A Fractal-based Decision Engine for Teaching & Learning

David Kokorowski, PhD
VP Product Management
Pearson

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The world’s leading learning company
Measurable impact on improving lives through learning
The Two Sigma Problem

Find an expression for $v_0$, the initial speed of the fired object.

$$v_0 = \sqrt{\frac{(m + M)}{m} \cdot 2gL (1 - \cos(\theta))}$$

**Feedback**

You set the initial energy of the object equal to the final energy of the object and pendulum. The object collides inelastically with the pendulum, causing energy to be lost in the process. Therefore these energies are not equal.
Socratic Hints

Hint 1. How to approach the problem

Hint 2. Determine which physical laws and principles apply

Which of the following physical laws or principles can best be used to analyze the collision between the object and the pendulum bob? Which can best be used to analyze the resulting swing?

- Newton's first law
- Newton's second law
- Newton's third law
- Conservation of mechanical energy
- Conservation of momentum

Feedback

Mechanical energy is conserved in elastic collisions, but there is another conservation law that applies to any collision.

Hint 3. Describe the collision

Hint 4. Describe the swing
Auto-scored AnswerTypes
Diagnostic Analytics
A Simple Model of Student Behavior

✗ - Incorrect answer is a step to the left

✓ - Correct answer is a step to the right

Net Score = # steps to the right – # steps to the left
Distinguishing Response Patterns

A student showing random walk behavior

Fractal Dimension = 1.94

A student not showing random walk behavior

Fractal Dimension = 1.60
Distinguishing Response Patterns

Fractal Dimension

1. Less irregularity in the response pattern 
   i.e., Persistent behavior 
   (an increase in net score at one instance is more likely to be followed by an increase at a future instance)

2. High irregularity in the response pattern 
   i.e., Anti-Persistent behavior 
   (an increase in net score at one instance is more likely to be followed by a decrease at a future instance)
A student with fractal dimension 1.32
A student with fractal dimension 1.81
A student with fractal dimension 1.60
A Tale of Two Students

Both students have the same net score
The Struggling Student can be Identified

Short runs of smoothness followed by short runs of irregularity.

Long runs of smoothness followed by long runs of irregularity, then a tipping point (onset).

Responses Submitted

start of course

mid-course

onset

alert
Towards Predictive Analytics
Spring 2013 Pilot — 1300 students

<table>
<thead>
<tr>
<th></th>
<th>Low Alerts</th>
<th>Medium Alerts</th>
<th>High Alerts</th>
</tr>
</thead>
<tbody>
<tr>
<td>A’s and B’s</td>
<td>88%</td>
<td>77%</td>
<td>73%</td>
</tr>
<tr>
<td>B’s &amp; C’s</td>
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<td>77%</td>
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<tr>
<td>C’s &amp; D’s</td>
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<td>73%</td>
<td>~40%</td>
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<td>D+ or lower</td>
<td>&lt;2%</td>
<td>&lt;10%</td>
<td>~40%</td>
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<td></td>
<td>&lt;10%</td>
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</tbody>
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Alerts identify previously invisible at-risk students

Despite high homework scores (86-95%), students that were identified as high alert, most often got a final course grade of C.

Algorithm identifies what was a previously invisible population of at-risk students.
73% of instructors agreed alerts were **accurate**

Instructors **intervened** with students whose grades were average, but who had high alert levels — expanding office hours & reviews; adding Adaptive Follow-up assignments

Students reported being **motivated** by the EA notification to attend office hours and reviews
A Fractal Based Decision Engine for Intervention


Inventors:
Dr. William Galen
Dr. Rasil Warnakulasooriya
Towards a Two Sigma Solution

ALWAYS LEARNING
***NEED THIS SLIDE, OR SKIP????***
Next Steps

[Or just skip to the next slide...]
Building the next generation of systems, products, and services

***NEED THIS SLIDE, OR SKIP??***