USC University of Southern California

Integrating an Engagement Classification Pipeline into a GIFT Cybersecurity Module

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ICT Learning Science – Analytics Research Objectives

Actionable AI & Machine Learning

- **Algorithms:** How to make better predictions with less data or cost?
- **Human Factors:** What metrics help humans train better?
- **Processes & Prototypes:** How to combine these so users benefit?

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Introduction

- **Engagement**: Action involving making a psychological investment in learning with heightened concentration and interest.

- Why should we study engagement patterns?
  - Lack of engagement - lower learning (Baker et al., 2010)
  - Student engagement predicts dropout (Christenson et al., 2012)

- Okay, but is it worth putting in the effort?
  - Engagement can be induced (Lehman, Graesser, et al., 2011)

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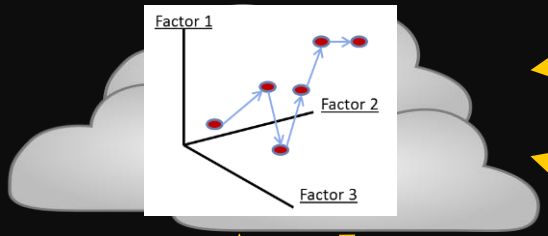
Goal : Constant Optimization of Engagement & Learning

Automating Exploration, Analysis & Improvement

SMART-E

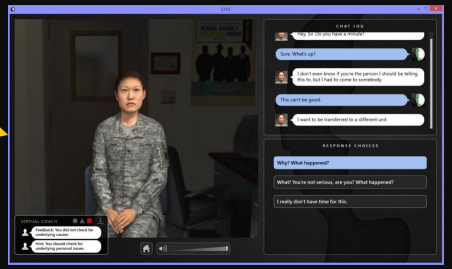


Human Expertise

Stats

Course Designers / Instructors

TALK-ON (ARL)



USMA - ELITE

GIFT (ARL)

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Challenges

- **Cold Start Problem**: Issue that the system cannot draw any inferences for objects about which it has not yet gathered sufficient information.

- **Automated Annotation Problem**: Can a purely algorithmic approach match human intuitions in annotating the level of a user's engagement?

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Prior Work

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ENGAGE: Promoting Engagement in Virtual Learning Environments

- Empirical work on this model using the ELITE-Lite training system (FY15 - FY17)
  - Interactive agents
    - Scenario character
    - Virtual coach
  - Targets basic skills for counselling subordinates with personal and performance problems.

Current Work

Semi-Supervised Learning Approach

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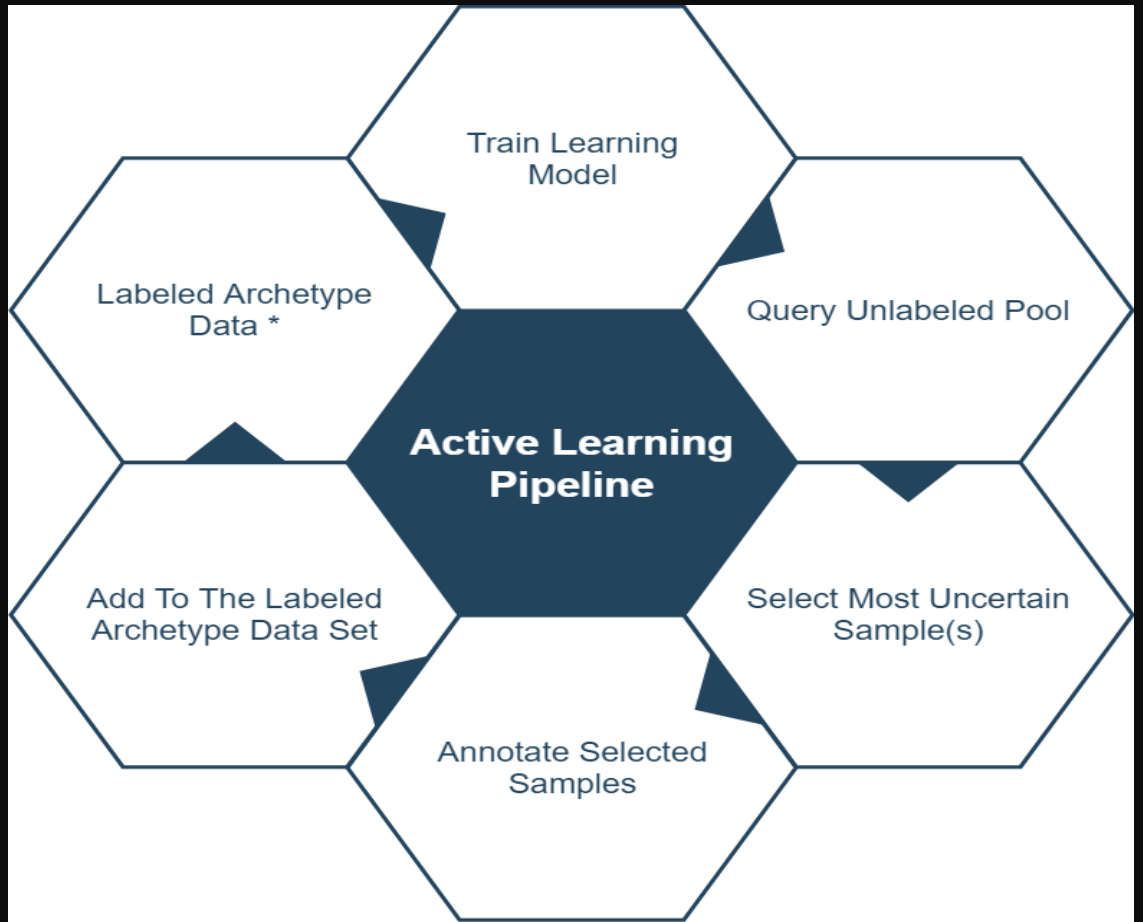

