USING AGENT-BASED SIMULATION TO ACCURATELY MODEL HUMAN PROCESSES

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ABSTRACT

In human processes, like the Integrated Disability Evaluation System (IDES), the variability in execution of thousands of interpersonal encounters will limit the systemic predictive capability of traditional modeling methods such as regression. To combat this limitation, we developed an agent-based model that replicates every step in the IDES process and simulates the associated human actions. In effect, our model simulates a digital twin of every human involved in the process. Analysis of model outputs shows that performance metrics of individual agents in the simulation are similar to their real-world counterparts, and that aggregate system performance is highly accurate. The success of this simulation model allows for increased confidence in the predictive accuracy of what-if analysis conducted on human processes, where process changes may be modeled to inform policy recommendations.

1   INTRODUCTION – WHEN DATA FAILS TO CAPTURE HUMAN PROCESS DETAILS

The IDES combines the Department of Defense (DoD) and Department of Veterans Affairs (VA) disability systems. Integrating these systems improves the accuracy and consistency of disability determinations and the timeliness of providing both DoD and VA disability benefits to eligible Service members (DoD Warrior Care 2019). Service member data is collected by government representatives throughout the IDES using the Veterans Tracking Application (VTA). VTA includes demographic and system progress information, which are used to assess IDES performance through metrics such as system timeliness and inventory.

Booz Allen Hamilton provides predictive analytic support to the IDES, so that policy directors can be informed of the potential systemic effects that policy changes can cause. Through exploratory data analysis and subject matter expert interviews, Booz Allen Hamilton realized that the variability caused by the human nature of the system was difficult to quantify using traditional statistical methods such as regression. Due to the human variability, we decided that an agent-based simulation would be the best approach to understand and replicate the system.

2   METHODS – INCORPORATING EXPERT ASSUMPTIONS TO BRIDGE THE GAP

Agent-based simulation is a computational modeling technique that simulates the actions and interactions of autonomous entities (agents) to assess their effect on the system as a whole (Moshref-Javadi 2019). This technique is particularly effective in the simulation of human systems, as agent-based models can capture emergent phenomena – a whole that is greater than the sum of its parts – which frequently escapes data collection (Bonabeau 2002). The massive quantity of individual decisions required in the IDES was key in the decision to implement agent-based simulation.

Booz Allen Hamilton utilized AnyLogic, a multi-method modeling software, to build its agent-based model with the goal of replicating the IDES. We began by mapping out the IDES process step-by-step, and

identifying the agents that perform actions at each step. Then, we conducted subject matter expert interviews to determine the timeliness and frequency of potential agent actions, and collected information on the business rules restricting these actions. Finally, we created agent profiles for all service members whom entered the IDES in 2018 (VTA data) and ran a 12-month simulation.

To evaluate our model's performance, we compared predicted system timeliness to VTA data over the same 12-month time period using the following metrics: mean, median, mode, standard deviation, interquartile range (IQR), spread, mild low and high outliers, and the system timeliness distribution. These metrics exhaustively tested the model's ability to predict aggregate system performance.

3   RESULTS AND DISCUSSION

Our model's predictions were similar to key IDES performance metrics, as indicated by a 96% mean timeliness accuracy and a 90% median timeliness accuracy (Table 1). Additionally, our model's aggregate timeliness distribution overlapped historical values by 88% (Figure 1). The high level of predictive accuracy demonstrated by the model allows increased confidence in what-if analyses conducted on human processes like IDES, where process changes may be modeled to inform policy recommendations.

Table 1: IDES model evaluation timeliness metrics and accuracy (12-month simulation).

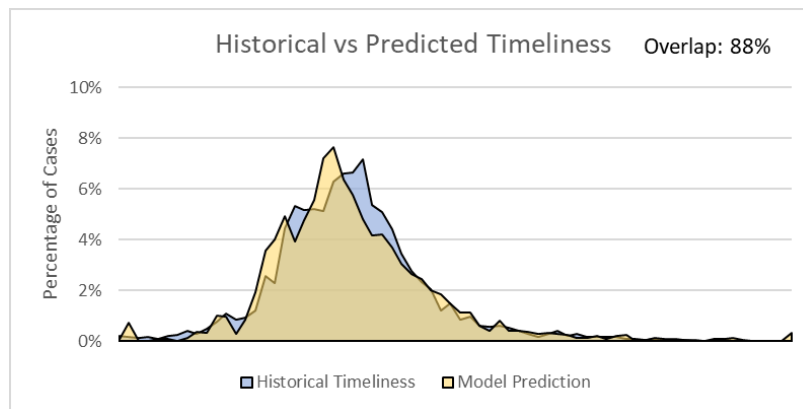| Statistic	Model Accuracy
Mean	96%
Median	90%
Mode	84%
Standard Deviation	94%
Interquartile Range	99%
Spread	99%
Mild Outlier Low	87%
Mild Outlier High	97%

Figure 1: Predicted and historical timeliness distributions (12-month simulation).

REFERENCES

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