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Supporting Technology Enabled Learning with Artificial Intelligence and Cognitive Modelling

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Overview

- Problem statement, proposed solution and challenges.
- Agile development of synthetic teammates.
- Team training readiness and verbal communication.
- Synthetic teammates essential characteristics.
- Evidence-based Synthetic teammates projects:
  - Landing Helicopters on Ship Decks;
  - Learning Ship Manoeuvres and Conning Orders;
  - Learning Tactical Voice Procedures.
- Conclusion.

Problem statement

- Needs for simulation-based training of team tasks:
  - Reduce reliance on live training;
  - Increase readiness of individuals to participate in team training.
- Issues in the transition from individual to team training:
  - High cost related to taking experts out of operation duties to play teammate roles;
  - Value of team training mostly for the development of strategic and tactical team skills;
  - Basic communication skills should already be mastered by individuals.

Proposed solution

- Agent-based modelling and simulation for training.
- Provide initial team communication training for novices without requiring involvement of human role players.
- Supported by:
  - Emerging technological trends such as cloud computing, artificial intelligence, data analytics, virtual and augmented reality, and advanced speech recognition technology.
  - High cognitive fidelity and natural language processing capabilities.

Agent-based training simulation challenges

- Shift from emphasis on human performance and skill acquisition towards technology and device fidelity (Hodges, 2014).
- Pressure to achieve more rapid development and deployment of training solutions, which means:
  - Less time to conduct detailed needs assessments (Bell, Tannenbaum, Ford, Noe, & Kraiger, 2017);
  - Less time to assess training effectiveness during development process, which limits ability to adapt development to user feedback.
- Need for agile and ongoing utility assessment beyond traditional transfer of training studies.

Agile development of synthetic teammates

- Iterative development methodology for refining training goals, and making design and implementation decisions.
- Some similarity with NATO Generic Methodology for Verification and Validation:
  - Strong focus on user needs;
  - Evidence-based process for supporting design, implementation decisions and/or results acceptance goals and criteria.
- Methodologies that prioritize instructional goals/design and interaction with the user may be more important/relevant than focus on technologies.

Range of evidence for synthetic teammates

- Passing Turing test: out of reach, unless seeking synthetic teammate with general intelligence.
- But with task oriented artificial intelligence, more realistic options are available :
  - Human subjective judgments,
  - Performance on data processing,
  - Agents competition.
- Needs to be complemented with test-driven development for software verification.

Team training readiness and verbal communication

- Natural language communication is a key element in operational team coordination.
- Communication skills must be learned concurrently with other operational skills.
- Hence the requirement to embed synthetic teammates in part-task training simulations.

Synthetic teammates essential characteristics

- Use of natural language to listen and speak;
- Mixed-initiative condition, where both humans and artificial agents can influence the course of a dialogue;
- Flexibility, where all dialogue partners can express information in a variation of ways;
- Adaptation, where partners in the dialogue cooperate and give feedback to help resolve ambiguities, misunderstanding and confirm what was said (Berg, 2014).

Synthetic teammates essential characteristics

- Very structured operational context where verbal communication is expected to follow a well-defined format will require less adaptation than an operational situation where verbal communication is to support problem solving (Grant, 1999).
- Synthetic teammates could be “shallow entities” in the sense that they only appear to have human-like properties without having much general intelligence.

