"EXPLORE THE AREA FOR SMOKE AND GAS DETECTION"
NATURAL LANGUAGE PROCESSING
FOR ROBOT-ASSISTED DISASTER RESPONSE TEAMS
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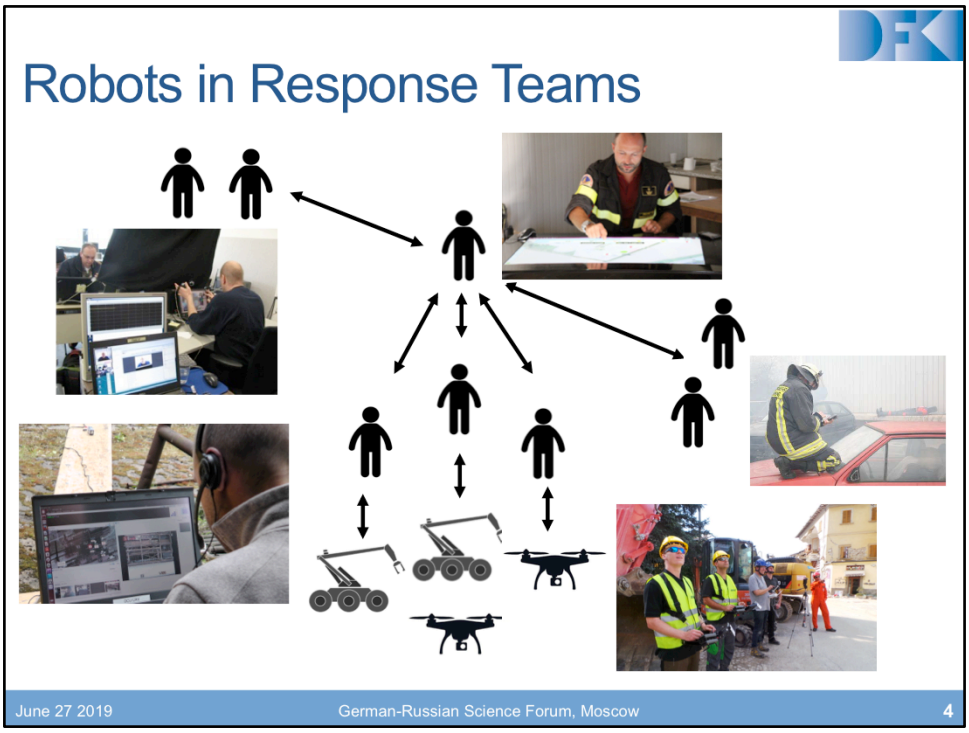
Outline

- Robots can improve disaster response
- Robots need mission knowledge
- Mission knowledge can be obtained from human team communication
- Mission knowledge enables (other) mission assistance

Disaster response: high risk situations, uncertainty
Robots can be used for reconnaissance, better situation awareness
Increased safety: first responders do not have to enter all areas with high risk
Increased capability: robots can enter areas which are otherwise inaccessible with currently available means/tools
Decreased costs: robotic operations can even be cheaper than using currently available means



Holistic perspective on robot-assisted disaster response:
Not only robot-operator
Also embedding of human-robot teams into the overall disaster response structure
→ teamwork

We have studied human-robot teamwork with first responders in a variety of scenarios
Also deployments in real disaster response (earthquakes in Italy 2012; 2016)
Use of robots by first responders is spreading; most recently: fire at Notre Dame, Paris, April 2019: drones for reconnaissance&observation; a ground robot with a water hose