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SMART-E Framework Architecture

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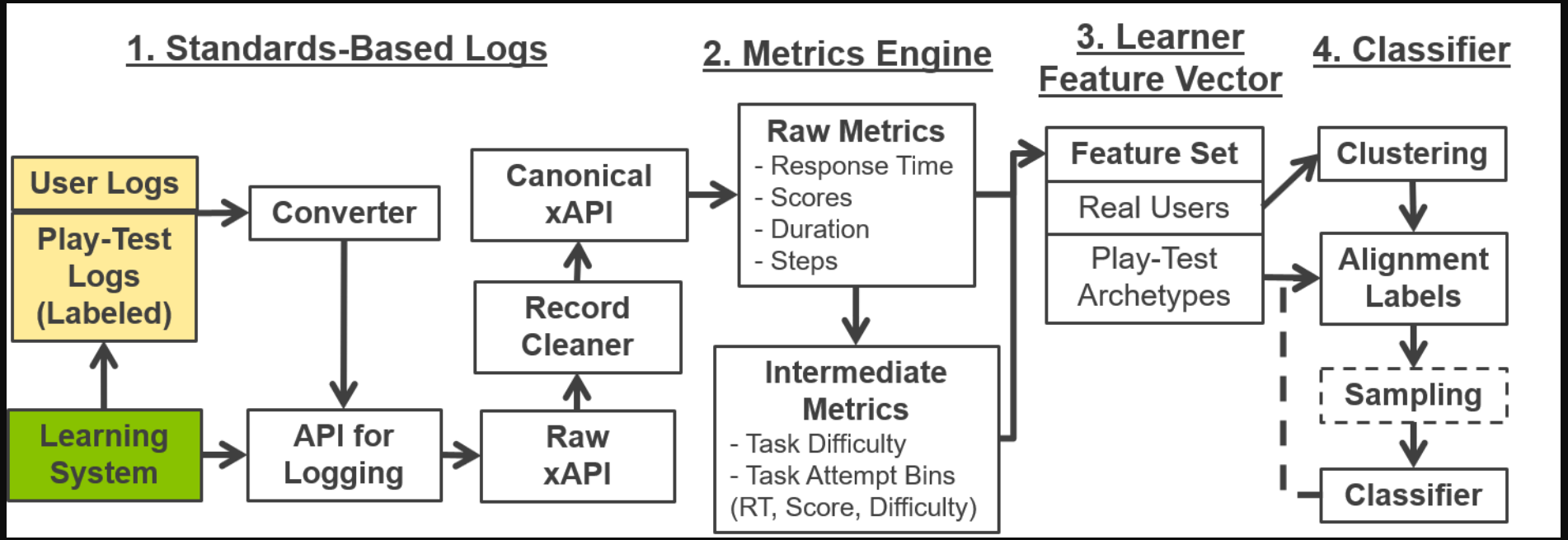

