

Automated Techniques for Measuring Team Communication

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The Problem

Team communication data can provide a rich data set for analyzing team performance. However, hand coding for content can take 28 hours per 1 hour of tape (Emmett, 1989) and can be subjective.

Goal

Predict team performance based on automated analyses of communication among team members.

Approach

- Use Latent Semantic Analysis, a computational model of language and semantic memory, to code/measure and content of communication team tasks.
- Evaluate effectiveness of these techniques for predicting team performance and decision making.
- Evaluate the combination of these techniques with other methods of cognitive modeling for improving measurement performance.

The CERTT lab

- Research laboratory to develop, apply, and, evaluate measures of team cognition.
- Hardware and software support synthetic team tasks
- Can be configured to simulate co-located or distributed task environments
- Current Configuration: Uninhabited Air Vehicle Control
- An automated measurement and recording system captures team behaviors:
 - audio & video streams
 - task performance indices
 - communication flow
 - computer events
- Post processing routines summarize the data.
- Experimenters observe team behavior remotely via:
 - audio & video monitors
 - performance indices
 - shared displays
- Experimenters record observations using time-stamped annotation software.
- Participants complete on-line measures that elicit task and team knowledge:
 - factual tests
 - structured interviews
 - concept ratings (individual & team levels)

Latent Semantic Analysis (LSA) is a:

- Psychological Theory
 - A theory of the acquisition, induction, and representation of knowledge
 - How people learn the meanings of words
- Model
 - A mathematical system for computational modeling of cognitive processes
 - Tool
 - An Artificial Intelligence (Machine Learning) system for matching words/texts at a semantic level
- LSA learns the relationships between text documents and their constituent words (terms) when trained on very large numbers of background texts (thousands to millions)
- LSA learns how to group documents and terms that are similar in a "Semantic Space"
- Documents can be domain knowledge, writing samples, e-mail files, course materials, personnel records, etc.
- LSA judgments of similarity agree well with human judgments

Experiments

- The Data
67 Transcripts from 11 teams, 7 missions
- XML tagged
 - ~2700 minutes of spoken dialogue
 - 20,545 separate utterances (turns)
 - 232,000 words (660 k bytes of text)
 - Logs of the speaker, listener, and duration of each communication from each participant
- Experiment 1: Predicting team performance from dialogues as a whole**
- Goal:** Predict objective individual and team performance measures based on transcript of team communication.
- Approach:**
- Match team dialogue patterns and content against database of prior dialogues.
 - Assign a predicted team score based on similarity of a transcript to other team transcripts with known performance measures.
- Result:** Correlation between LSA-derived measures of communication to Team Performance measures $r = .76$ ($p < .01$)
- Implication:** We can automatically predict how well a team is performing based on analysis of their communication

Measuring Team Communication with LSA

- **A good team**

DEMP: This is PLO, what would be the next target after SEN-1?
 PLO: Our next target is KSTL, repeat KSTL, with an effective radius of 5 miles.
 DEMPC: Yes ma'am.
 PLO: Roger that.
 AVO: AVO, uh, right next to STR is MSTR and that has an altitude rule of a minimum of 2000 and a maximum of 5000, so if you want to do it for both, go right ahead.
 PLO: AVO this is PLO, for this site I need you to be above 3000.
 AVO: OK, right now, PLO, we're right at 3150 so that should be OK for both, right?
 DEMPC: That's good that's good.
 AVO: Alright.
- **A poor team**

DEMP: AV, AVO?
 AVO: This is AVO.
 DEMPC: Ok, what's going on? Why are we off course?
 AVO: We're on, we're enroute to OIK.
 DEMPC: We're on, we're way off. You are going around it.
 AVO: Around it?
 DEMPC: Well, it looks like it is coming down but
 AVO: Well, I'm adjusting right now the course deviation.
 DEMPC: You should have done that a long time ago, AVO, come on.
 AVO: We're only like 10 degrees off though, it shouldn't be that much.
 DEMPC: You see, that ROZ exit, that's a ROZ exit, we have to hit it at a radius of 2.5 miles.
 DEMPC: OK.
 AVO: But according to my map, we're doing good.
 DEMPC: OK.
 PLO: Uh, where it says waypoint, the two, shouldn't it already say SST?

- How do we automatically determine what makes a good/poor team?
- Analyze semantic components of communication
 - Use these semantic components to predict knowledge and communications skills and predict team performance

Conclusions

- Team cognition is revealed through discourse.
- Discourse level is best for obtaining diagnostic information for training, design, and selection.
- Semantic and statistical analyses of team dialogues can reveal the effectiveness of a team.
- Permits automatic analyses of the content of team dialogues.
 - Avoids tedious hand coding.
- Can be applied to any domain in which there is team dialogue.

Current Extensions

- Can use the approach to determine what makes a good team
 - Match team dialogue patterns and content against database of prior dialogues.
 - Predict individual and team performance.
 - Detect "unusual" events.
 - Automatically code utterances for types of dialogues.
 - Matching individuals, skills, training material to teams.

Applications of LSA

- Individual/Team Assessment
- Evaluating teams and individuals through measurement of communication
 - Identifying critical events
 - For training teams
 - Suggest when trainer needs to intervene
 - Suggest ways to improve team communication
 - Matching individuals, skills, teams, and training material
- Additional Applications
- Automated essay scoring/ knowledge assessment embedded within training (scaffolding)
 - Automated tools for aiding collaborative learning environments
 - Within and Cross-Language filtering/retrieval/topic-detection systems
 - Lessons Learned systems

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