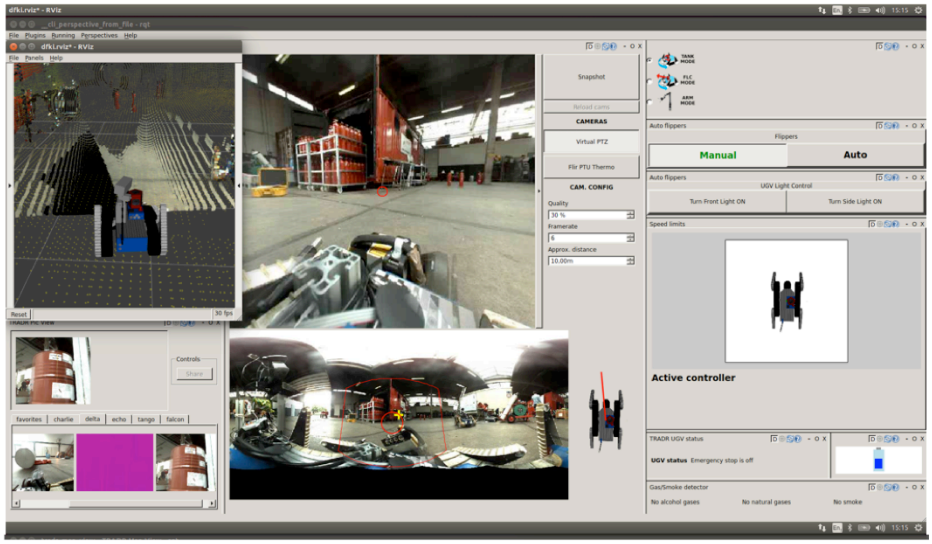
Robots in Response Teams

Tasks

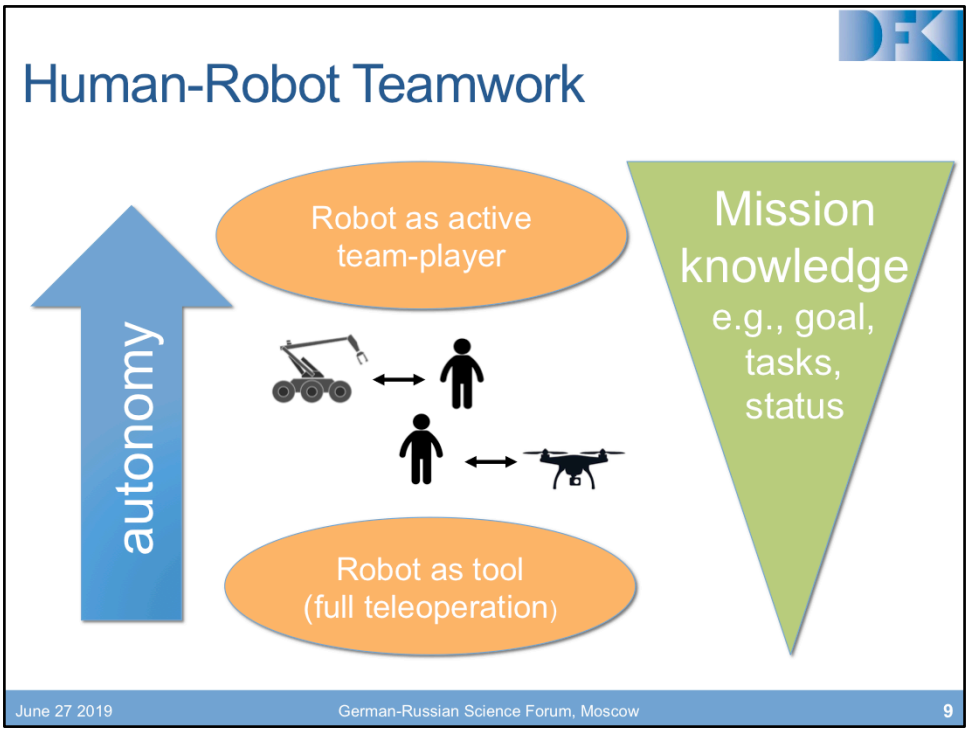
- overview (anytime)
- search, e.g., victims, hazards
- measurements, e.g., temperature, gasses, radioactivity
- data for 3D models
- collecting samples
- tactile sensing
- monitoring/patrolling, exploration