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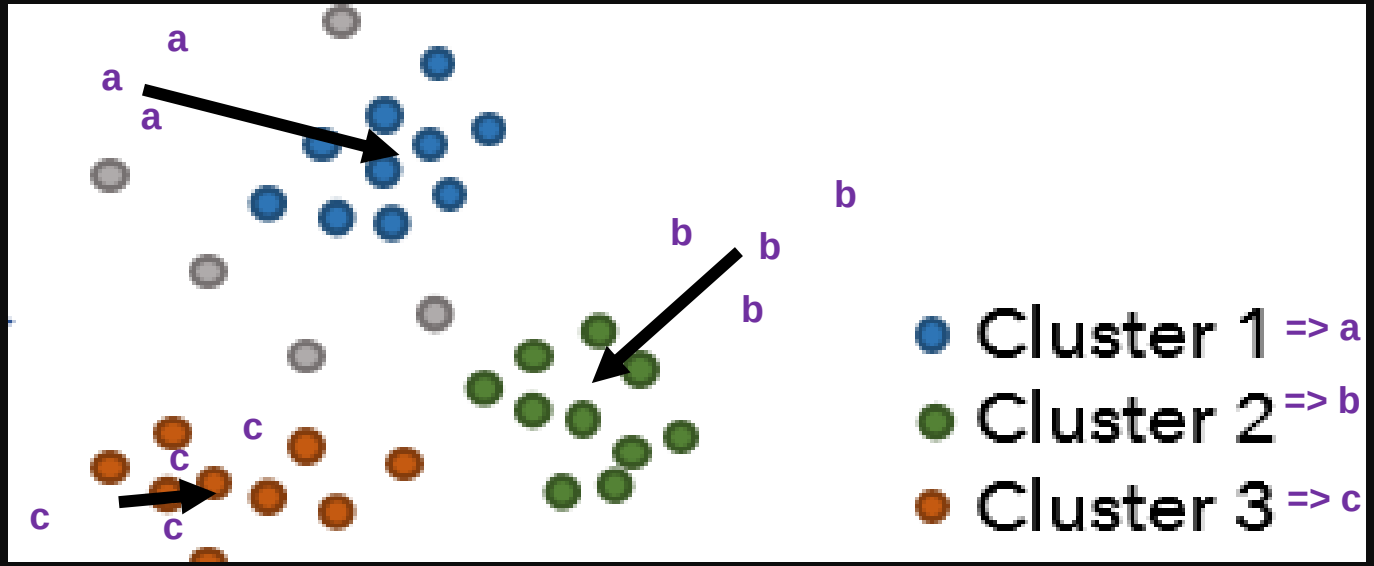
Cluster Alignment Process



Semi-Supervised Approach

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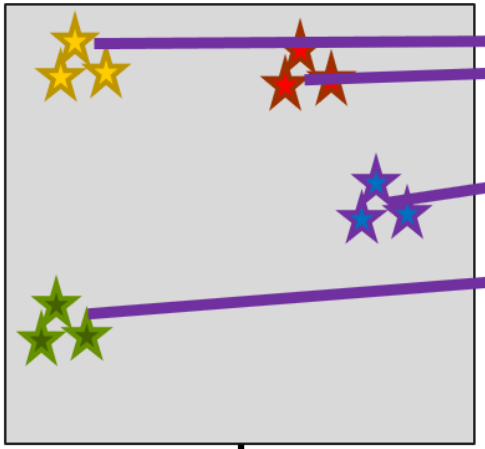
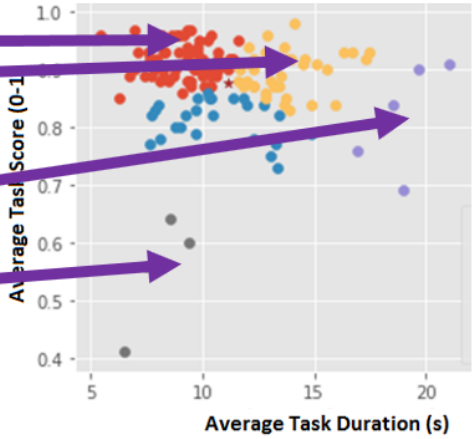
1. Collect Labeled Archetypes

2. Align to Unlabeled Clusters (e.g., GMM)

3. Training Set (Sampled)

4. Train Classifier (e.g., SVM)





A:Y1	A:Y2	A:Y3
0.0	0.0	0.0
391.0	384.0	543.0
562.0	478.0	584.0
746.0	798.0	715.0
823.0	754.0	669.0
736.0	846.0	742.0
832.0	855.0	799.0
923.0	750.0	816.0
801.0	854.0	826.0
811.0	795.0	864.0
942.0	831.0	938.0

Engagement Classifier

Labeled Data

Unlabeled Data Sample

Sampling (Optional)

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What is the cost of the data?

Data Costs (from high to low)

- **Pedagogical Expert:** Reliable, trained annotators who review data
- **Expert User:** Highly trained user who uses system to generate data

- **Novice User:** Users who are barely ready for a task to generate data

- **Target Users:** Users who would typically use system in their normal training, but whose skill levels may be unknown