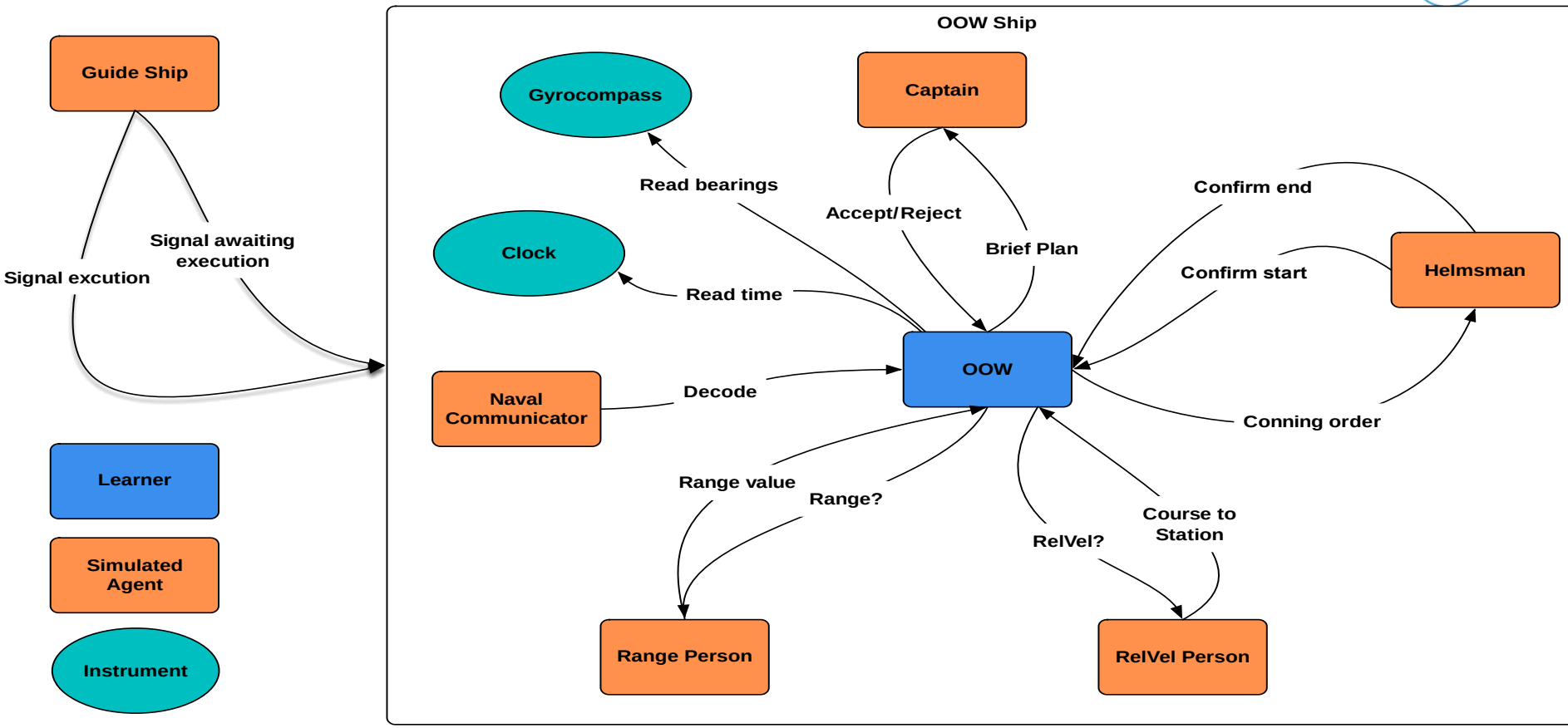
Landing Helicopters on Ship Decks

- Synthetic teammates complexity
  - Human Behaviour Representation (HBR) approach limited to representing only the teammate behaviours required for Landing Signals Officers (LSOs) to perform the task and representable in the virtual environment.
- Supporting evidence
  - A reverse-transfer-of-training methodology showed that both novice and expert LSOs were able to learn the task, but experts achieved proficient performance much more quickly than novices, thereby providing an empirical demonstration of the viability of this approach for training team skills.

Learning Ship Manoeuvres and Conning Orders (RCN-ULEARN)

- Synthetic teammates complexity
  - Shallow synthetic teammates with no knowledge and task representation.
  - Software simply maps learner speech input to change in environment conditions or to performance assessments.
  - Communication from shallow synthetic teammates is also a simple mapping from text strings to sound using text-to-speech technology.

