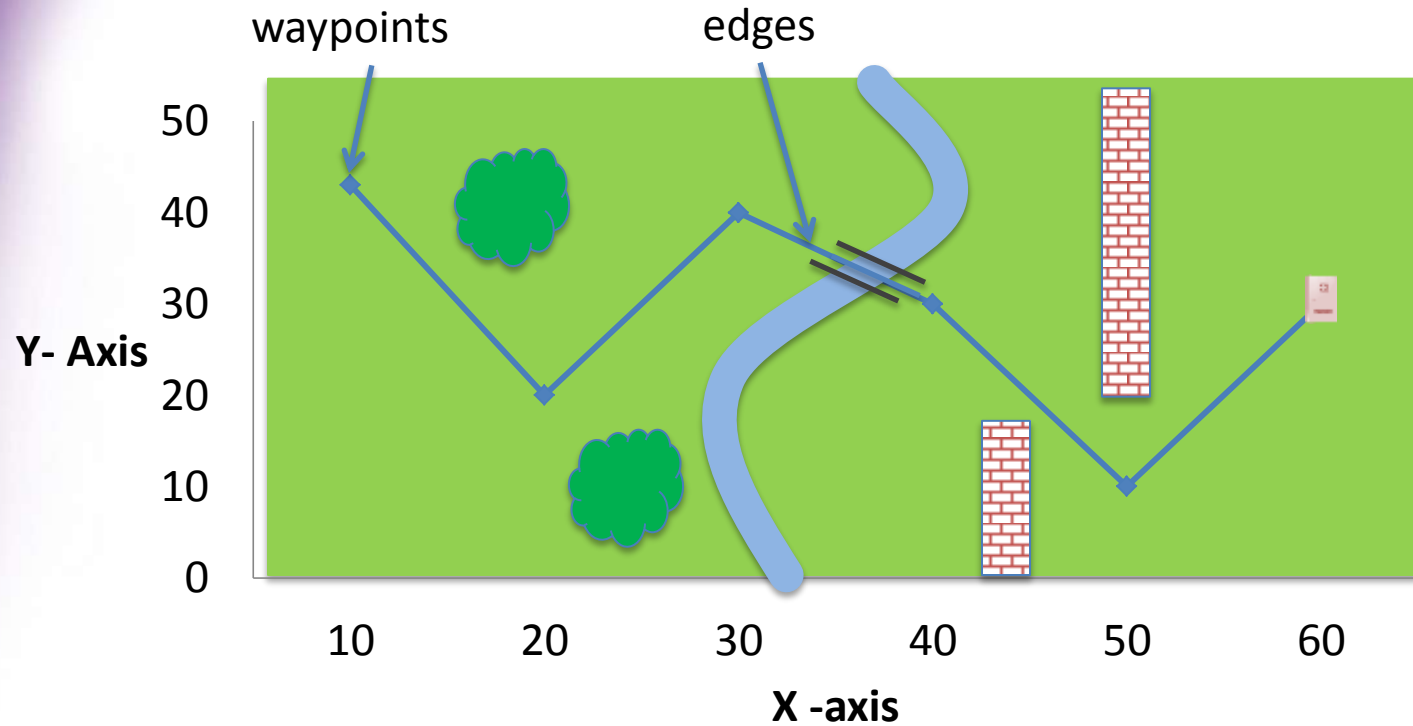
Graph theory



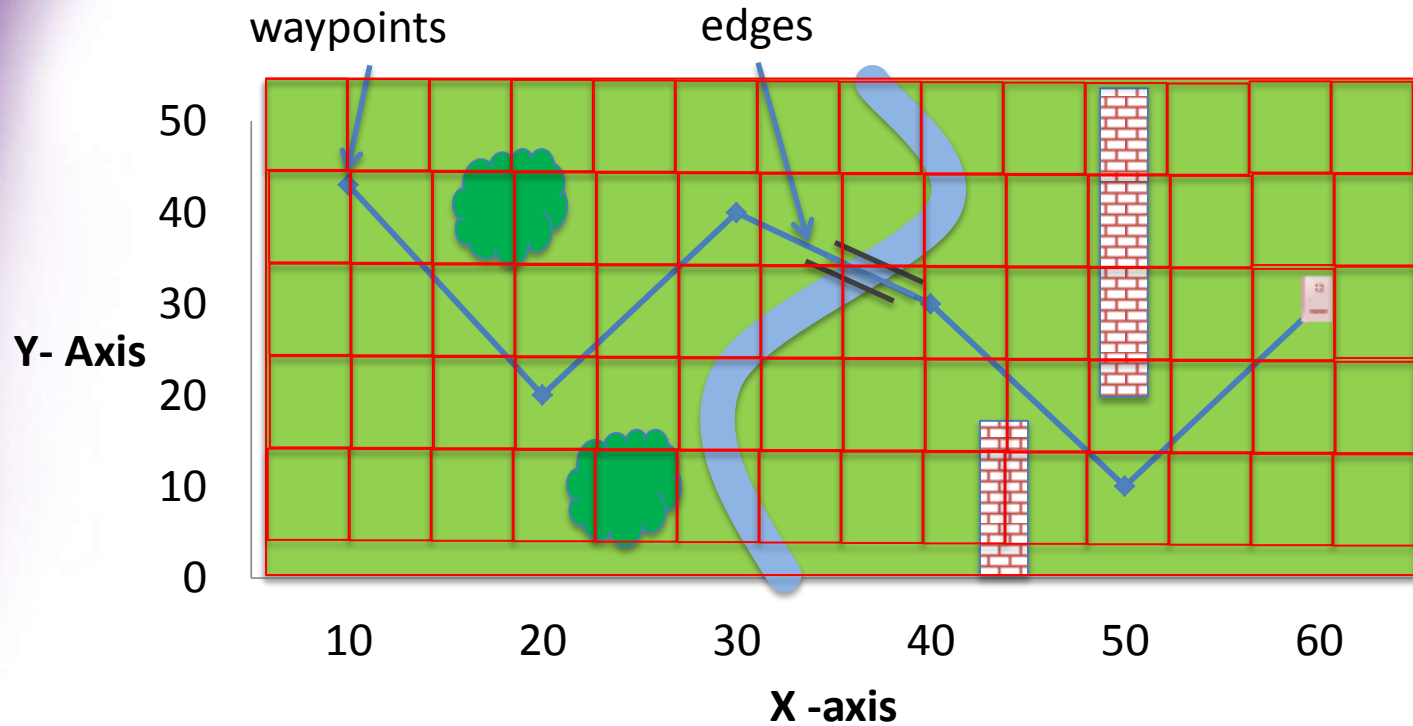
Graph theory



Graph theory



Graph theory



Graph implementations

- Graph types
 - Navigation graph
 - Dependency graph
 - State graph
- Data structures
 - Adjacency matrix
 - Adjacency list

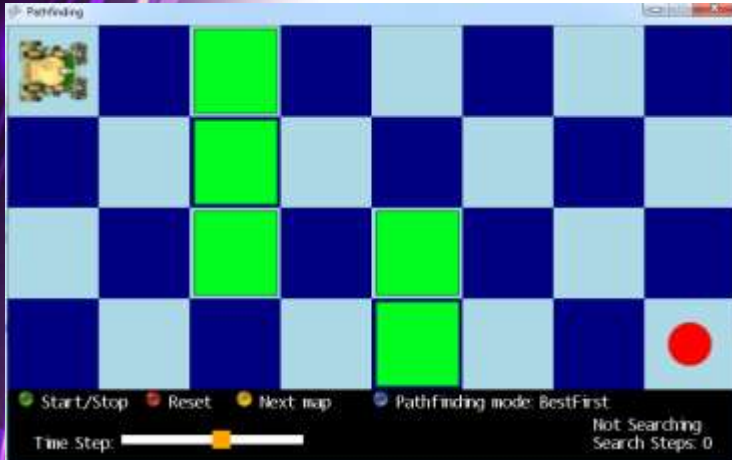


Algorithms

- Best-first search
- Depth-first search
- Depth-limited search
- Dijkstra's search algorithm
- A* search algorithm



Pathfinding sample



- OpenList
- ClosedList
- Paths
- Map

1. Current node taken from OpenList[0]
2. Each node connected horizontally or vertically to current node and not a barrier is evaluated against search criteria
3. Successfully evaluated node:
 1. Is added to OpenList where not on either list already
 2. Current node is added to Paths
 3. Current node is removed from OpenList
 4. Current node is added to ClosedList
4. On reaching target end node, paths contains all linked nodes
5. Paths is examined working backwards from end node to find the final path