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ELITE Results

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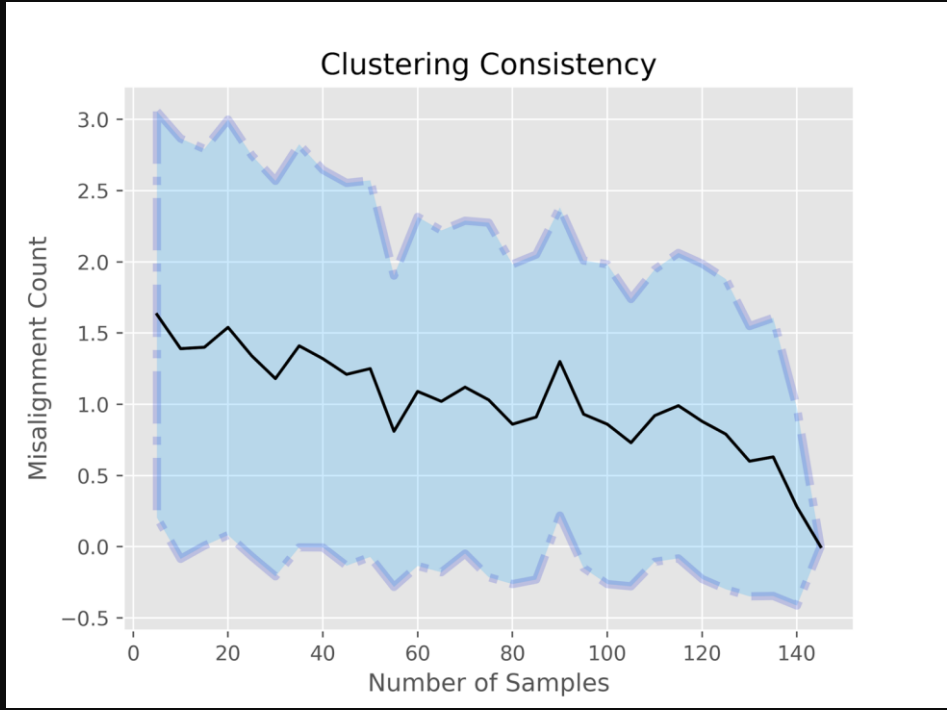
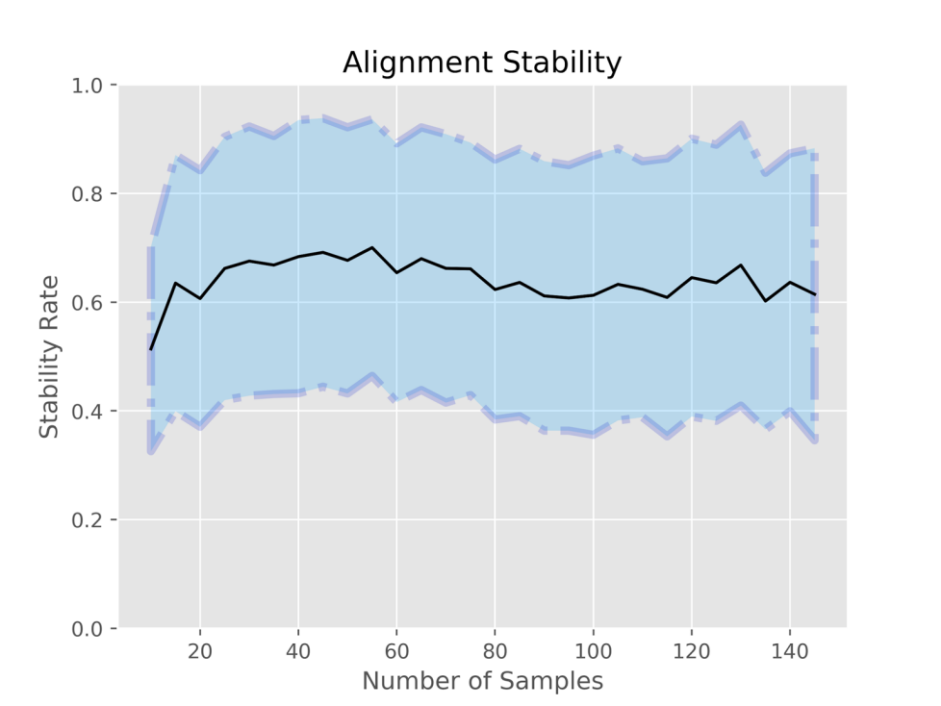
Clustering and Alignment Analysis