Complex Manoeuvre Execution Using Speech Recognition



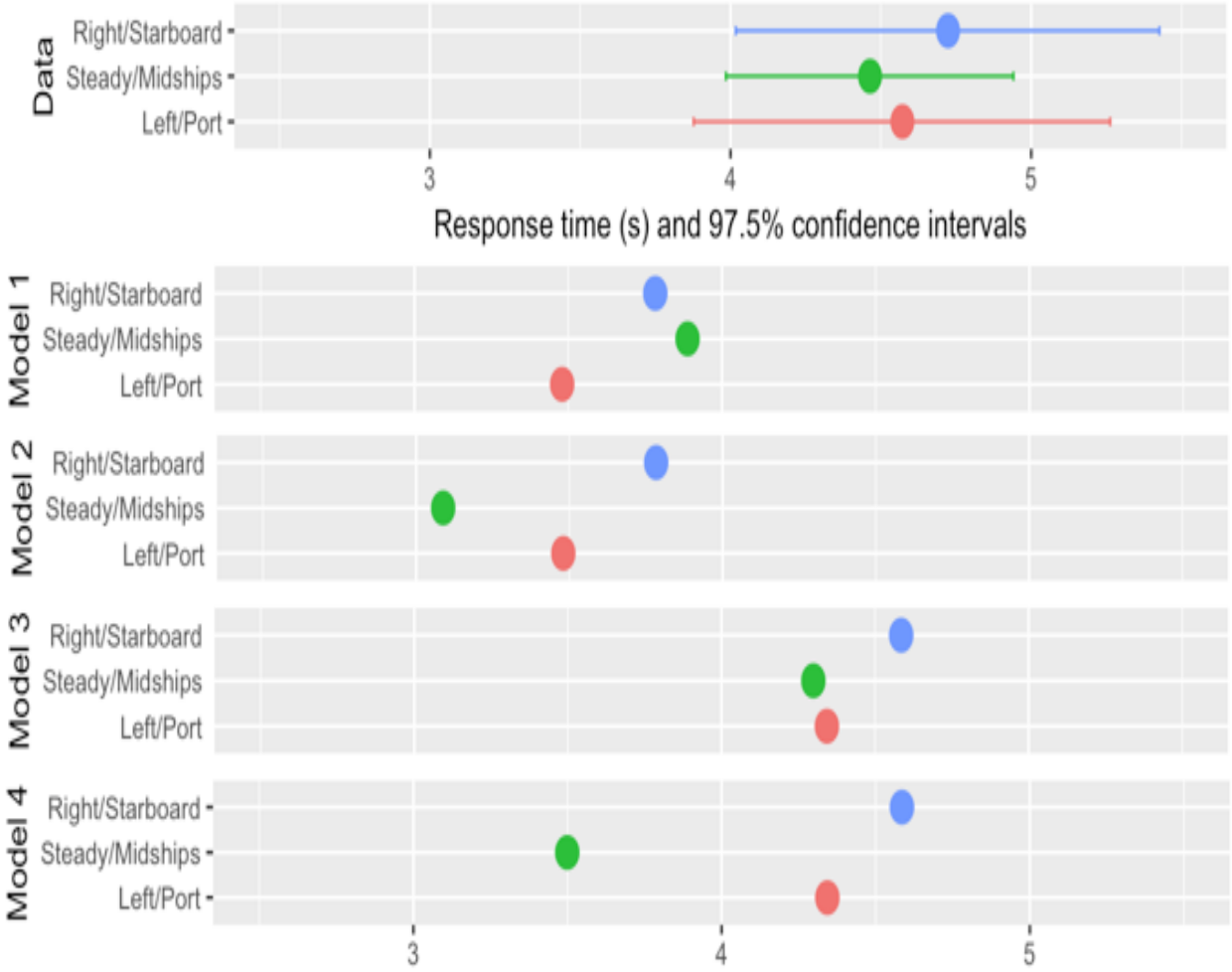
Learning Ship Manoeuvres and Conning Orders (RCN-ULEARN)

- Supporting evidence
  - Assessing the usability of speech recognition during an iterative grammar development. Reduction of errors over time.

	Encoded in system	**Not encoded in system**
In scope	Concept-error Fault-tolerant (success after second attempt) Input-error (external factors)	Validation-error
Out of scope		Training-error

  - Collecting novice performance on conning task, using cognitive models to decompose task components.

