Under The Gun

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Outline

The Module

Audience

Objectives

Robocode

The Case Study

Conclusions
Module: Audience

- Undergraduates
- Majors: Math, CS, MIS
- Courses: Data Analysis, AI, Game AI, Programming
- Prerequisites: Cartesian coords, angles, notion of algorithms
- Additional prerequisites: as needed for intended use
Module: Objectives

- Introduce students to data mining.
- Engage students in problem solving.
- Demonstrate interdisciplinary connections.
- Motivate students to dig deeper.
- Have fun!
Module: Robocode

Robot tanks that move and shoot.

Controlled by AIs written by programmers.

Compete in a rectangular arenas of varying size.

Each tank starts with 100 energy.

Tanks expend energy to fire.

The more energy used...

- More damage.
- Slower bullet.
- Longer delay before tank can fire again.
Module: Robocode Data

- Size of arena
- Distance and angle to opponent
- Opponent’s heading, speed, and energy
- Own position \((x,y)\), heading, speed, energy, and gun heading
- If own bullet hits or misses.
- Cannot see opponent’s bullets.
Outline

The Module

The Case Study

Objectives

Data selection and gathering

Tool selection

Knowledge discovery

Interpreting results

Integrate results

Conclusions
Case Study: Objective

Scenario
- Sprinkler: stationary bot that spins gun, firing randomly.
- SittingDuck: stationary bot.
- Bots’ starting locations are random.

Goal
- Improve Sprinkler bot’s firing decision.
Case Study: Data

Objective - we want sprinkler to learn when it should fire.

Attributes of Instances

- Gun angle.
- Distance to target.
- Energy put into shot (energy determines speed).
Sprinkler collects this data and dumps it to console.

Instances have the following form:
Angle, Distance, Energy, Hit \{true, false\}
Case Study: Data

Distance-calculated as the Euclidean distance between the source and target at the time of a scan.

Shot Energy- for the sample robot, this is a random number in $[0.1, 3.0]$ as recorded at the time of scan.

Gun Angle relative to bearing- the scan provides the heading of a robot, the gun heading relative to the heading and the relative bearing to the target.
Case Study: Data

Gun Angle relative to bearing - the scan provides the heading of a robot, the gun heading relative to the heading and the relative bearing to the target.

Aim angle = Bearing – Gun heading
Outline

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Case Study: Data Mining Tools

- Build the model
- Test and validate it
- Compare candidate models

Weka was used with a training set containing approximately 700 instances collected from a set of Robocode games.
Case Study: Knowledge Discovery

Most significant factor affecting a shot? Angle of aim?

Observation of the attributes seems to support this.

All successful hits were in a single range.
Case Study: Knowledge Discovery

Classification algorithms used

- ZeroR (baseline)
- J48 (decision tree)
- PART (decision table)
Case Study: Knowledge Discovery

PART Decision List

if aim angle > 0.100273 : false
if aim angle <= -0.20129 : false
if distance to target ≤ 336.666575 : true
otherwise : false

This was the simplest rule set to implement
Case Study: Interpretation of Results

- Cross-validation used during classification to facilitate comparison of models
- Low TP rate in training set (16/712)
- All models had a high success rate (≥ 99.7%)
- All models except ZeroR had both high precision and recall
## Case Study: Interpretation of Results

Confusion matrix for ZeroR

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<thead>
<tr>
<th></th>
<th>true</th>
<th>false</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>0</td>
<td>695</td>
<td></td>
</tr>
</tbody>
</table>
Case Study: Integrate Results

- Changed robot’s firing decision by implementing the model learned
- Results – more successful hits, but not as much as expected
- In particular, long distances require leading the target, which the model did not include

**Note:** More data resulted in a significantly more complicated rule set, with no corresponding improvement (overfitting)
Outline

- Module
- Case Study
- Conclusions
  - Module improvements
  - Further exploration
  - Classroom use
Module Extensions

- Conjectures
- Discussion questions
- Project suggestions
- Provide larger data set with more attributes for further explorations
Further exploration

- Train Sprinkler against other robots
- Train other robots
- Data sets with more attributes
- What other elements can we tune using DA
  - Energy management
  - Effects of corners and walls
Classroom use

- Machine Learning
- Mathematics
- Computer Science
- Inter-disciplinary