In our experiments first responders used robots for a range of tasks

Robot Control



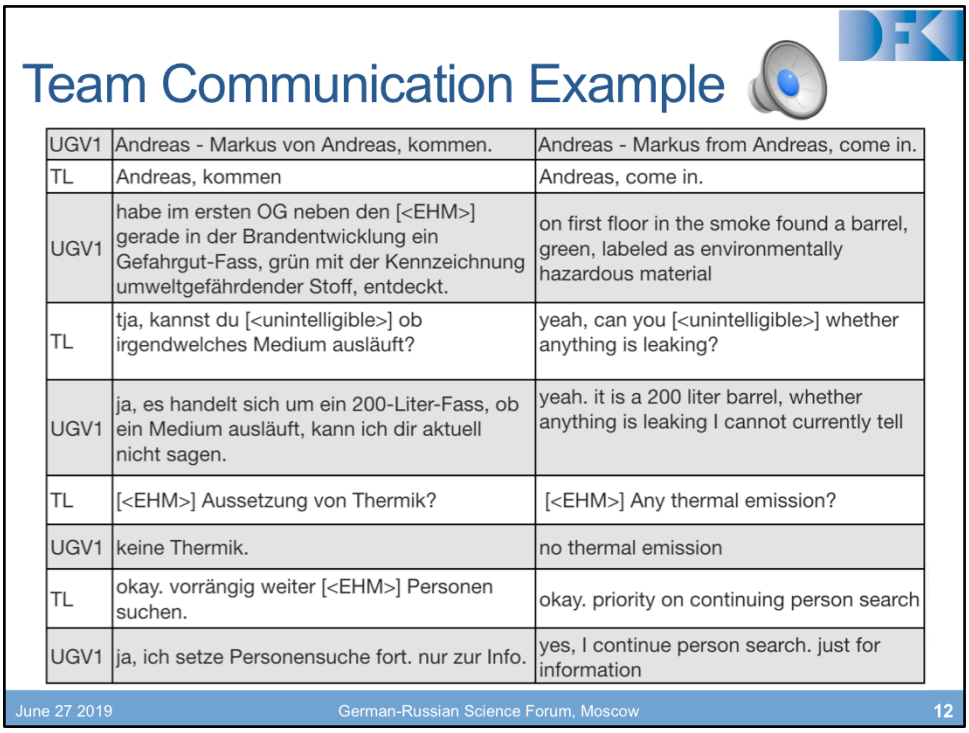
Robots are currently mostly deployed in teleoperation. Increased (partial) autonomy is desired.



As robots become (more) autonomous they need to act according to human expectations. This requires knowledge of the mission: goals, current status, assigned tasks, status updates, etc.

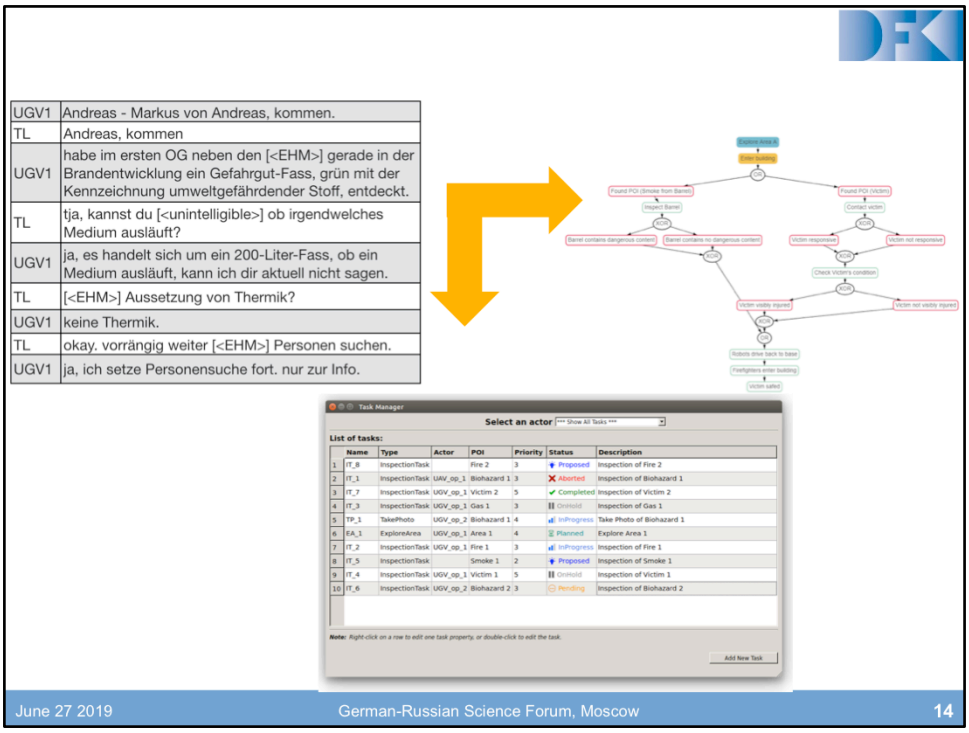
Disaster response missions are very dynamic, the environments are complex. It is not possible to “pre-script” disaster response missions. So, where to get mission knowledge from?