ELITE Results

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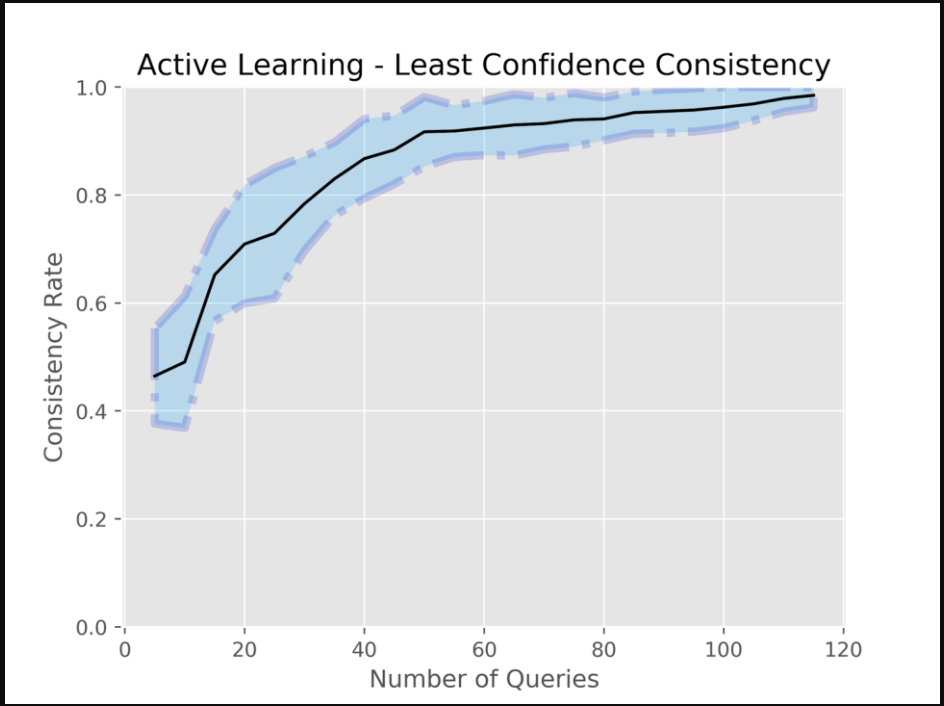
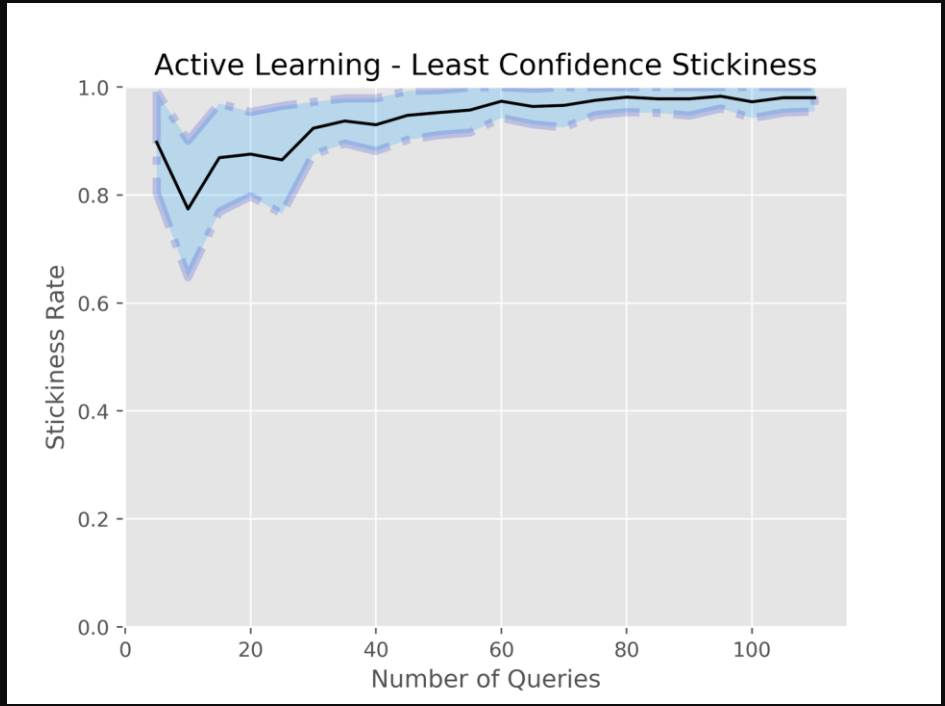
Classification Analysis





GIFT Cybersecurity Mini-Course & Integration

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GIFT Integration

GIFT

Learning System

Agent Container Module

xAPI Logging Service

Raw xAPI

Canonical xAPI

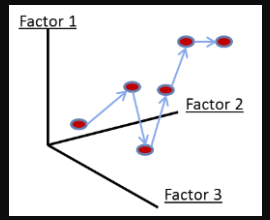
Metrics Engine

Classifier Model

Record Cleaner

Archetype Benchmarks

Individual Metrics (Scores, RT, etc.)



Classification

	Video	Planning	Sim-pt1	Sim-pt2	AAR
User1					
User2					
User3					
User4					

Disengaged

Engaged

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GIFT Cybersecurity Mini-Course

- Two modules: Phishing and HTTPS (lighter vs. drier)

- Each module has 6 activities:
  - Text Introduction
  - Video Overview
  - Basic Questions (3 multiple choice)
  - Intermediate Questions (3 harder multiple choice)
  - External URL
  - Dialog-Based assessment

