

# A Cooperative Multiagent Architecture for Turkish Sign Tutors

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# Outline

- Sign Tutoring Tool;
- Possible Architectures;
- Case studies;
- Protocol;
- Suggestion for experimental setup and testing.

# Sign Language

- A sign is a combination of
  - Facial expressions
  - Head movements
  - Hand movements
- A sign only with hand movements is called a manual sign.
- A sign is called a non-manual sign when it also includes head movements or facial expressions.
- There are roughly 10000 signs in Turkish Sign Language.

# Sign Language Tutoring Tool

- The aim: Help users learn signs by watching recorded videos and trying the same signs on their own.
- The recorded video of a sign performance is analyzed by the system.
- The tool uses a classifier to recognize trials of users.
- The system gives the user feedback both verbally and by animation.
- Does not only recognize manual signs, but also non-manual signs.

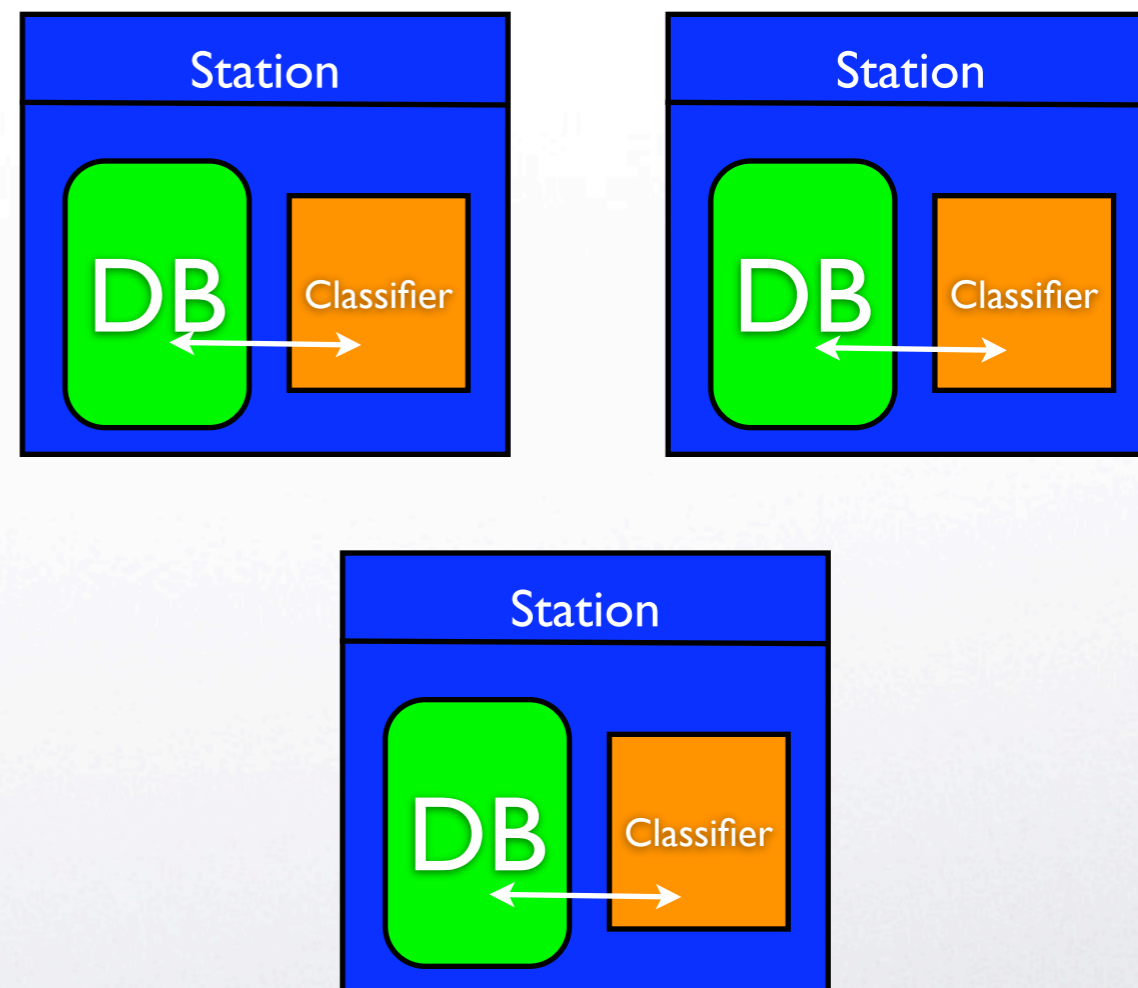
*An interactive System for Sign Language Tutoring, Oya Aran et. al., IEEE Multimedia, to appear 2008.*