First responder have high work load and work under stress. Cannot be burdened with additional tasks to capture mission knowledge for the robotic system.
Mission knowledge is contained in the communication among the team members!

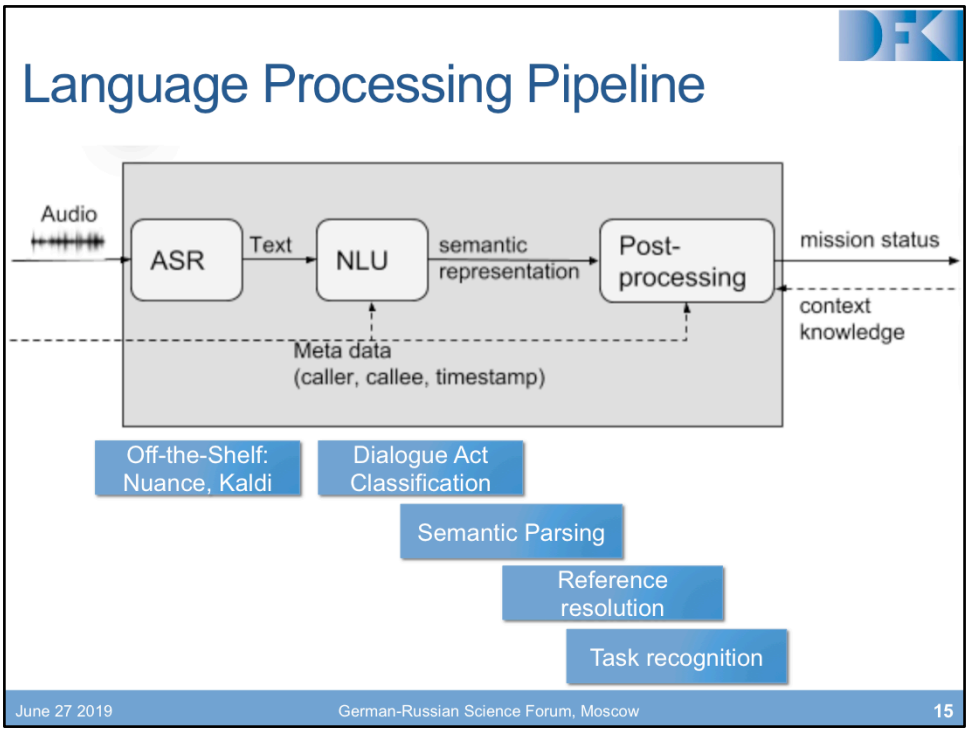


Extract is at 12:45 min

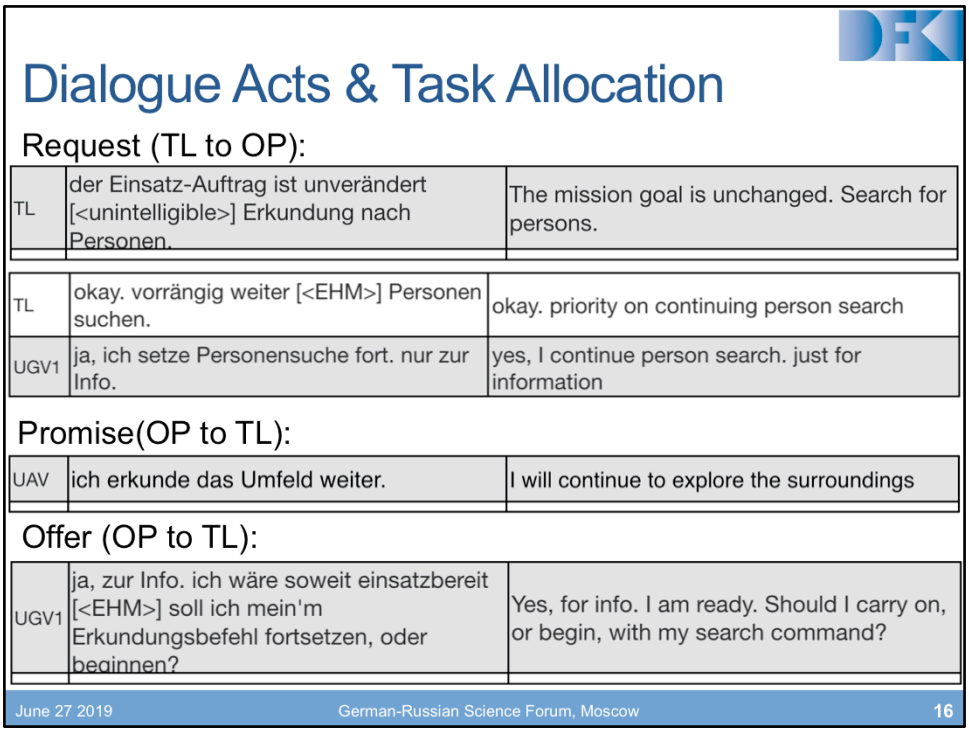
Example from the Team Communication corpus collected during the TRADR project experiments with first responders
Roles: Team Leader; Operator of UGV1 (Unmanned Ground Vehicle)



Our goal is to obtain mission knowledge from the team communication, by interpreting the spoken natural language



Classical spoken language processing pipeline, focusing on the semantic content
Automatic speech recognition
Natural language understanding
We are currently working on the modules of this pipeline using various sate of the art methods
Example: dialogue act recognition/classification



Dialogue act recognition needed, for example, because task assignment happens not only on request from the team leader; sometimes the operators also propose tasks.

