A System-General Model for the Detection of Gaming the System Behavior in CTAT and LearnSphere

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Abstract. In this paper, we present the CTAT (Cognitive Tutor Authoring Tools) implementation of a system-general model for the detection of students who "game the system", a behavior in which students misuse intelligent tutors or other online learning environments in order to complete problems or otherwise advance without learning. We discuss how this publicly available detector can be used for both live detection of gaming behavior while students are using CTAT tutors and for retroactive application of the detector to historical data within LearnSphere. The goal of making this detector publicly available is to foster new research about how to best intervene when students game the system and to increase the large scale adoption of such detectors in the classroom.

Keywords: Gaming the System, System-general models, Cognitive Tutor Authoring Tool, LearnSphere, Student model

1 Introduction

Research in AIED technology has sometimes been criticized for being too siloed [1]. Although high-quality research is produced by a wide variety of research teams, there has been limited effort to bridge the gap between individual projects. For example, even though multiple research teams [2, 3, 4, 5, 6] have contributed to the topic of building models able to detect students who "game the system" [2], a behavior in which students misuse intelligent tutors or other online learning environments in order to complete problems or otherwise advance without learning, such detectors have not been used at scale to drive pedagogical interventions or to inform teachers in the classroom. This is in part due to the difficulty of building detectors that are general enough to work in multiple tutoring contexts, requiring researchers interested in studying pedagogical interventions related to gaming to develop their own detector or validate that an existing detector is appropriate for their system, both of which require considerable resources.

In this paper, we present the Cognitive Tutor Authoring Tool (CTAT) [7] implementation of a system-general model that detects students who game the system. By devel-

oping this general model and making it available within a widely-used tutor development framework, we aim to reduce the amount of effort required to conduct research involving gaming the system behavior and to increase adoption of gaming detectors by intelligent tutor developers, whether for driving automatic interventions or for reporting gaming behavior to teachers through dashboards.

2 The Model

The model we implemented was developed using data collected from Cognitive Tutor Algebra [8] where 10,397 sequences of student actions were classified as either containing or gaming behavior or not. We used a rigorous knowledge engineering process, in which we observed and interviewed the expert who classified each of those sequences, to build a model that replicated her decision process [5]. The resulting model identified 13 patterns of actions that are associated with gaming behavior, such as quick repetitions of the same answer in different text fields and sequences of incorrect answers that are similar to each other. In our CTAT implementation, every sequence of five actions (repeated help requests are counted as only one action) is compared to those 13 patterns. Students are identified as gaming the system if the actions within the sequence match any of the 13 patterns. Otherwise the student is identified as not gaming.

This model was selected due to its good generalization across different tutoring contexts. Although the model was developed for Cognitive Tutor Algebra, it was also validated in two new contexts [9]: the scatterplot lesson of Cognitive Tutor Middle School and ASSISTments [10]. This previous study showed how the model, developed using knowledge engineering approaches, outperformed a second model, developed using a combination of machine learning and knowledge engineering, in those new contexts. The knowledge-engineered model obtained a level of performance in new systems comparable with past detectors successfully used for intervention, making it a good candidate to be implemented in CTAT.

3 Using the Model

The detector is contained in one JavaScript file ("gaming.js") that can be downloaded from CTAT's detector library[1]. Once downloaded, the file can be integrated into a CTAT tutor to automatically detect gaming behaviors during runtime or can be loaded in the widely-used LearnSphere[2] data platform (formerly the PSLC DataShop [11]) to retroactively apply the detector to historical data from a range of learning systems.

In CTAT, the detector can be applied to any tutor created using CTAT's HTML interface. Using the detector simply requires the tutor's author to include a reference to the detector's JavaScript file in "transaction_mailer_users.js" (see CTAT's documen-

[1] The CTAT detector library is accessible from the CTAT detector wiki: https://github.com/d19fe8/CTAT-detector-plugins/wiki/CTAT-Detector-Library

[2] http://learnsphere.org/

tation for detailed instruction). Once the tutor is included in the tutor, it will automatically generate gaming/not gaming diagnosis every five actions (displayed in CTAT's "Variable Viewer" window).

Retroactively applying the detector to historical data using LearnSphere requires the user to create a workflow in the Tigris authoring tool. In this workflow (figure 1), the user can load any tab delimited text file containing data formatted according to the DataShop [11] standard as well as load the "gaming.js" file containing the gaming detector. Those two files are then used as inputs for the "Apply Detector" operator which will apply the detector to the dataset. The output of this workflow is a file containing all of the model's diagnoses. It is important to note that, although it is possible to apply the detector to any dataset stored using the DataShop standard, the detectors have not yet been validated on systems beyond Cognitive Tutors, CTAT Tutors, and ASSISTments.

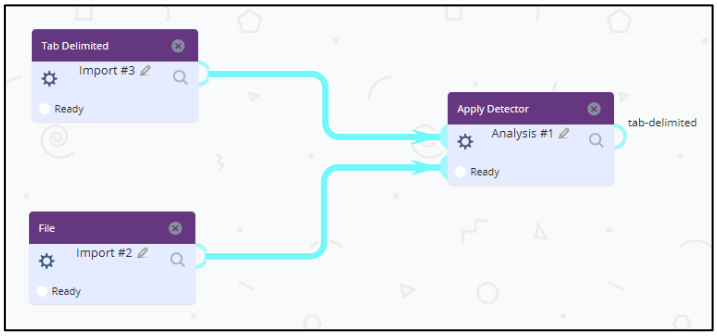

Fig. 1. Tigris workflow used to apply the gaming detector to historical data.

4 Limitations and Future Work

By making our gaming the system detector publicly available and easy to integrate into CTAT tutors, we hope to contribute to scaling up the usage of automated detectors of student behavior in research, for example by studying the impact of different pedagogical strategies, and hope to support the broader deployment of those detectors in classroom interventions.

Making our detector publicly available is only the first step, further work will need to be done to develop tools that can take advantage of the model in concrete ways. For example, we are currently evaluating the feasibility of integrating our detector to a teacher dashboard [12] that could support teachers by producing live reports of gaming behaviors in their classroom. In addition, we encourage researchers interested in the usage of models of student behaviors in adaptive learning to develop, evaluate and share their own tools and pedagogical strategies.

Finally, although our detector has been validated across multiple tutors with promising results, we intend to conduct further work to iteratively improve the detector and evaluate its applicability to additional systems. This will allow the detector to be used in an increasing number of contexts while simultaneously improving our understanding

of gaming the system behaviors. We see the inclusion of this detector in CTAT as an important step towards achieving this goal.

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