Learning Ship Manoeuvres and Conning Orders (RCN-ULEARN)



- Using artificial intelligence (cognitive models) to decompose task performance.

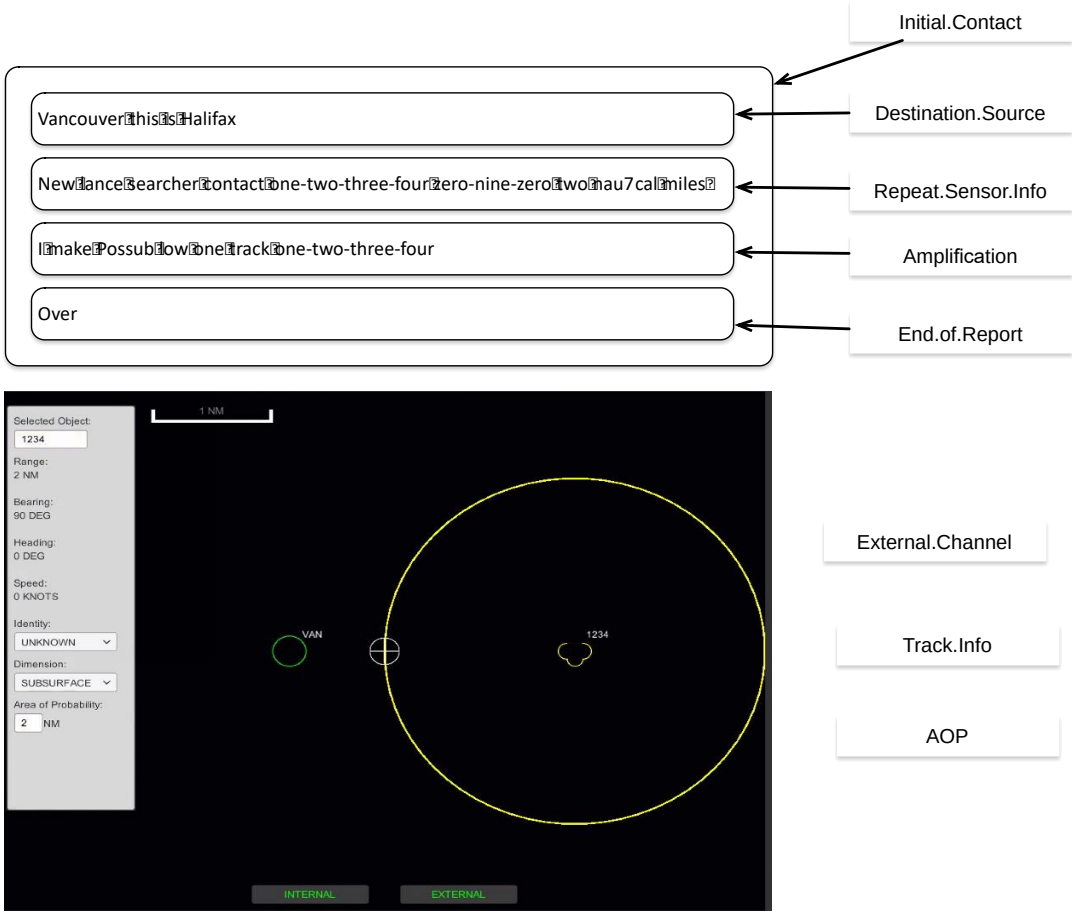
	Retrieval only	Retrieval and mnemonic
Long interpretation	Model 1	**Model 3**
Short interpretation	Model 2	Model 4

Learning Tactical Voice Procedures (RCN-ASPO)