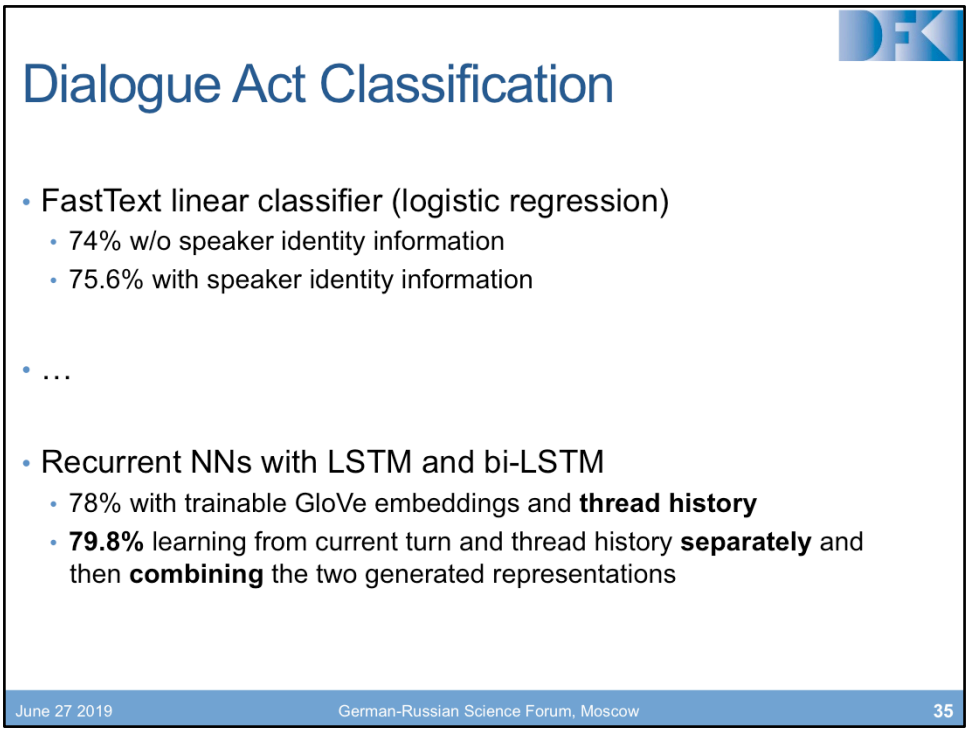
Dialogue Act Distribution

TRADR Team Communication Corpus:

Dialogue Act	MC	TL	OP	Total
Contact	32	**350**	360	742
Inform	**19**	132	**476**	627
Affirmative	8	217	127	352
Request	9	262	3	274
Question	12	150	84	246
Confirm	2	28	131	161
Disconfirm	0	4	49	53
Negative	0	6	8	14

Majority baseline acc. 41.3%
Relative-frequency baseline acc. 25.6%

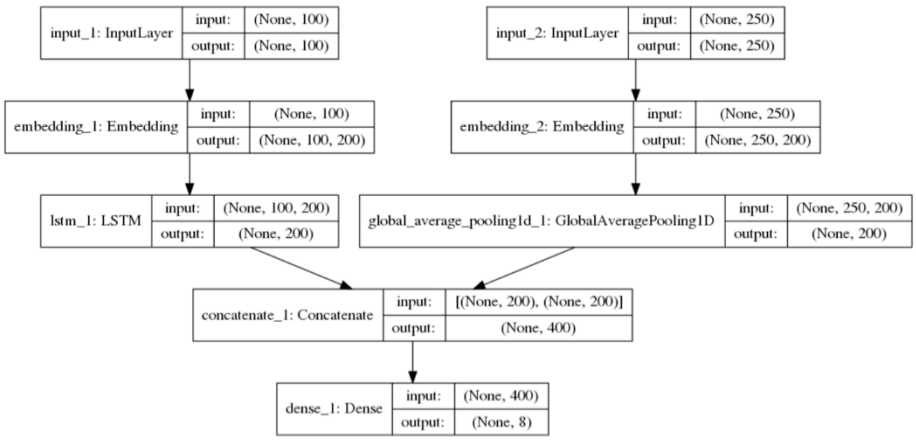
We use the corpus of team communication collected in the TRADR project experiments.
Roles: Mission Commander; Team Leader; Robot Operators
Approximately 3000 utterances in total
Most frequent dialogue act overall is Contact