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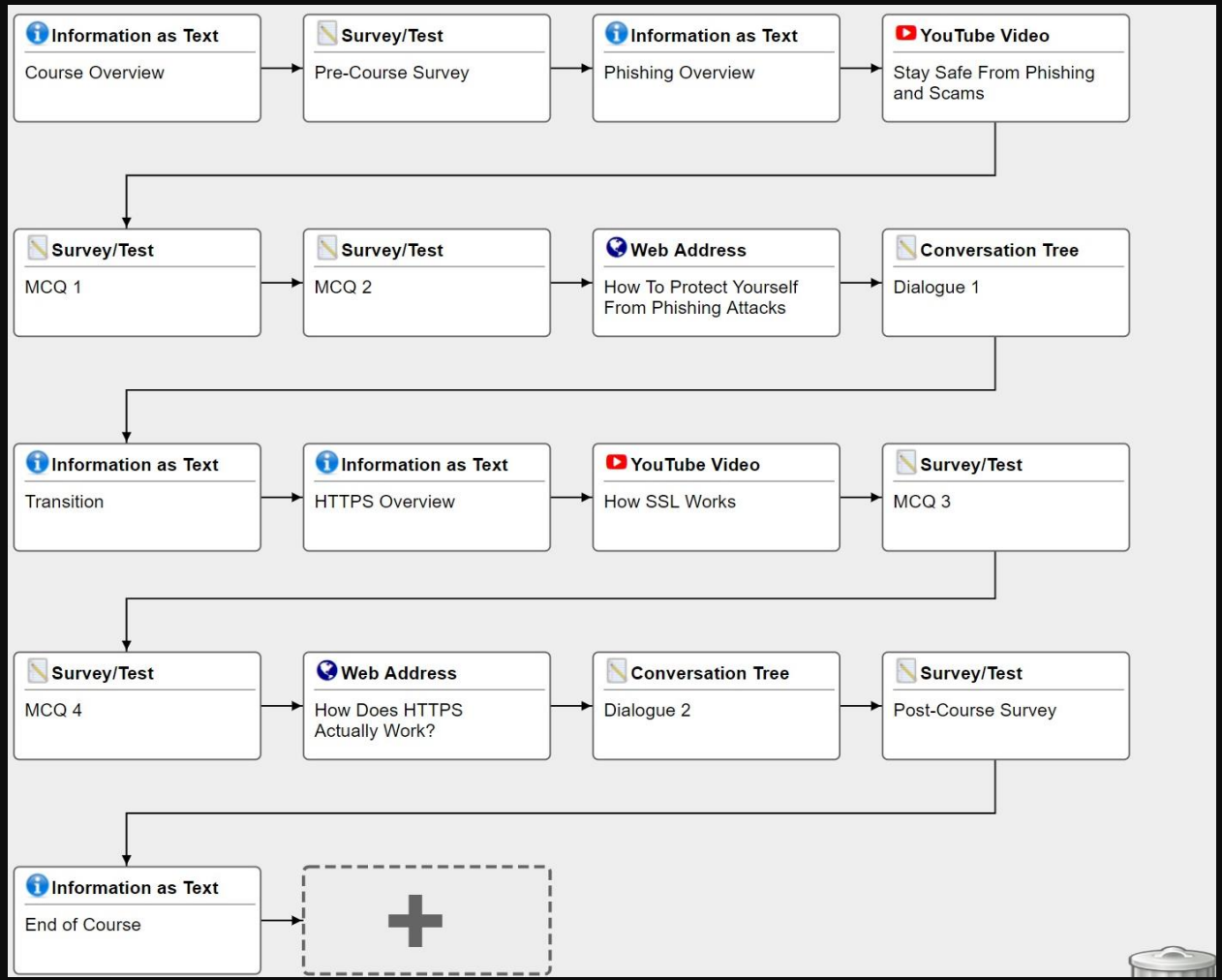
GIFT Course



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ishing) vs. Drier (HTTPS)

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GIFT: Welcome to the Interactive Dialogue Assessment! Please answer the following questions to the best of your ability.

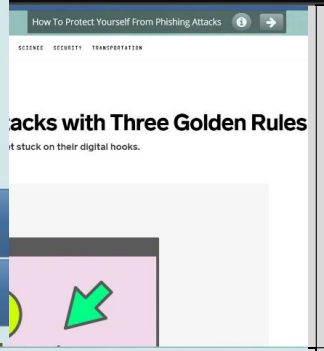
GIFT: The entire SSL Certificate model has a primary point of weakness in context of which of the following?

- The Certificate Authority (CA) and the public-private encryption model.
- The root Certificate Authority (CA).
- The ability to spectate network traffic.

me: The Certificate Authority (CA) and the public-private encryption model.

GIFT: In what sense do Digital Signatures help in communication?

- The use of public key ensures that no one can tamper with the certificate.
- If a server claims to have a certificate that is signed by some other CA, the browser doesn't have to take its word for it.
- The digital signatures provide authentication that the certificate is actually from the person to whom one intends to talk.



GIFT: Welcome to the Interactive Dialogue Assessment! Please answer the following questions to the best of your ability.