# Sign Language Tutoring Tool



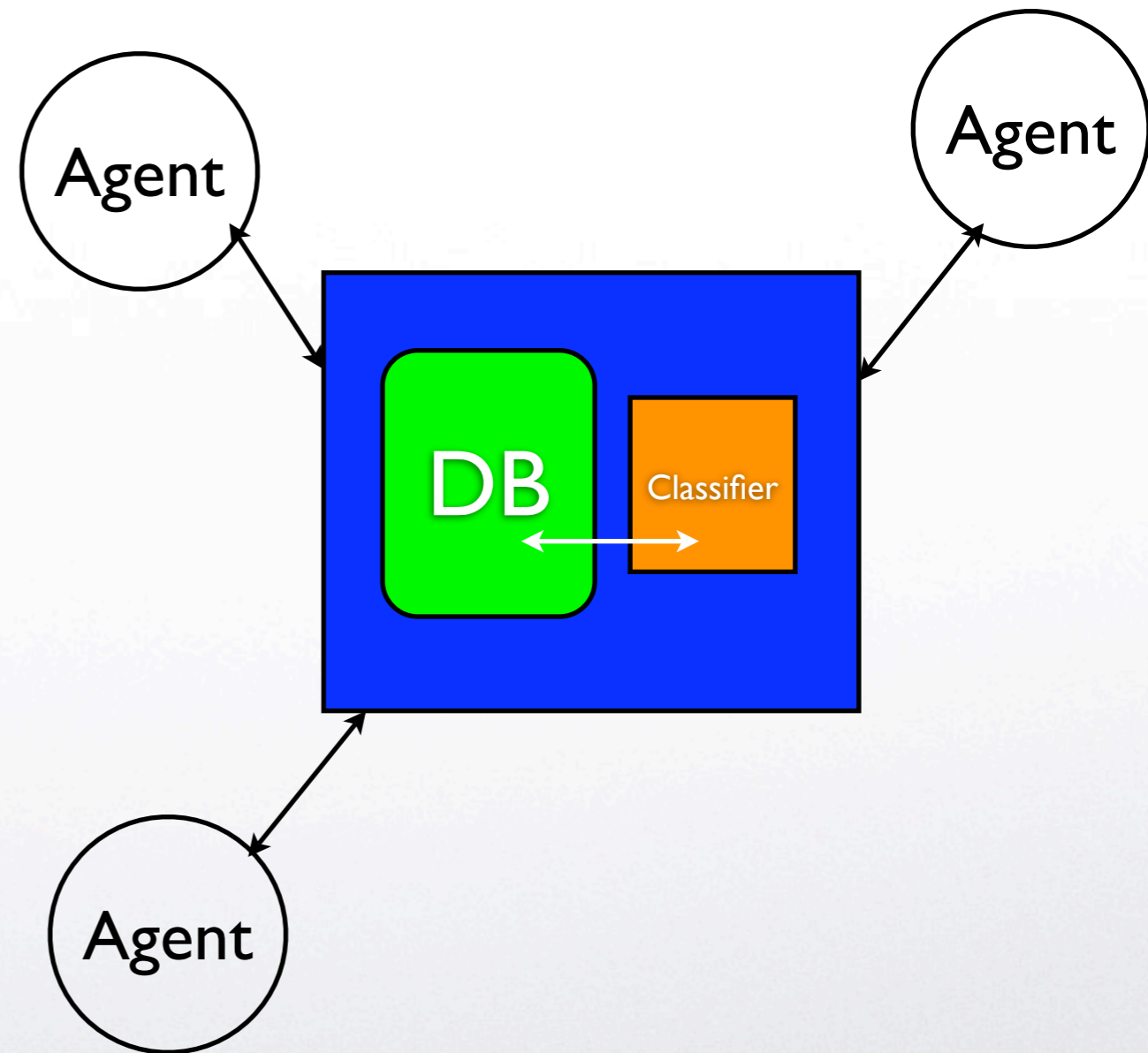
# A Stand-alone Collection of Stations

- The very same tool distributed to many different locations, and each tool is a station.
- No interaction between stations.
- Each station can improve due to learning and experience.
- Stations cannot pass their experiences to others and cannot benefit from experiences of others.