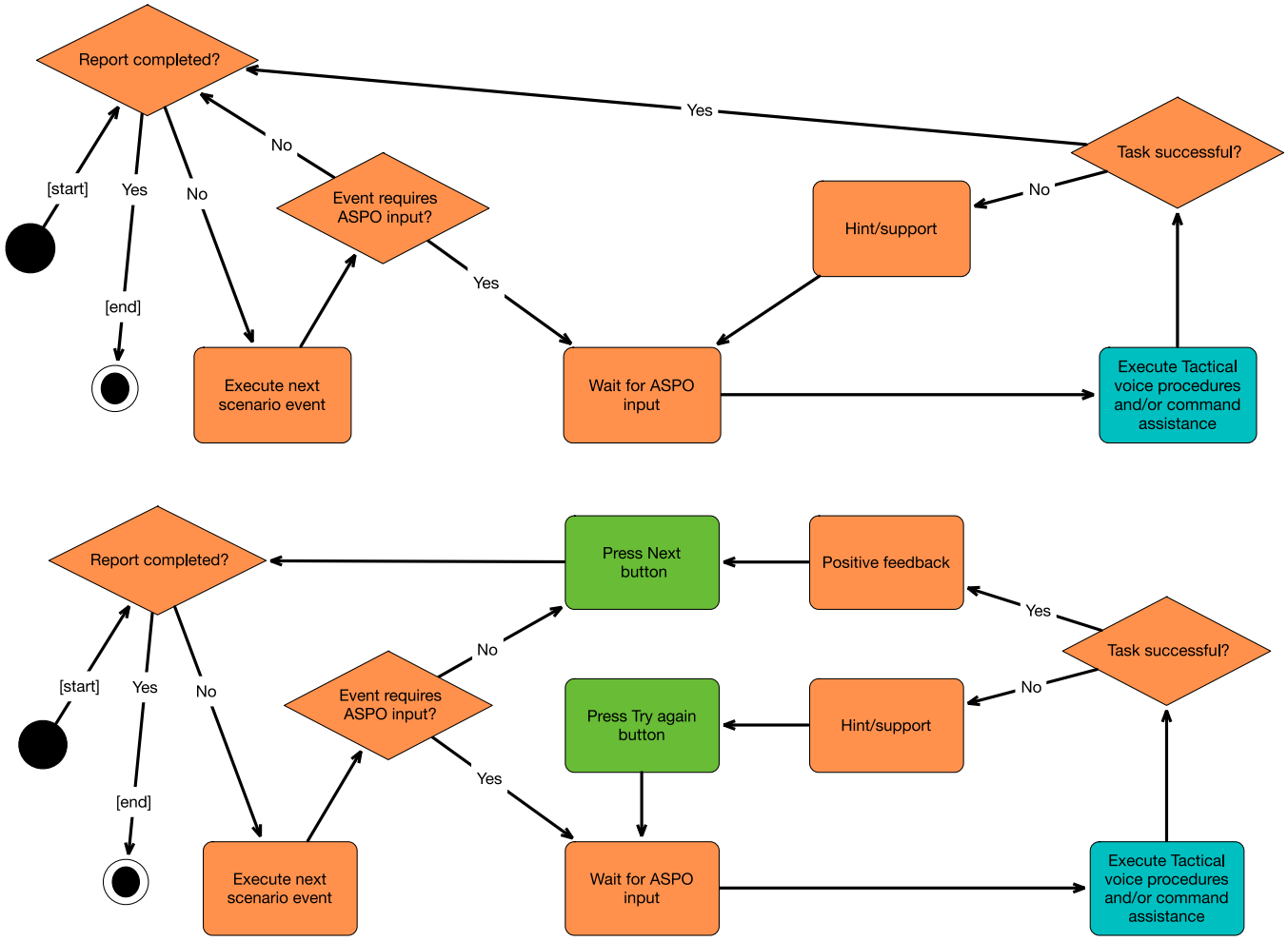
- Synthetic teammates complexity (same as RCN-ULEARN)
  - Shallow synthetic teammates with no knowledge and task representation.
  - Software simply maps learner speech input to change in environment conditions or to performance assessments.
  - Communication from shallow synthetic teammates is also a simple mapping from text strings to sound using text-to-speech

