Dropout Prediction in MOOCs using Learner Activity Features

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Motivation

Student activity data → Dropout Model → Student behavior → Course design

Structure

Outputs → Persistence
Motivation

Student activity data

Dropout Model

Outputs

Diagnosis + Intervention

Success criteria

Red-flag

Red-flag

Red-flag
Figures of Merit

Recall = \frac{Succ. Pred. Dropouts}{Total Dropouts}

Specificity = \frac{Succ. Pred. Healthy}{Total Healthy}

Intervention Window
Prediction Goal

A student has dropped out if:

Videos viewed $< 50\%$  \hspace{1cm} OR \hspace{1cm} Total absence $> 4$ weeks
Design Principle and Objective

Design Principle

Persistence Factors

- Relevance
- Self-regulation
- Satisfaction
- Ability and confidence
- External commitments

Persistence

Student behavior

Design Objective

Prediction Model

Course-independent model

Course 1  Course 2  Course 3  Course 4  Course 5  ...
Candidate Features

Active mode features

**Pace:** Started week $x$ material after week $y$? (for various $x,y$)

**Quiz performance:** Avg quiz score $< x$? (for various $x$)

**Video persistence:** Skipped $> p\%$ of videos? (for various $p$)

**Quiz persistence:** Reattempted more than $p\%$ of quizzes with first score $< 50\%$? (for various $p$)

**Forum activity:** Median posts per week $> n$? (for various $n$)

Absent mode features

Total absence length: $> n$ days? (for various $n$)
The Resulting Model

Active mode features
- Avg score (2 or more assns) < 50%?
- Lagging by > 2 weeks during 1st month?
- Skipped any videos?
- Skipped any assessments?

Absent mode feature
- Total absence > 14 days?
Evaluation

For each test course:

**Active mode only**

- !
- !
- !
- !

**Integrated predictor**

- !
- !
- !
- !

S, R for active mode predictor
S, R for integrated predictor
Intervention window length distribution
Results: Accuracy

**Active mode only**

- Spec: 0.72
- Recall: 0.48

**Active + absent modes**

- Spec: 0.58
- Recall: 0.93
### Results: Intervention Window

<table>
<thead>
<tr>
<th>Median % of dropouts flagged with in active mode</th>
<th>Intervention window</th>
</tr>
</thead>
<tbody>
<tr>
<td>70%</td>
<td>&gt;= 2 weeks</td>
</tr>
<tr>
<td>18%</td>
<td>1 – 2 weeks</td>
</tr>
<tr>
<td>15%</td>
<td>&lt; 6 hrs</td>
</tr>
</tbody>
</table>
Conclusions

- Identifying students in need for intervention
- > 50% intervention windows are > 2 weeks
- Dropout correlations with course features
- MOOCs vs Classroom-based via the dropout model
Thank you
Backup Slides
Figures of Merit

Failure Cases

Accuracy

<table>
<thead>
<tr>
<th></th>
<th>Red-flagged</th>
<th>Will drop out?</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>FP</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>TN</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>FN</td>
<td>N</td>
<td>Y</td>
</tr>
</tbody>
</table>

Recall = \[ \frac{TP}{TP + FN} \]

Specificity = \[ \frac{TN}{TN + FP} \]

Intervention Window
Feature Abstraction and Data Set Composition

Non-abstract features

- First assignment score > 20?
- Started topic 2 by week 3?

Abstract features

- First assignment score > 50%?
- Start week 2 material by week 3?

Data point

| F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | ... | FN | Dropout Truth |

Data Set

- Course 1
- Course 2
- Course 3
- Course 4
- Course 5

Training set

Test set
Feature Scoring and Selection

**Feature Scoring**

*Feature i*  Predictions

**Specificity** ($S(i)$)

$$fpr(i) = 1 - S(i)$$

**Recall** ($R(i)$) = $tpr(i)$

Eliminate if $S(i) < 0.75$

**Greedy Forward Feature Selection**

1. tpr/fpr for SFS = \{F1\}
   tpr/fpr for SFS = \{F2\}
   tpr/fpr for SFS = \{F3\}
   tpr/fpr for SFS = \{F4\}

   **Best score**

   SFS = \{F3\}

2. tpr/fpr for SFS = \{F3 + F1\}
   tpr/fpr for SFS = \{F3 + F2\}
   tpr/fpr for SFS = \{F3 + F4\}

   **Best score**

   SFS = \{F3 + F1\}
### Results: Accuracy

<table>
<thead>
<tr>
<th>Individual feature predictors</th>
<th>M1 predictor</th>
<th>M2 predictor</th>
<th>Integrated predictor</th>
</tr>
</thead>
<tbody>
<tr>
<td>asgn-performance</td>
<td>1.0</td>
<td>0.85</td>
<td>0.68</td>
</tr>
<tr>
<td>video-skip</td>
<td>0.86</td>
<td>0.93</td>
<td>0.58</td>
</tr>
<tr>
<td>asgn-skip</td>
<td>0.96</td>
<td>0.72</td>
<td>0.58</td>
</tr>
<tr>
<td>lag</td>
<td>0.96</td>
<td>0.80</td>
<td>0.29</td>
</tr>
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#### Specificity

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<tr>
<td>video-skip</td>
<td>0.86</td>
<td>0.82</td>
<td>0.40</td>
</tr>
<tr>
<td>asgn-skip</td>
<td>0.96</td>
<td>0.92</td>
<td>0.73</td>
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<tr>
<td>lag</td>
<td>0.96</td>
<td>0.84</td>
<td>0.47</td>
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#### Recall

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<tr>
<td>asgn-performance</td>
<td>0.008</td>
<td>0.006</td>
<td>0.00</td>
</tr>
<tr>
<td>video-skip</td>
<td>0.58</td>
<td>0.30</td>
<td>0.23</td>
</tr>
<tr>
<td>asgn-skip</td>
<td>0.38</td>
<td>0.25</td>
<td>0.10</td>
</tr>
<tr>
<td>lag</td>
<td>0.43</td>
<td>0.17</td>
<td>0.14</td>
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<td>0.77</td>
<td>0.91</td>
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Results: Recall

Min, Median, and Max Recall

Model component

Min | Median | Max
---|-------|---
assn-performance | 0.006 | 0.008
video-slip | 0.23 | 0.38
assn-slip | 0.1 | 0.38
log | 0.14 | 0.43
active-mode | 0.4 | 0.48
absent-mode | 0.67 | 0.99
integrated | 0.92 | 0.99
Results: Specificity

Min, Median, and Max Specificity

Model component:
- vssn-performance
- video-skip
- assn-skip
- lag
- active-modes
- absent-modes
- integrated

Specificity values:
- Min
- Median
- Max

Values shown in the graph (e.g., 0.96, 1.0, 1.0 for vssn-performance).
Results: Intervention Window