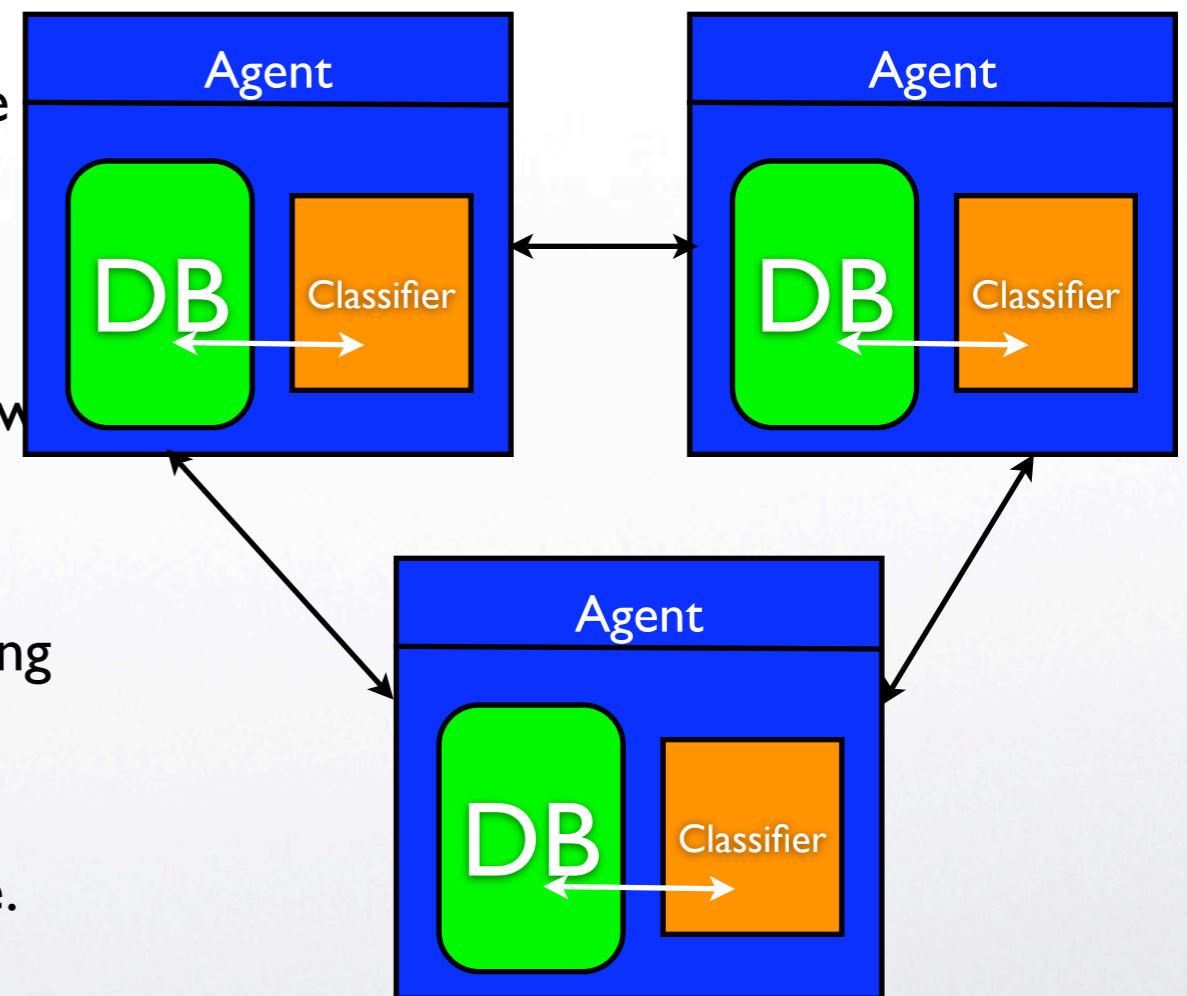
# A Distributed Architecture

- Agents are geographically apart.
- Share a common DB of signs.
- They may not always be online. Hence not be able to access the DB.
- Privacy concerns. The videos may belong to certain individuals.