Inform is most frequent for Operators
Baselines based on frequency are very low



We experimented with various methods of DA classification
Using available libraries
FastText classifier achieves reasonable results comparable with state of the art
We tested also various neural network models
Best results achieved with RNNs
Taking dialogue context into account for the classification
Diaogues consist of “threads”, a thread typically starts by Contact; each thread addresses a task (task assignment; status update; …)

DA Classification Architecture

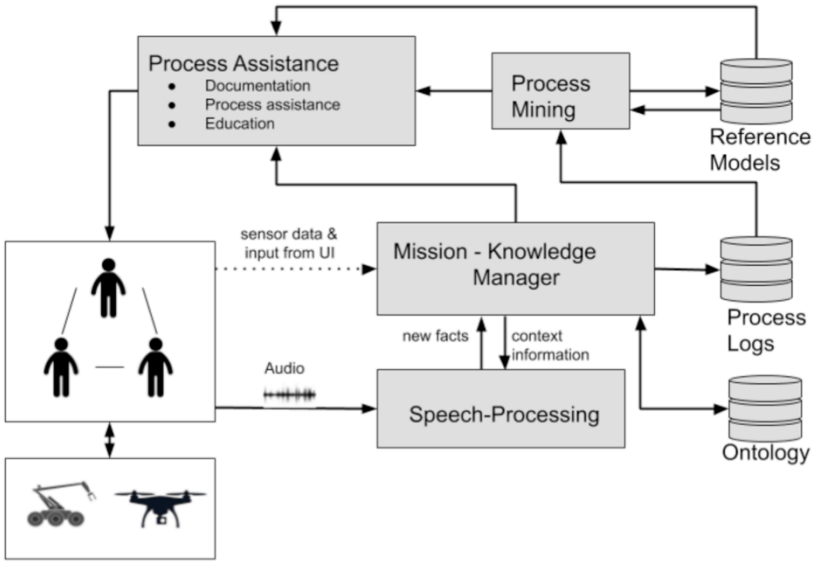
Separate learning from current utterance and from thread history