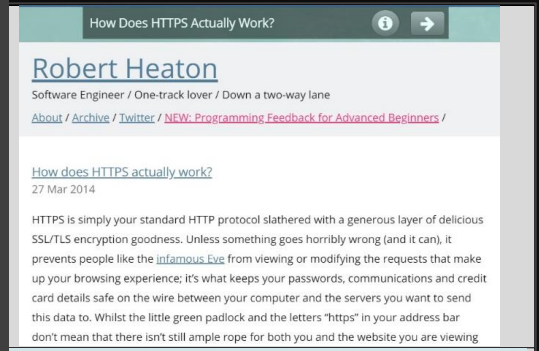
GIFT: Which of the following is the best way to prevent a possible phishing attack?

- Carefully thinking before clicking any link in any email or text, or downloading attachments and putting personal information or login credentials into any form that one might have any reason not to trust.
- Assessing the threat posed by the link and informing the appropriate fraud prevention authorities.
- Not clicking on any email or text from a person you have never met before.

me: Assessing the threat posed by the link and informing the appropriate fraud prevention authorities.

GIFT: Why should dormant accounts (whether in the domain of personal communication or finance) be closed?

- Institutions don't have enough controls and programs over internal actions and they are not flagged for review.
- Dormant accounts have lower scrutiny and security restrictions compared to active accounts.



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GIFT Mini-Course Data Set

- Collected 17 archetype data points
  - Diligent, Distracted, Racing, Expert
- Collected 100 real user data points
- Surveyed pre-post interest and confidence/experience in topic

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Preliminary Results (K-Means)

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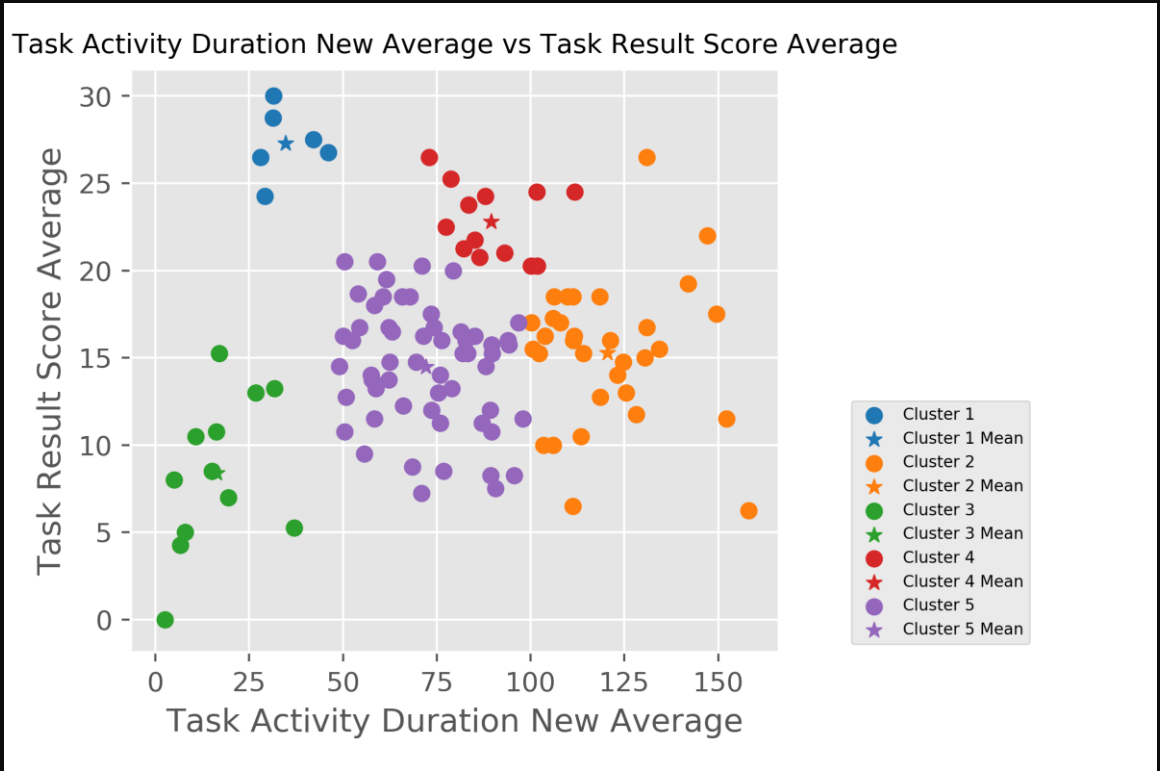

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Conclusions & Next Steps

- Integration Successful Overall
  - 100 subjects completed study with GIFT+SMART-E logging
  - No notable data loss
  - Logs have been processed into viable metrics
  - Initial clusters look promising and similar to ELITE

- Classification Research Ongoing
  - Conduct a sweep for different amounts of user data
  - Analyze classification results with self-reported engagement