# The Cooperative Multiagent Architecture

- Represent each station as an agent.
- Associate a local DB with each agent.
- Each agent can improve its classification performance to its own experience.
- An agent may decide to include a practice sign in its training data or a sign language teacher may add a new training data.
- Agents can help each other classify signs by exchanging classification requests.
- Each agent can itself make a decision even it is offline.
- Possibly provide more accurate classification as a result of cooperation.



# Case Study- I

- *Each agent can decide if a sign is performed right or wrong.*
- *However an agent may not have high confidence in its decision.*
- *The agent can request others to provide opinions. (i.e. in the form of votes)*

# Majority Voting

- Upon request of a help for an input performance, each agent responds as either the performance is correct or wrong.
- The agent which received the input performance from the user counts the number of corrects and wrongs. And the majority wins.
- Hence, a sign is accepted only if the majority of the agents accept it.

# Case Study-2

- *Previous case assumes that all agents are equally knowledgeable.*
- *There are two important criteria for decision:*
  - *Accuracy: How similar is the performance of the user to the real sign.*
  - *Certainty: How certain about that accuracy.*

# Weighted Majority

- Each agent, upon a request, can calculate an accuracy and a certainty for an input performance.
- The agent which is requested by the user to recognize a performance collects accuracies and certainties of other agents.
- The agent which received the input performance makes decision after weighting accuracy value of each responding agent by that agent's certainty.

# Case Study-3

- *What if number of agents is high?*
- *What if most agents have low certainty?*
- *The aggregation of their votes may influence the system in a wrong way.*
- *Instead, each agent can model others based on expertise and direct queries accordingly.*
- *Ex: The agent which is requested by the user to recognize her performance of the sign “theater” thinks that an agent knows very well signs about art and literature.*

# Model-based

- Each agent models other agents in the system.
- An agent, when it is requested by the user to recognize a performance, requests a subset of other agents for help. The agent decides which subset of agents to ask using its models.
- Since agents improve via experience, these models need to be dynamic. So we need methods for updating models of others.

# Referral System

- Since there are a lot of agents, each agent may not be able to model each other.
- If an agent does not know whom to ask exactly, it can ask to another agent that she thinks that may know.
- The queried agent may either reply an answer or refer to another agent.

# Composition

- *Agent is requested to recognize a sentence in sign language.*
- The sentence is divided into its parts.
- Agent decides on each part individually with support of other agents. And makes a final composed decision.
- How to combine individual decisions?