Demonstration XNAAI_3

<http://youtube.com/WP7XNA>

Pathfinding

Sample available from App Hub

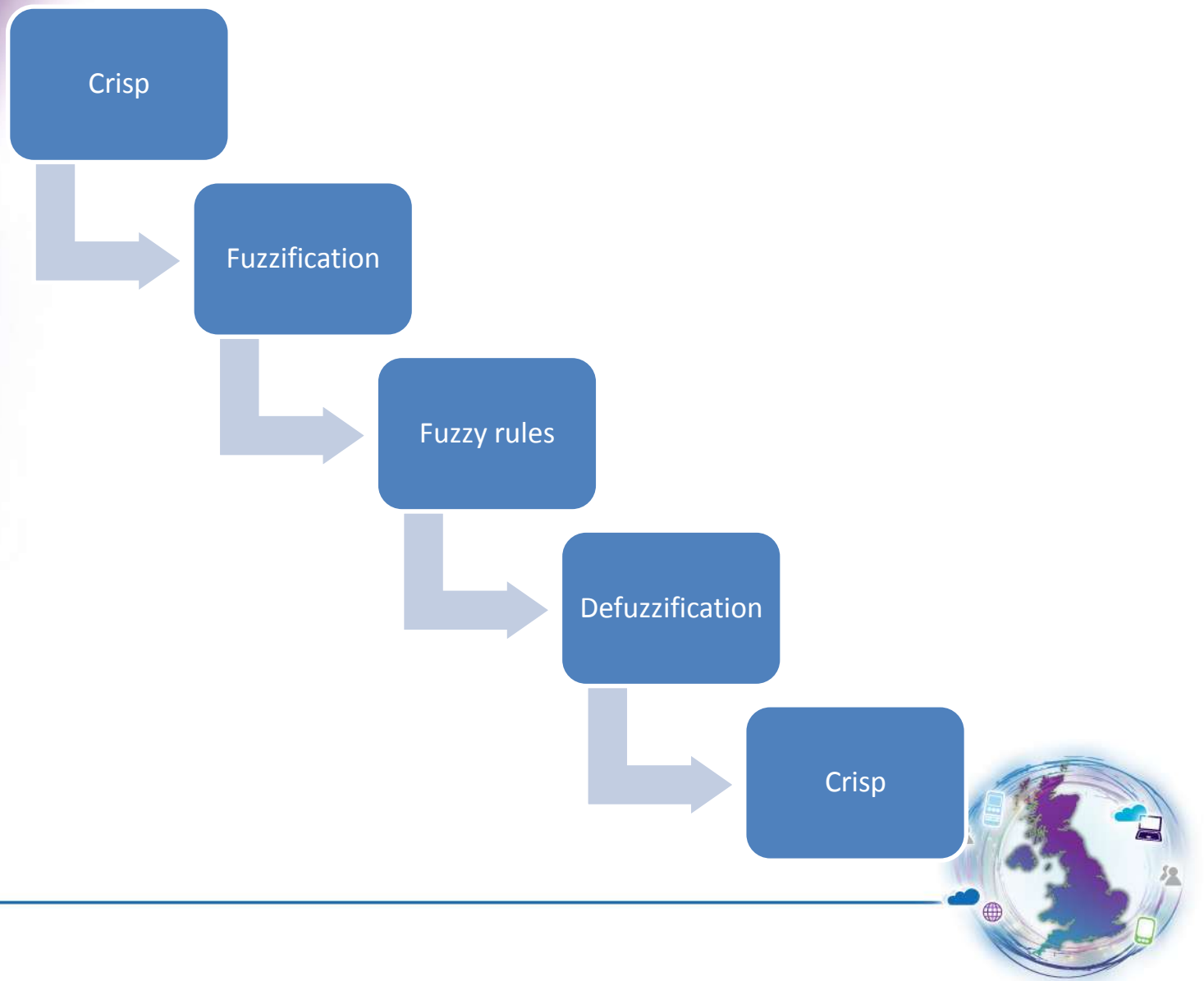


