Using Players’ Gameplay Action-Decision Profiles to Prescribe Training

Reducing Training Costs with Serious Games Analytics

Christian Sebastian Loh & I-Hung Li

Virtual Environment & Reality Lab (V-Lab)
College of Education & Human Services
Southern Illinois University
Carbondale, IL, USA.
GAMES VS. SERIOUS GAMES

- Serious Games: Non-entertainment games (also, games4change, games4health, games for training, game-based learning.)
- Serious Games are **TOOLS**
- Can be used for many purposes:
  - human performance training (workplace),
  - game-based learning (education)
  - policy change (social)
- Need to maximize values of SG for clients!!
MORE TERMS

- **Acton-Decision Data**: Most player generated *in-game* data are consisted of actions (result of decision-making process), hence: *action-decision* data

- **Profiles**: Binning of action-decision data into groups based on certain ‘identifying features’.

- **Training**: especially that of human performance (AIM: *improve* human *performance* over time).

- **Prescribe**: When to _____, how much to _____, what to _____ (procedure to follow), **OR NOT**

- **Reducing training cost**: A desired outcome for many training organizations (maximizing values of serious games for your customers!)
  - VS. Monetization (*maximizing value of serious games for the developing company*)

- **Serious Games Analytics**: creating insights for *performance* measurement, assessment, and *improvement* (also include information *visualization* and *predictive* analytics)
GAMES VS. SERIOUS GAMES

- S.G. -- tools for human performance training (workplace) and game-based learning (education)
- Serious Games Analytics – predict, measure, assess, and improve performance; as well as reporting/visualization

- **How about diagnostics to ‘prescribe training’**
  - Who should receive training?
  - When to provide training?
  - How much content should be included or withheld?
Motivation: Use Serious Games Analytics to reduce training cost.
- Improve performance (reduce cost) through Serious Game Analytics.

Why?
- 25% of Global Fortune 500 companies use serious games for training.

Information Trails (our system) contains BOTH telemetric data capturing and visualization

Performance Report Tracing assistant (PeTRA): ad hoc (real-time) and post hoc (after action) reporting
Before improving performance, you must first understand performance gap.

According to literature in the field of Instructional Design & Technology, a Performance Gap is caused by the combination of three factors:

- Only the Knowledge Gap is bridgeable through training, but not the Resource and Motivation Gaps.
- Five-level Model of Expertise (Dreyfus & Dreyfus, year)
- Only the first three levels can be achievable through training
- Expert and Master are only attainable through long period of deliberate practice (up to 10 yrs/10 000 hrs)
THE NEEDS OF ORGANIZATIONS FOR EXPERTISE

- Majority of workforce in the lower levels: Novice, Competent, and Proficient.
- Expert/Master ‘role models’ are very valuable but RARE assets \(\rightarrow\) need time to grow
- New hires enter at absolute Novice level to some degrees of Proficient.
- Deliberate practice is severely lacking in organizational (F2F) training \(\rightarrow\) achievable through technology-enhanced training (e.g., serious games, simulation, etc).
WHY PRESCRIBE TRAINING?

- Maximized Players’ Data for Value: Players’ in-game actions and decisions can be measured in lieu of performance in situ serious games and visualized as insights
  - For PREDICTING performance and PRESCRIBING training
- If we can predict players’ performance, we can prescribe training → Identifying who, what, and when to train, or not to train.
- Evidence-based training prescriptions:
  - Under-training puts organizations at high risk (workers’ mistakes → liabilities)
  - Just-right training (common sense approach → but how much is just right?)
  - Over-training (higher cost → Seriously, why?)
WHY PRESCRIBE OVER-TRAINING?

Research shown **Over-training** is necessary to:

- Achieve automaticity (efficiency and quality assurance)
- Maintain *adequate* performance during *high-stress* situations
  - Athletes (Olympics)
  - Pilots (emergency landing)
  - First Responders (disaster training), Surgeons, etc.
- *Training prescription* is a relatively untapped area, more research needed to determine what to prescribe.
INFORMATION TRAILS

Gameplay action-decisions data (Course of Actions)

Performance Tracing Report Assistant (PeTRA)

Loh, Anantachai, Byun, & Lenox (2007)
DATA TELEMETRY

Game Play (capturing COAs)

Information Trails (visualisation)
SIMILARITY MEASURES

Please see our other paper on how this can be done (Loh & Sheng, 2013; 2014).