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Next Steps

- SLATS for STE
  - Semi-Supervised team assessment
  - Team metrics as inputs
- Team Types:
  - Expert Team
  - Team of Experts
  - Weak Link(s)
  - Novices

SMART-E Baseline Framework

Learning System

Existing Logs

API for Logging

Converter

Raw xAPI

Canonical xAPI

Metrics Engine

Reporting Interface

Record Cleaner

Archetype Benchmarks

Individual Metrics (Learning, Engaged)

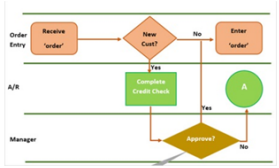
Collective Training Additions

Team Roles & Responsibilities

Roles
- MOS/Skills
- Team Slot

Actions
- Must do
- Should do
- Should not do

Task Processes (Roles & Actions)



Team Classifier Benchmarks

Team Diagnostic Metrics

	Individual	Team
Process	- Engagement & Commitment - Action Performance (Steps of task)	- Task Performance - Teamwork Perf. (Communication & Coordination)
Outcome	- Task Performance - Supporting Behavior - Efficiency/latency	- Mission Performance - Team Archetype - Efficiency/latency

SLATS service

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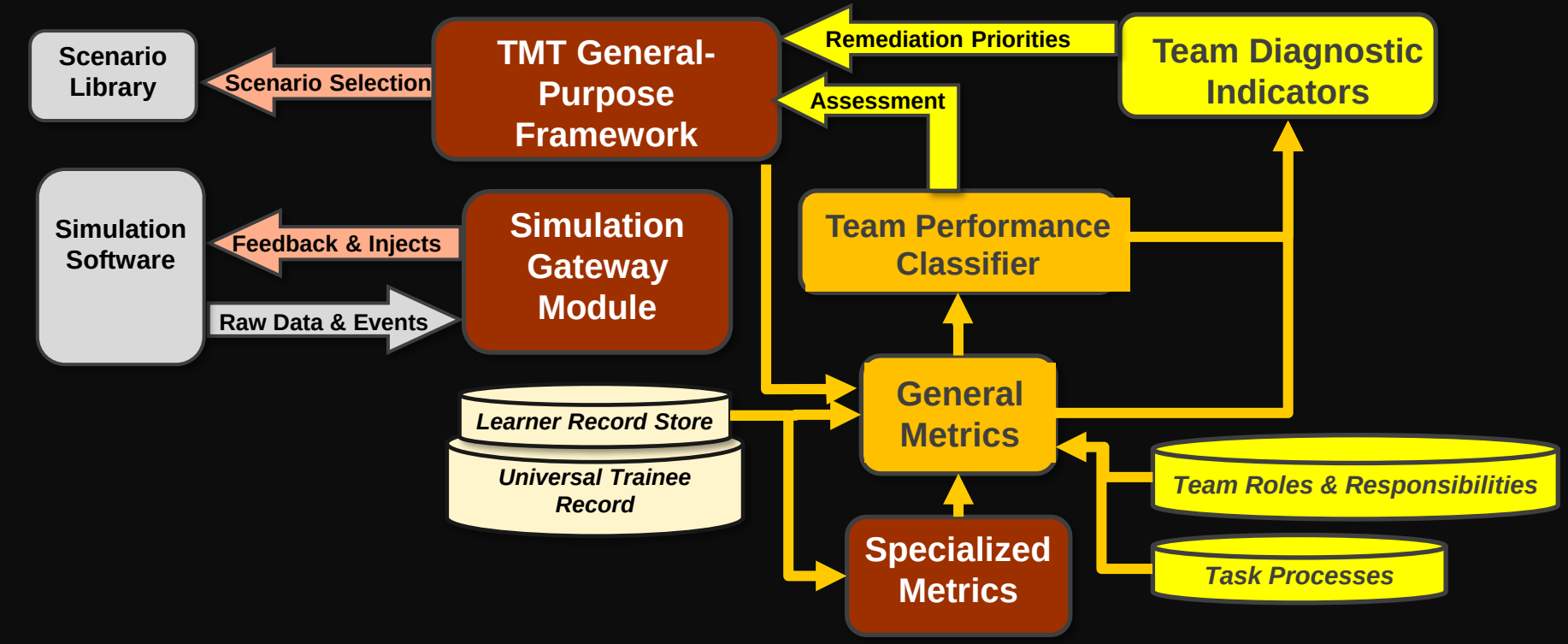

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Team Diagnostic Indicators (Input Categories)

	Individual	Team
Process	- Engagement & Commitment - Action Performance (Steps of task)	- Task Performance - Teamwork Perf. (e.g., communication) - Backup Behavior
Outcome	- Task Performance - Supporting Behavior - Efficiency/latency	- Mission Performance - Efficiency/latency

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