Fuzzy Logic

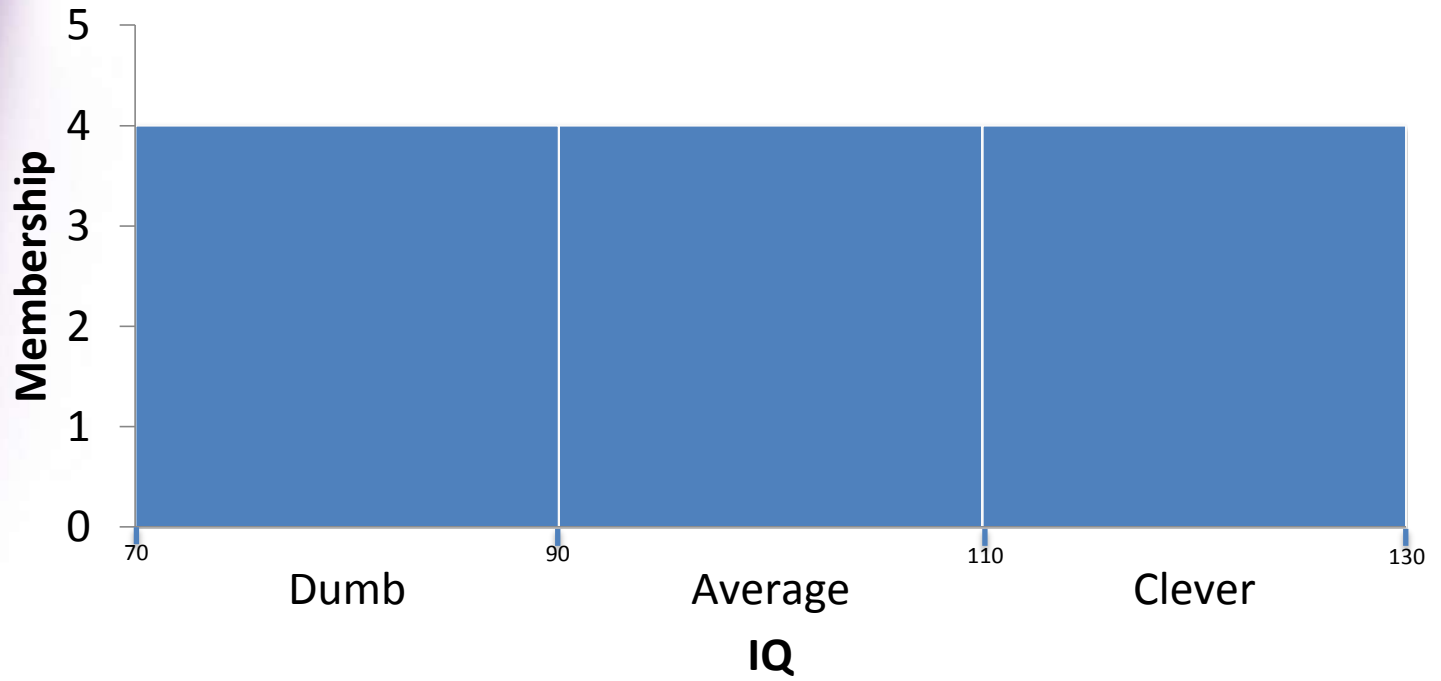
- Humans use vague linguistic terms
- AI needs to understand same vague terms



