A Protocol for Validating Social Navigation Policies

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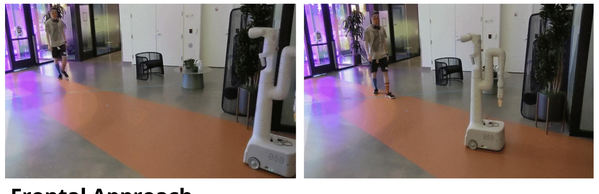
Objective

Define Benchmark Protocol for **Social Navigation Policies** with three objectives:

- **Realism:** the benchmark is implemented in a real environment, real robot, and real humans.
- **Scalability:** the benchmark allows for testing on a diverse set of social situations, with a cost which allows for frequent evaluations.
- **Repeatability:** the benchmark is repeatable across different runs and instantiations in different physical spaces.

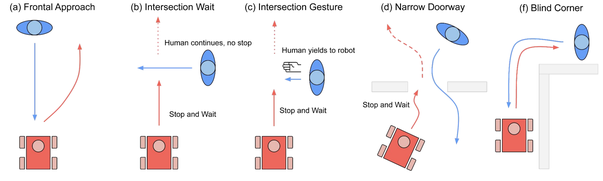


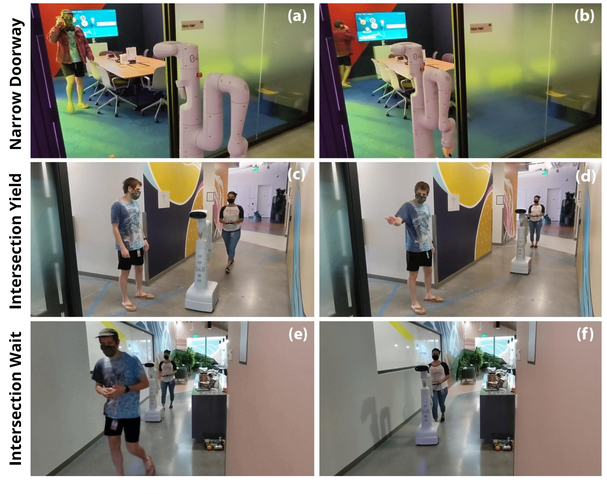
Frontal Approach

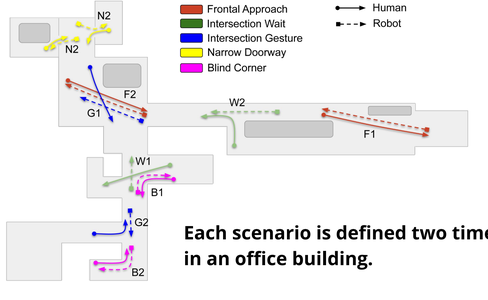
Approach

- Set of five **canonical social navigation scenarios** (e.g. frontal approach) that can easily be replicated by different labs.
- Metric based on an in-situ questionnaire to obtain **human experience ratings**.
- **Real world** environment with **real robots**.

Social Scenarios







Each scenario is defined two times in an office building.

In-Experience Ratings

Human Experience Ratings:

- We measure socialness with a **questionnaire in an in-situ setting**.
- Participants **are asked questions** after running the social interaction.
- Statements are formulated to provide answers on a **5-stage Likert scale**.

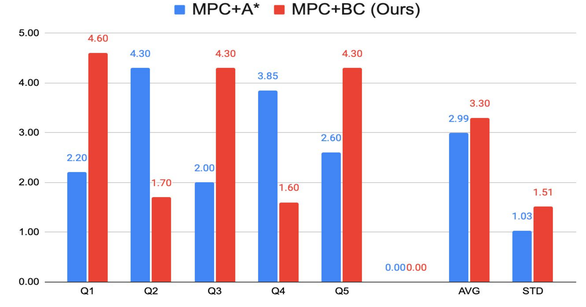
How much do you agree with the statement ...

Frontal Approach	
1	The robot moved to avoid me.
2	The robot obstructed my path.
3	The robot maintained a safe and comfortable distance.
4	The robot nearly collided with me.
5	It was clear what the robot wanted to do.
Intersection Wait	
6	The robot let me cross the intersection by maintaining a safe and comfortable distance.
7	The robot changed course to let me pass.
8	The robot paid attention to what I was doing.
9	The robot slowed down and stopped to let me pass.
Intersection Gesture	
...	
Narrow Doorway	
...	
Blind Corner	
18	The robot moved to avoid me.
19	The robot stopped to let me pass.
20	I had to move around the robot.
21	The robot nearly collided with me head-on.

Evaluation

MPC Baseline vs Social Imitation Learning:

- **MPC+BC:** Waypoints chosen for MPC navigation by a behavior cloning policy trained on human expert trajectories for frontal approach scenario.
- **MPC+A*:** Baseline MPC with A* waypoints.



Evaluation

- In-situ human rating questionnaire showed significant differences between policies.
- For 3 of 5 questions, **MPC+BC** trained on frontal approach was superior to the baseline **MPC+A*** not trained on frontal approach, as expected.

Blind Corner : Collision Example (see persons foot):