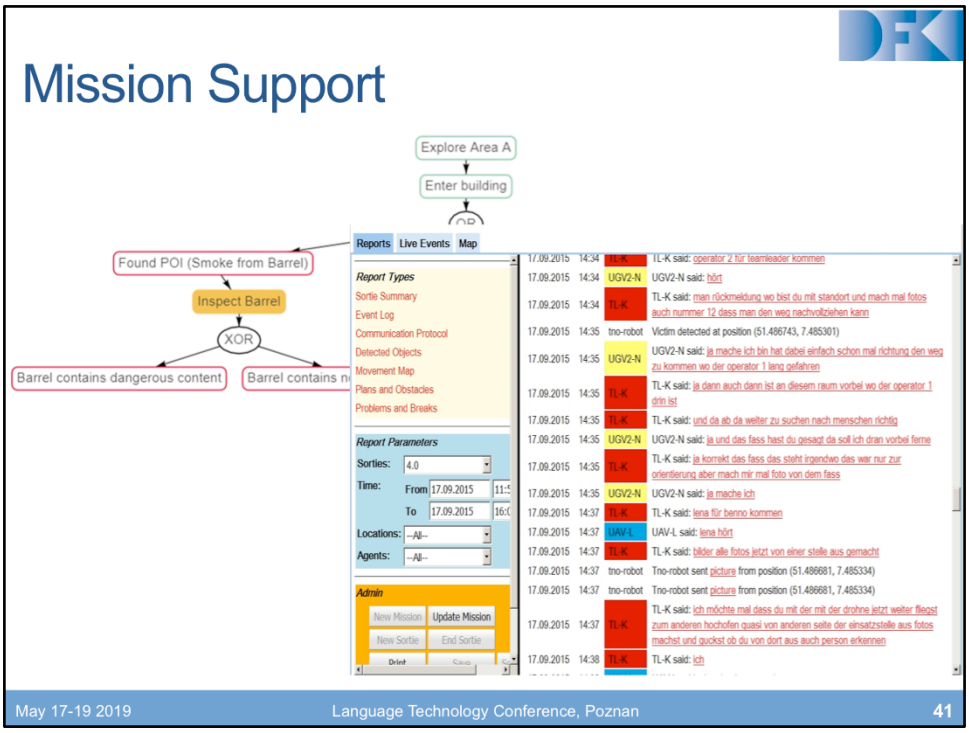


combining the representations

Mission knowledge extracted from the team communication is NOT ONLY useful for the the robots / robotic system.
It can be used to support the human team operation during the mission and mission documentation after the mission

Mission Support





Mission process model
Mission log

Summary

- Robots (can) improve disaster response
- Robots as team players require mission knowledge
  e.g., knowing the current task to act appropriately
- Mission knowledge is contained in human team communication
  - Understanding the dialogue act of a turn and what task it is about reveals task assignment
  - Off-the-shelf ASR is usable, needs domain adaptation
  - Dialogue act classification accuracy 78.9% with a context-sensitive RNN LSTM architecture
- Mission knowledge obtained from team communication enables various forms of mission support

Acknowledgements

2010-2013

Natural Human-Robot Cooperation in Dynamic Environments

nifti.eu

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rettungsrobotik.de

GEFÖRDERT VOM

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