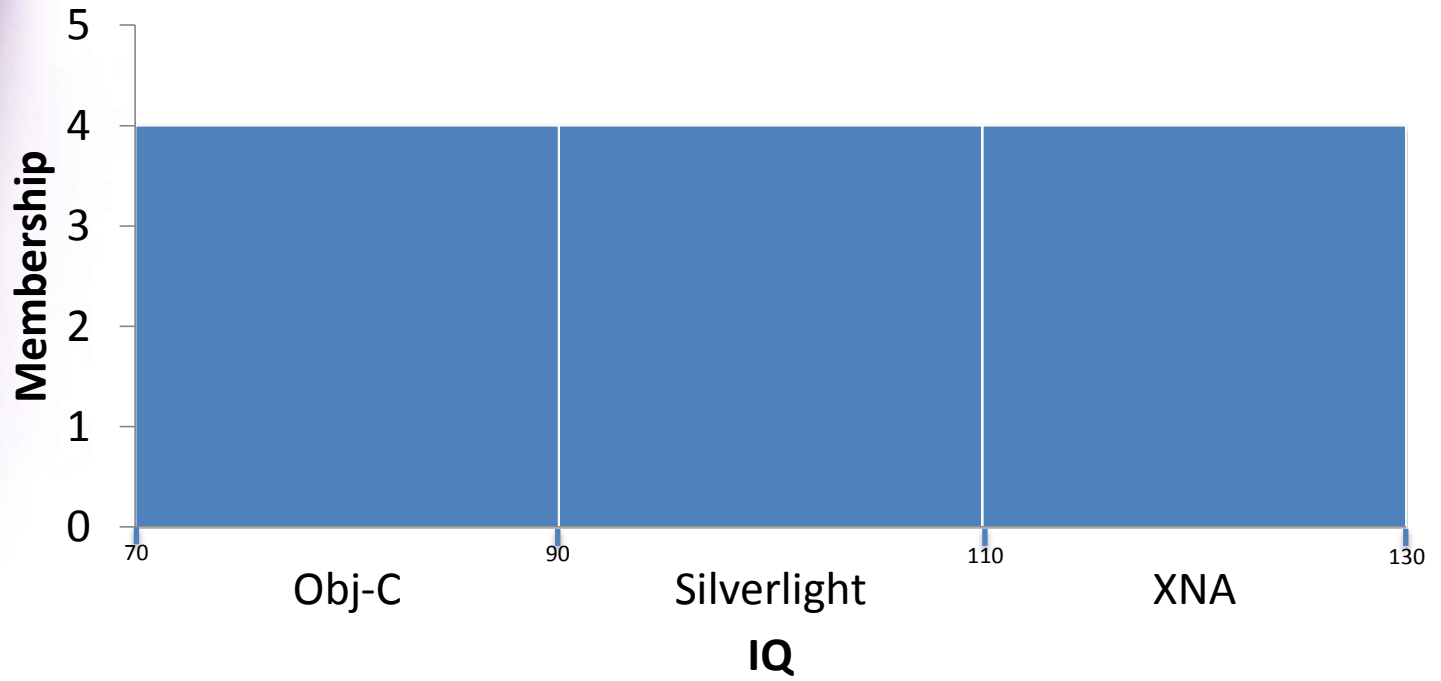
Fuzzification



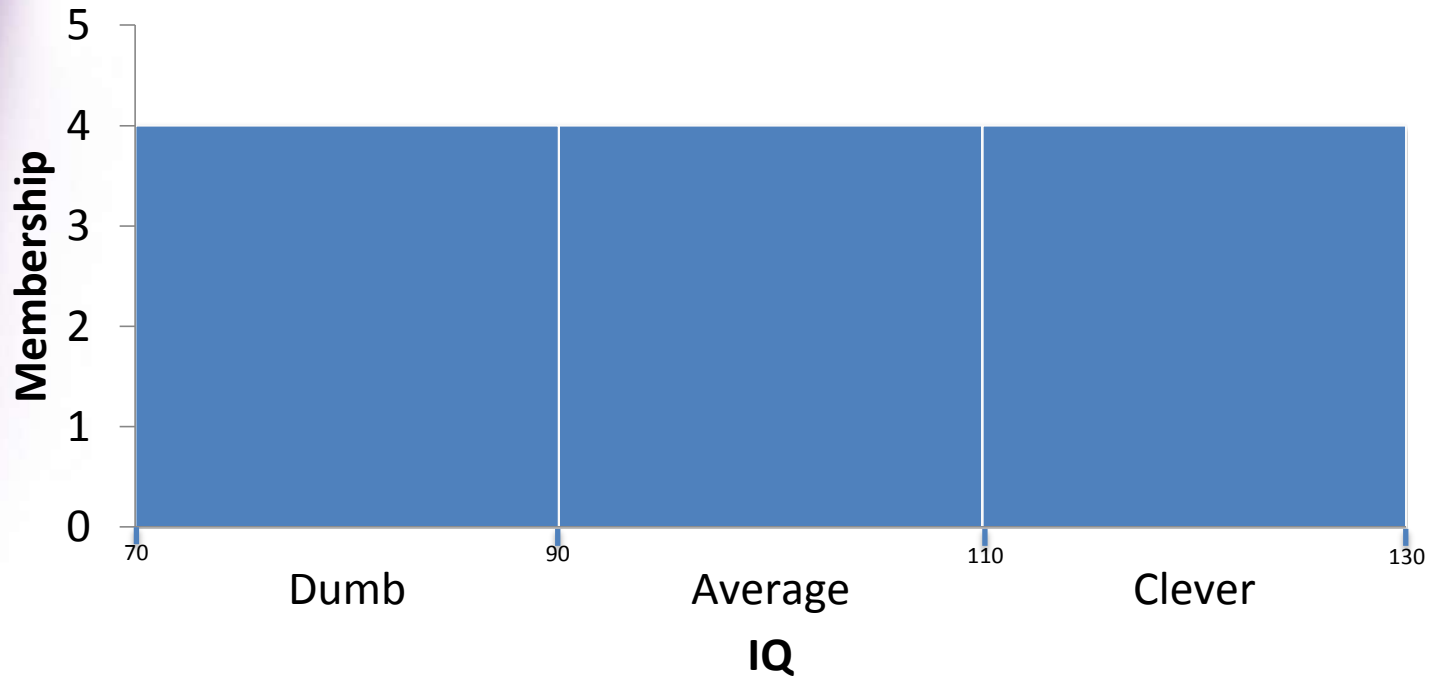
Crisp sets



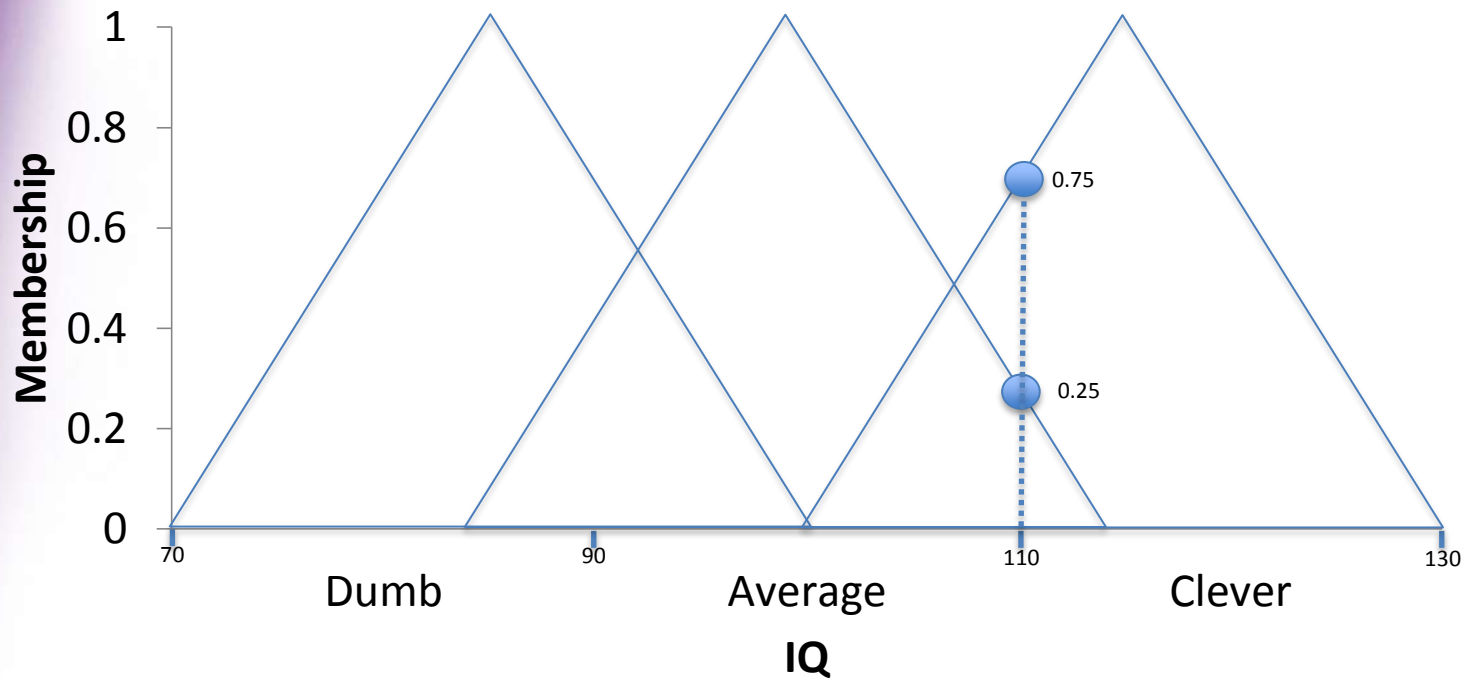
Crisp sets



Crisp sets



Fuzzy sets: degree of membership



$$\text{Clever}_{(\text{dev})} = F_{\text{clever}}(110) = 0.75$$

