Bi-directional Intention Recognition

Humans consistently convey internal state and planning information
- Informs co-workers’ predictive models of their behavior

Implicit communication improves performance
- Under temporal constraints
- With team fluency through co-worker anticipation

Communicating Intent at the subtask level
- Broadcasts intended motion paths
- Informs teammates of one’s goals
- Leads to fewer instances of turn-taking behaviors during collaboration
- Is a dynamically calibrating process

Enabling Multi-channel Communication

- How can robots generate non-verbal cues for known skills or learn to recognize such cues from others?
- How can robots overcome physical disparities to leverage communication channels humans understand?
- How can a robot identify human intent, and better use this information for action selection?

Role Selection With Human Teammates

Humans can decompose tasks into multi-role, multi-collaborator endeavors
- Leverages contextual knowledge
- Ambiguities are resolved by shared experience and environmental reasoning

Role assignment is not a static activity
- Pre-activity role assignment sets initial expectations
- Roles and responsibilities may overlap or be traded

Role selection through social modeling of co-workers
- Can be achieved with adaptive planning systems
- Improves fluency of action selection

Task decompositions must be comprehensible to both humans and robots
- Learned from low repetitions of skill sequences
- Parallelization of subtasks must often be inferred

Dynamic And Adaptive Role Assignment

- How can a robot synchronize its computed task decompositions with its human teammates?
- Given a set of roles and associated actions within a task decomposition, how does a robot know which roles to assume while minimizing conflict with team preferences?
- How can a robot effectively communicate its understanding of roles within a task to its teammates?

Performance vs. Preference Optimization

Some subtasks can be better suited for either robot or human execution
- Maximizing the duration of avoiding team roles when introducing co-robots requires careful design
- Violating worker preferences of process or role selection can be costly

Established teams can be reluctant to accept new members
- Robots bear the burden of instilling trust in co-workers, particularly within potentially dangerous tasks
- Demonstrations may be too complex or too costly to use as a means of proving readiness

Task performance criteria is complex
- Varies by team and task
- Incorporates elements that are difficult to quantify

Robot co-workers must balance multiple factors

- Time
- Money
- Energy
- Worker satisfaction
- Environment management
- Internal authorities
- Safety considerations

Modeling And Acting On Co-worker Subtask Proficiency

- When and how should a robot leverage information about which agents are best suited for particular subtasks?
- How can a robot adapt its role selection to optimally integrate with existing human teams?
- How can co-worker preferences be quantified, and when should a robot object to an observed role distribution?

Live Self-evaluation In Team Contexts

Evaluating oneself as a team member requires
- A shared mental model of the task
- Knowledge of co-workers’ roles and responsibilities
- Accurate estimates of expected task progress at various times

Contingency detection and planning
- Measures the impact one’s actions have on co-workers
- Helps model teammates’ personal or workspace boundaries

Self-evaluation as a “Team member” provides heuristics for
- Reinforcing role selections
- Refining skill execution choices
- Evaluating novel task decompositions

Success can have situationally-dependent definitions
- Self-improvement within subtask execution
- Reduction of team idle times
- Encouraging and building team cohesion

Using Teamwork Metrics To Drive Self-assessment

- How can a robot determine if it is performing in line with teammate expectations?
- What actions should a robot take if it detects it is underperforming within the context of a team?
- When is it appropriate for a robot to ask for help, if it means interrupting a teammate?