

July 2021

Iterative Program Synthesis for Adaptable Social Navigation

Jarrett Holtz¹ (johltz@utexas.edu),
Simon Andrews², Arjun Guha², and
Joydeep Biswas¹

¹Department of Computer Science,
University of Texas at Austin
²Department of Mechanical Engineering,
University of Texas at Austin

Motivation

End-User Behavior Design and Deployment

Empower end-users to design and adapt social navigation behaviors to accomplish personalized objectives in unstructured human environments.

Motivation

IDIPS Overview

Iterative Dimension Informed Program Synthesis (IDIPS)

How can end-users intuitively learn and adapt policies for changing requirements or unexpected scenarios?

A program synthesis approach that combines parameter optimization, program repair, and synthesis to learn and adapt symbolic action selection policies from a small number of human demonstrations.

[Holtz and Andrews and Guha and Biswas, 2021]

Action Selection Policies

Preferences

Symbolic Policies

Symbolic Policies for Social Navigation

Predicates: Simple & (tiny) Parameter

```

if (a_i == GoAlone && |p_r - H_p[0]| > 2.0) : return GoAlone
elif (a_i == GoAlone && (p_r - H_p[1]).x > 1.0 &&
v_r.x - H_v[0].x > 0.0 && |p_r - H_p[0]| <= 2.0) : return Pass
elif (a_i == GoAlone && (p_r - H_p[1]).x <= 1.0
&& |p_r - H_p[0]| <= 2.0 ||
v_r.x - H_v[0].x <= 0.0 && |p_r - H_p[0]| <= 1.0) : return Follow

```

Symbolic Policies

Why Symbolic Policies?

Interpretable + Adaptable + Data Efficient

```

if (a_i == GoAlone && |p_r - H_p[0]| > 2.0) : return GoAlone
elif (a_i == GoAlone && (p_r - H_p[1]).x > 1.0 &&
v_r.x - H_v[0].x > 0.0 && |p_r - H_p[0]| <= 2.0) : return Pass
elif (a_i == GoAlone && (p_r - H_p[1]).x <= 1.0
&& |p_r - H_p[0]| <= 2.0 ||
v_r.x - H_v[0].x <= 0.0 && |p_r - H_p[0]| <= 1.0) : return Follow

```

IDIPS

Iterative Dimension Informed Program Synthesis (IDIPS)

Iterative system for learning and adapting ASPs for social navigation from demonstration.

IDIPS

Synthesis Module

IDIPS

Fault Localization

IDIPS

Parameter Optimization

IDIPS

Parameter Optimization

IDIPS

Synthesis Module

IDIPS

Synthesized Policy Performance

Demo Set	Satisfied (%)		# of Demo Timesteps
	Nice-I	Greedy-I	
Nice	92	76	5642
Greedy	81	94	2618

Fig. 9: Percentage of demonstration sets satisfied per policy.

Fig. 6: Performance for synthesized policies and baselines. The shaded regions around lines represent the 90% confidence intervals.

IDIPS

Novel Scenario Policy Performance

Policy	Success Rates (%)	
	Simulation	Real World
Nice-I	92	76
Greedy-I	81	94

Fig. 10: Success rates for different ASPs on closed door scenarios.

IDIPS

Adapting for Novel Scenarios - Real World

Drives too close for door to open!

Waits at safe distance!

July 2021

Iterative Program Synthesis for Adaptable Social Navigation

Jarrett Holtz¹,
Simon Andrews², Arjun Guha², and
Joydeep Biswas¹

¹Department of Computer Science,
University of Texas at Austin
²Department of Mechanical Engineering,
University of Texas at Austin