$$\text{Average}_{(\text{dev})} = F_{\text{average}}(110) = 0.25$$



Fuzzy linguistic variables

- Speed = {Slow, medium, Fast}
- Height = {Midget, Short, Medium, Tall, Giant}
- Allegiance = {Friend, Neutral, Foe}
- Target Heading = {Far Left, Left, Centre, Right, Far Right}



FLV: Target heading

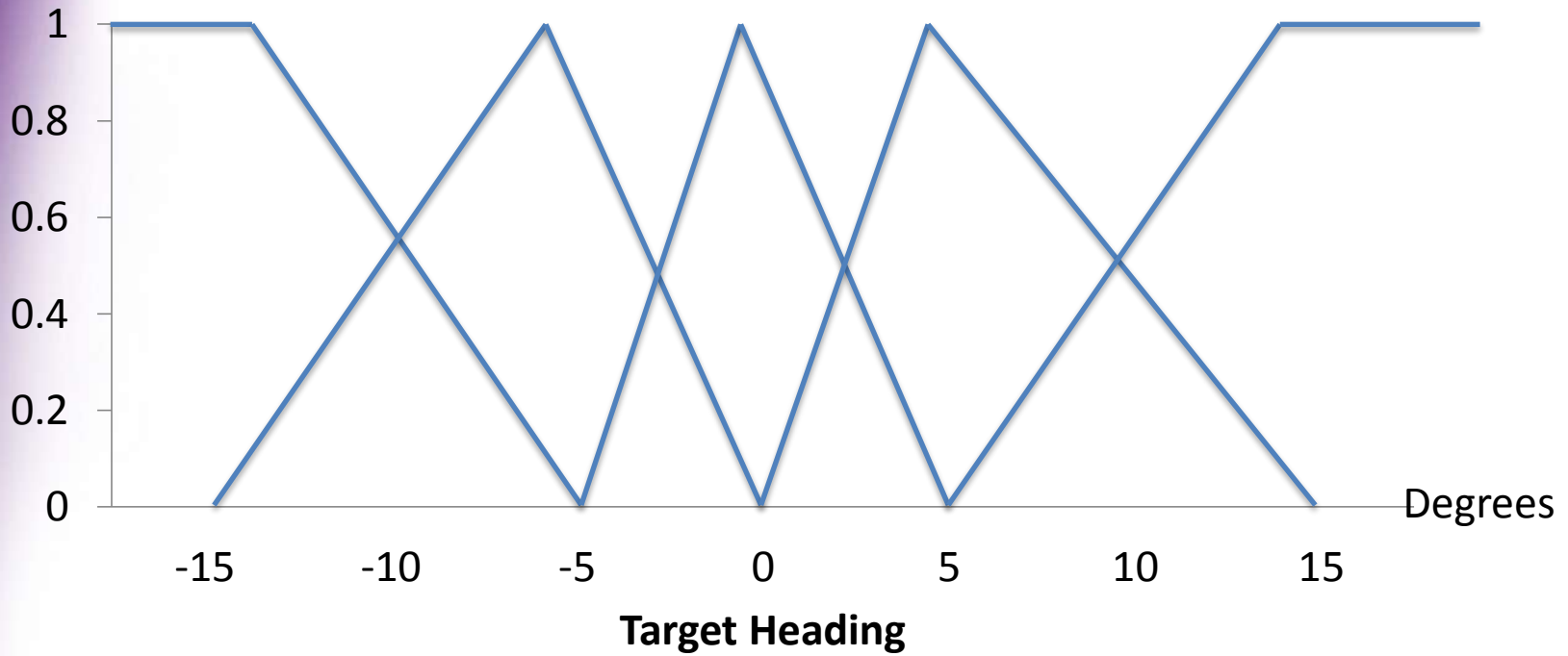


Illustration credit: Mat Buckland

Fuzzy rules

- IF antecedent THEN consequent
- IF Target_isFarRight Then Turn_QuicklyToRight
- IF Target_isFarAway AND Allegiance_isEnemy THEN Shields_OnLowPower