Initial contact report

SCS	“Hot Lance searcher zero-nine-zero at two nautical miles”
ASWC	“All positions conduct underwater resolve zero-nine-zero at two nautical miles”
ORS	ORS checks radar displays for any surface tracks – Finds none in that position and reports “Underwater resolve Negative in OPS”
Bridge	“Chart check negative on the bridge”
	SCS upgrades contact and it is entered into CMS as unknown surface



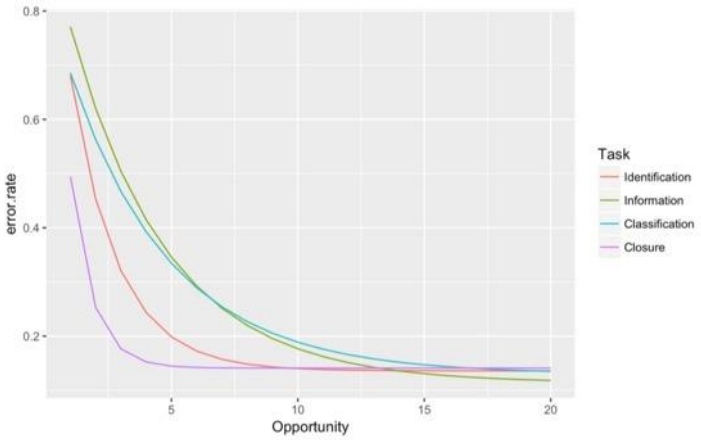
Learning Tactical Voice Procedures (RCN-ULEARN)

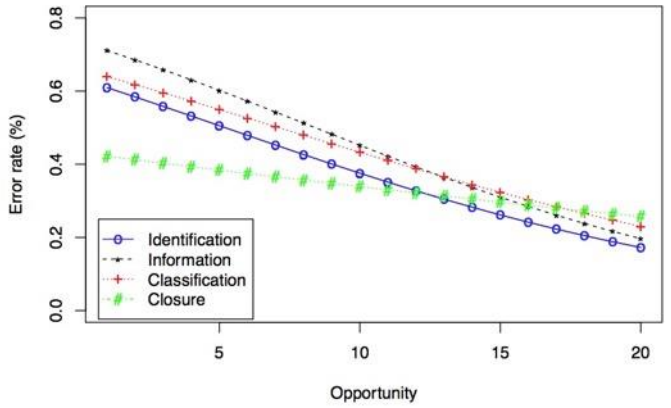


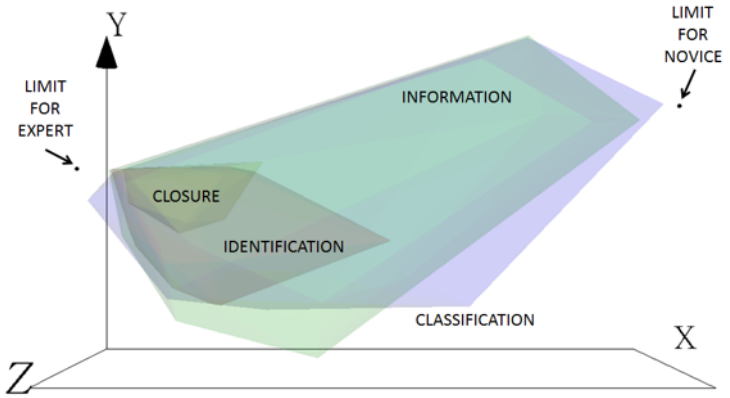
- Subject matter experts used in usability trials helped determine best methods for capturing user performance on tactical verbal procedures.

Learning Tactical Voice Procedures (RCN-ASPO)

- Using simulated data to assess learning analytic methods of student learning.







Conclusion

- Enabling individual trainees to “overtrain” fundamental communication skills to be performed concurrently with other mission-critical tasks, without requiring the use of team training resources, could be a game changer for military organizations.
- Assessment of the applicability of the “shallow entity” modelling approaches beyond those involving well-defined teamwork interactions.
- Design systems for training teamwork skills that are more responsive to, and more scalable across, training requirements, and whose training effectiveness is easier to evaluate.

Questions?