Developing intelligent tutoring support for forecasting

The Forecasting Intelligent Tutoring System
Modern education: challenges

• Facilitating large classrooms
• Designing assessment and marking
• Providing individually tailored feedback
• Encouraging participation
• Developing resources: nature, type and quantity

“I have too much homework to mark. It becomes almost impossible to give effective feedback for everyone.”
Anonymous
Current landscape of business forecast education

• Expensive specialist forecasting training courses\textsuperscript{1,2}
• Self taught using text books and/or a combination of ad hoc web-based content and online tutorials
• Short online courses
• A handful of universities provide a module on business forecasting at the Undergraduate and Masters level
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• \textit{Forecasting and decision support systems}

\textsuperscript{1} CPDF In Demand Forecasting [Online] Available at: http://cpdftraining.org/ (Accessed March 19, 2015)
\textsuperscript{3} Lancaster University Management School [Online] Available at http://goo.gl/osS7gA (Accessed March 31, 2015)
Research objectives

1. Develop individualised tutoring support for the business forecasting curriculum
2. Understand how individuals/forecasters *learn* 'key' forecasting task
Developing ‘intelligent’ tutoring support

Immediate and customized training individually tailored to the user
Intelligent tutoring systems

- Educational software systems that use artificial intelligence techniques to adapt the instruction to the individual student.
- Immediate and customized training individually tailored to the user
- Underpinning theories include:
  - Ohlsson's theory of learning from performance errors (Ohlsson, 1996)
- Learning from negative and positive feedback (Mitrovic, Ohlsson, & Barrow, 2013).
The Domain: time series decomposition

• A first step in creating forecasts and a prerequisite in all time series analysis.

• Allows an understanding of the underlying components present in the time series.

Classical time series decomposition:

• The additive model: assumes that seasonal variation is relatively constant over time is as follows: \( y_t = S_t + T_t + E_t \)

• The multiplicative model: assumes that seasonal variation increases over time is given as follows: \( y_t = S_t \times T_t \times E_t \)
Conceptual design informed by:

- Research Literature
  - Forecasting
  - Education and learning
  - Human computer interaction
  - Psychology
  - ...

- Experts
  - Forecasting
  - Pedagogical design
  - Intelligent Tutoring Systems
  - Protocol analysis
  - ...

- Think-aloud Protocols
  - The ‘student voice’
Conceptual design: literature

• Feedback
  • Keep records of forecasts and use them appropriately to obtain feedback. Reduce forecasters reliance on memory of previous performance
  • ‘outcome feedback’ e.g. related to the accuracy (Harvey 2001)
  • Immediate (Bolger and Wright 1994; Fischer and Harvey 1999)

• Presentation of data
  • Present data in graphical form
  • Forecasts of trended series presented graphically are much less biased than forecasts presented in tabular form (Harvey and Bolger 1996).

• Data availability
  • Increases event recall
  • A positive correlation between availability and speed and confidence in task execution (Goldstein and Gigerenzer 1999)
1. **Interface** – controls interaction between student and tutor e.g. select/change domains/problems, submit solution for evaluation etc.

2. **Student model** – maintains a long-term model of the student’s knowledge

3. **Pedagogical module** - decides how to respond to each student request.

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**FITS Architecture**

- **Interface**
- **Session Manager**
- **Pedagogical Module**
  - **Diagnostic Module**
  - **Domain Manager**
- **Log Manager**
- **User Manager**
- **Domain models Logs, Users**

The FITS Architecture
Knowledge representation

• “If <relevance condition> is true, then <satisfaction condition> had better also be true, otherwise something has gone wrong.

• Example of a syntax constraint:

```
(and (equalp (page-number *ss*) 1)
  (not (null (Trend *is*)))
  (not (null (Trend *ss*)))
  (component-available-p (Trend *ss*))
  (match '(?*d1 <i> ?id "Trend" ?p0 </i> ?*d2) (Trend *ss*) *bindings*))
  (not (equalp "" ?p0))
```

Feedback Message: “You have forgotten to specify a value for the trend”
Problem 1: Airline Passenger

The following is a time series of monthly observations of airline passenger arrivals. Using the classical time series decomposition method, provide the multiplicative decomposition of the time series into its individual components.

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<th>AG</th>
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</tbody>
</table>
Pilot Study Evaluation

The "two-sigma problem" - students who receive one-on-one instruction perform two standard deviations better than students who receive traditional classroom instruction (Bloom 1984).
Pilot Study: Design

• Participants:
  • Masters level students enrolled on business forecasting module at Lancaster University (approx. 70).
  • Management Science, Accounting and Finance, Commuting and Communications
  • Knowledge of decomposition: students had previously received a lecture and workshop on time series decomposition

• Experiment Setup:
  • Week 1: Students do pre-test
  • Week 2-3: Students are able to use the system
  • Week 4: Students do post-test
# Pilot Study: Results

**Pre-test:**
- 17 students
- Avg. score of 4.41 out of 15
- Min score 0
- Max score 15

**Post-test**
- 9 students
- Avg. score 7.11 out of 15
- Min score 0
- Max score 15

<table>
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<tr>
<th>Participant</th>
<th>Constraints Used</th>
<th>Solved Problems</th>
<th>Messages</th>
<th>Time (Mins)</th>
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<th>Post-test</th>
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The team

• Developers
  • Prof. Tanja Mitrovic – University of Canterbury (middle)
  • Mr. Jay Holland – University of Canterbury (left)
  • Dr. Devon Barrow [Principle Investigator] – Coventry University (right)

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• Comments
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Questions?

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References