# Composition

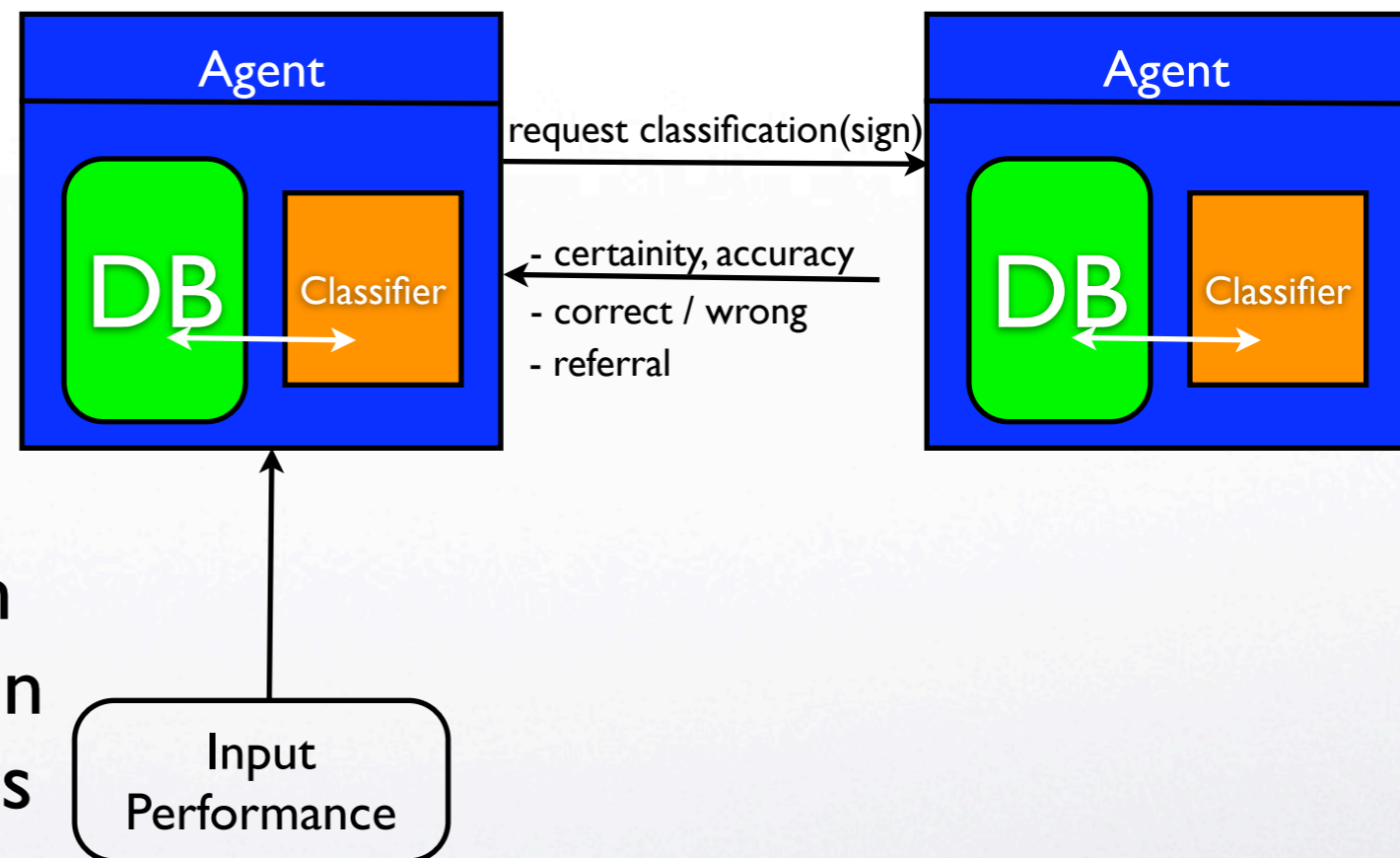
- Example: The user performs sign of “Turkish sign language”
- Agent has to come up with one composed decision as either accept or reject.
- After decision, “Turkish” is accepted, “Sign” is accepted, but “language” seems to be wrong.
- What should be the overall decision: accept or reject?

# Dialects

- There are dialects of Turkish Sign Language.
- *Assume there are two different signs for the word “father”. And two different agents are educated for the different “father”s.*
- Then here is the problem: For the performance of the sign “father” one agent says correct, whereas other says wrong and actually they are both saying the right thing.
- How to recognize and deal with dialects?

# Generic Multiagent Protocol

- Protocol depends on the approach.
- Although we do not have a critical bandwidth problem, there is a trade-off between accuracy of the final decision and the number of messages exchanged.



# Experimental Setup - Training

- A training data will be distributed to each agent. Each agent's training data is not disjoint from others, there may be intersections.
- Each agent will train its classifier using its portion of training data.
- The training data may include errors or variations of the same sign on purpose.

# Experimental Setup-Testing

- For majority and weighted majority voting, run test data over the system and calculate the percentage of success.
- For model-based approach measure how successful the models of agents are. And measure what the cost for each agent is.

# Conclusion

- Develop a cooperative MAS for sign language tutoring.
- Study different techniques for distributed decision making.
- Plans to experimentally evaluate the performance of such a system.

# Acknowledgement

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Thank you for listening!  
Let's discuss it!