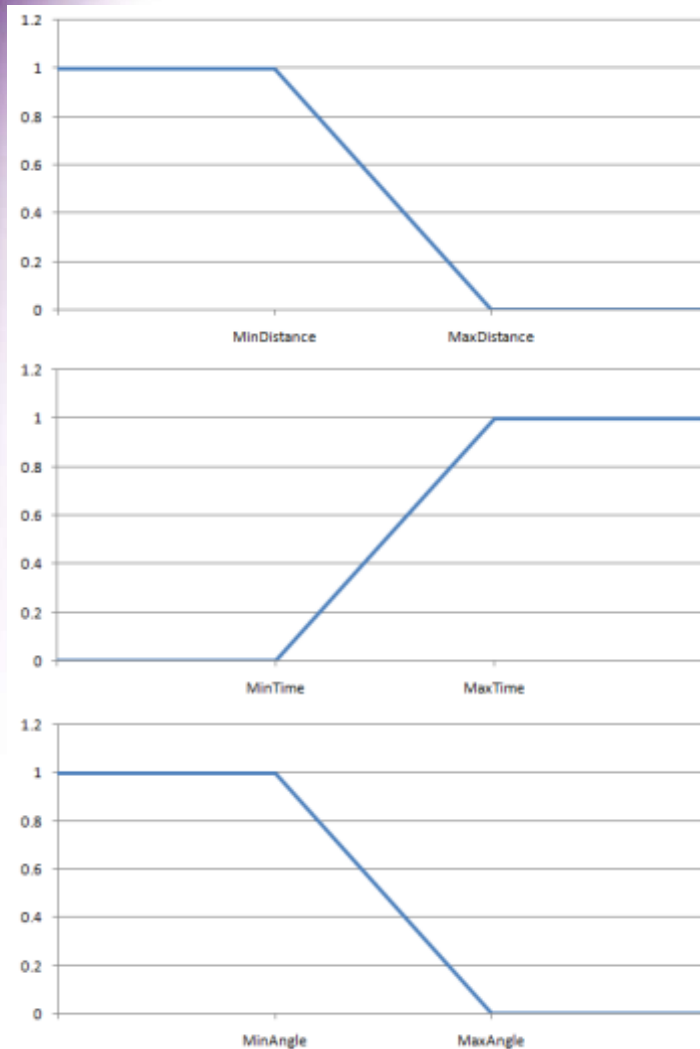


Calculating Mouse Desirability

- Which mouse to chase?
- Fuzzy linguistic terms:
 - Distance to mouse
 - Time chasing mouse
 - Angle from facing mouse



Calculating fuzzy factors



- **Distance**

- $(1 - ((\text{distance} - \text{MinDistance}) / (\text{MaxDistance} - \text{MinDistance})))$

- **Time (clamped)**

- $((\text{time} - \text{MinTime}).\text{TotalSeconds} / (\text{MaxTime} - \text{MinTime}).\text{TotalSeconds});$

- **Angle**

- $(1 - ((\text{angleDifference} - \text{MinAngle}) / (\text{MaxAngle} - \text{MinAngle})));$



Defuzzificaton

- The process of turning a fuzzy set into a crisp value
 - Summation
 - Mean of maximum
 - Centroid
 - Average of maxima
- Mouse with highest score is chased



Demonstration XNAAI_4

<http://youtube.com/WP7XNA>

Fuzzy Logic

Sample available from App Hub



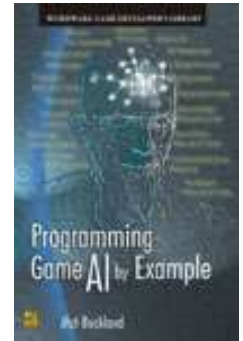
Summary

- XNA is a great platform for game development!
- AI can be built easily
- AI has to be balanced
 - For game play
 - For computing resource usage



Resources

- Programming Game AI by example
 - Mat Buckland, Wordware Publishing Inc. (1 Oct 2004),
 - **ISBN-10:** 1556220782
- App Hub education samples
 - <http://create.msdn.com>
- XNA-UK.net
 - User group, blogs and samples!





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