Competency is characterized by an observable and demonstratable course of actions (COAs) during problem-solving (Dreyfus & Dreyfus, 1980).

Steps:
1. Traced players’ Course of Actions (i.e., gameplay action-decision data) telemetrically
2. Converted COAs into strings for similarity comparison
3. Pairwise comparison: Players (any levels) against the Expert baseline (ideal route)
   - Expert can be anyone you name (depending on your purpose)
Players’ Course of Actions (COA)

Loh & Sheng (2013, 2014)

Convert players’ movement to COAs:

Expert (Ideal route):
ABGMNSY

Player (novice/unknown, extra movements):
ABHCIIHNIOTY
DIFFERENTIATING EXPERT NOVICE BY SIMILARITY

Loh & Sheng (2013, 2014)

- Pairwise string similarities comparison (in our study, Cosine similarity)
- Similarity coefficient (ranges from 0 – 1, or, 0% – 100%)
  - value of 1: is identical to the expert/ideal route.
  - value of 0: furthest distance (or, most dissimilar) from expert route.

- Further Readings: Additional similarities (Dice, Jaccard, etc), see Loh & Sheng (2013, 2014)
- Efficiency comparison of 5 similarities, see Loh, Li, & Sheng, 2016
Please see our other paper (Loh & Sheng, 2014)

Sometimes, multiple experts may be present in a training scenarios.

You cannot “Average” expertise performance → it is no longer expertise.

Instead of 1 (player) to 1 (expert) similarity comparison, players’ routes need to be compared to multiple expert routes simultaneously.

Loh & Sheng (2014) developed a method called Maximum Similarity Indices (MSI) to compensate for this situation to obtain players’ ‘true’ similarity score.
In-house game (Unity3D Maze)

16 participants (student volunteers)

Two critical routes, both are ‘correct’

- RouteA – Longer
- RouteB – Shorter, but with obstacle
  - “Pressure Plate” puzzle (take time to solve, but yield better long-term performance)
LONG VS. SHORT (CRITICAL) ROUTE
METHOD

- In-house game (Unity3D Maze)
- 16 participants (student volunteers)
- Two critical routes, both are ‘correct’
  - RouteA – Longer
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- R to calculate Cosine similarity: “stringdist” package (van der Loo, 2006).
- Maximum Similarity Index (MSI) needed for some profiles.
- Visualization of COAs reveal three patterns of problem-solving strategies
- We name this Gameplay Action-Decision (GAD) profiles.
Players who quit in less than 5 rounds.
GAME ACTION-DECISION PROFILES: EXPLORER
t-test ($\alpha$-level = 0.01), difference between three groups.

Statistically significant difference between Quitters and the two other profiles ($p < 0.0001$ for both cases).

No detectable statistically significant difference between the Explorers and Fulfillers ($p = 0.805$).

Performance/similarity scores:
- Quitters ($M = 0.399$, $SD = 0.068$)
- Fulfillers ($M = 0.794$, $SD = 0.117$)
- Explorers ($M = 0.846$, $SD = 0.108$)
- The highest score (0.959) belonged to a Fulfiller.
CONTRIBUTIONS OF GAD PROFILES

- Gameplay Action-Decision (GAD) profiling is data-driven and evidence-based.
- GAD profiles can be used to visualize how people make decisions in situ virtual training habitats.
- Open ways to decision-making and training research using similarity in game data science for corporate use → Prescribing Corrective, Regular, Over-Training.
- Maximizing player value in gameplay data through deliberate practice:
  - Increase proficiency under normal circumstances.
  - Maintain adequate performance under high-stress situations (e.g., disaster training).
  - Encourage workers to learn new decision-making strategy (Fulfiller ↔ Explorer).
Many potential applications for Gameplay Action-Decision (GAD) profiling, reducing training cost is just one obvious application in training performance improvement.
Behavioral & Decision Analytics Profiling for Performance Improvement

- Military, Healthcare, and Business training industry
- (Serious) game design improvement / monetization
- Behavioral and procedural learning / training (e.g., sports, surgery, rehabilitation, game-based training)
- Prescription of over-training, corrective training
- Cross profile training

Methodologies and Applications

- Identifying users’ action-behaviors and decision-making information
- Modeling temporal behavior and decision-making behavior
- Efficient techniques for online/real-time behavioral processing