Intention Perception and Human-Robot Interaction

"We" =

David Pautler

Bryan Koenig **social psychologist**

Edwin Wirawan **engineer**

Kumaresh **engineer**

Kum Seong Wan **psychologist**

Personal Background

- PhD in Natural Language Generation,
  - "Computable Social Communication"

- Software engineer—Spoken Dialog Systems—9 years

- Research manager—A*STAR Singapore—6 years
  - Detecting Alzheimer's through serious games
  - Cognitive model of intention recognition, "intention perception"

- AI & NLP consultant—NZ—international clients

David
Pautler

Personal views on HRI

Three main challenges:
1. Tracking human activity to detect opportunities to offer assistance
2. Having a rich model of human activity and needs in order to generate relevant plans
3. Tracking human readiness to engage in any system-initiated proposals

Many HRI systems, especially museum guides, *finesse* these challenges rather than solve them.

If we're going to get HRI systems into hospitals and nursing homes in time to help with the coming tsunami of elders needing care, we need to take these challenges head-on.

Personal views on HRI, part 2

- We've made a good start on challenges 1 and 2 via activity recognition and AI planning, but less so on having rich models of humans.

  - For example, even Lenat's Cyc project has avoided creating models of human psychology.

- Progress on challenge 3 is at an even earlier stage. Horvitz's BusyBody initiative[1] is the most advanced system I know of.

- This talk focuses on progress toward computer systems that can recognize human activities *and* their driving psychology.

What is "Intention Perception"?

- The ability to make good guesses about other people are trying to achieve, just by watching what they do

- We all do this every few minutes of every day

Navigating
shared space

Working
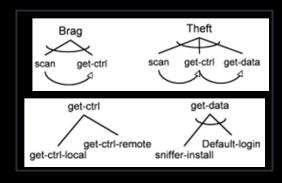collaboratively

Recognizing that
others need help

Related subfields

Biological motion studies
(Psychology & Neuroscience)
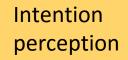
Activity recognition
(Computer vision)

Plan recognition
(Artificial Intelligence)

Character animation techniques

Intention perception

Causal perception (Psychology)
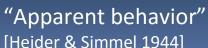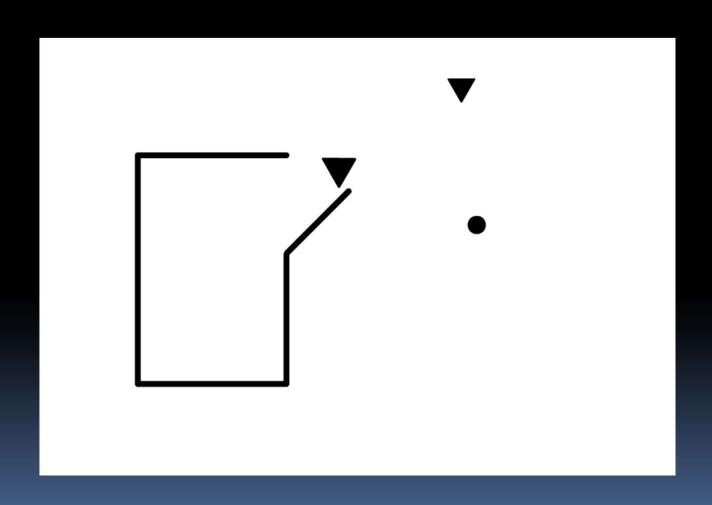
Animacy / Agency perception
(Psychology)

"Apparent behavior"
[Heider & Simmel 1944]

Event perception
(Psychology)

It started in 1944 in Kansas...

From Heider & Simmel's 1944 experiment in social psychology

Comparison of Models

There have been 3 kinds of models:

1. Schema-matching (Grammar-based)

2. Fast-and-frugal heuristics (Induced decision trees)

3. Bayesian inference

We propose 8 design objectives for evaluating these

MODEL 1: Schema-matching

Target Intentions = {Approach, OpenDoor, PalAlong, LookIn, Kiss, Hit (agent), Break (obj)}

Bob Thibadeau

Schema snippet

CON:	**HIT**(aggressor,aggressee)
COLLECT:	MoveToward(aggressor,aggressee) **AND** At(aggressor,aggressee) **AND** (MoveFaster(aggressor,aggressee) **OR** notMoveToward(aggressee,aggressor))
ACHIEVE:	At(aggressor,aggressee)

Hand-coded representation of each of _1690_ frames

Frame 2:
(door open)
(at largeTriangle houseInterior)
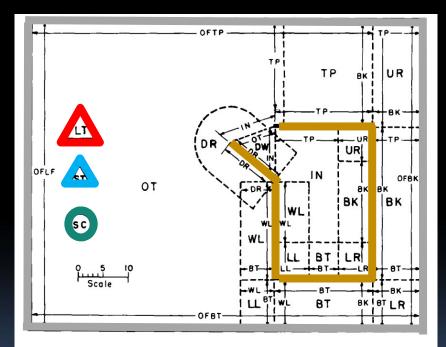(move largeTriangle normalSpeed)
…

Figure 2. Worksheet for analyzing film frames in the Heider and Simmel Film. The heavy linework, including the box with the door, the small circle, and the large and small triangle, could appear in a film frame. The dotted lines demarcate places, for example, the doorway (DW). The arrow lines label surfaces against which actors can move, for example, in (IN) or out (OT), or toward the back of the box (BK).
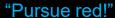
MODEL 2: Frugal heuristics

Target intentions = {Pursue/Evade, Fight, Court/BeCourted,
Lead/Follow, Invade/Guard,
PlayTogether}

"Pursue red!"

"Evade blue!"

Clark Barrett
Anthropologist

Philip Blythe
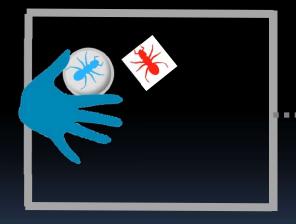
Peter Todd

Geoffrey Miller

MODEL 2: Frugal heuristics

Target intentions = {Pursue/Evade, Fight, Court/BeCourted,
                          Lead/Follow, Invade/Guard,
                          PlayTogether}

Pursue/Evade   Court/Be Courted

Time
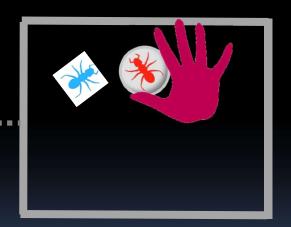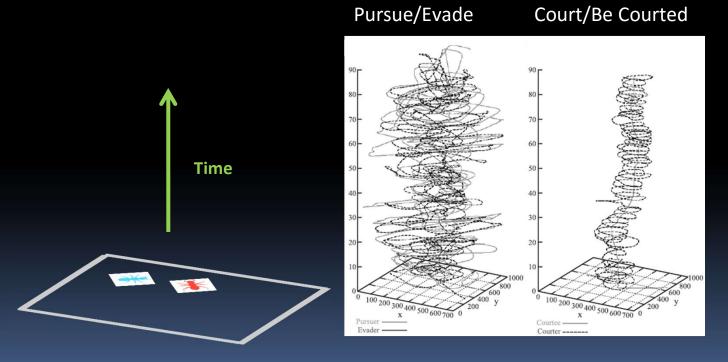
Derived measures:
1. Relative distance
2. Relative velocity
3. Relative vorticity
4. Relative heading
5. …
6. …
7. …

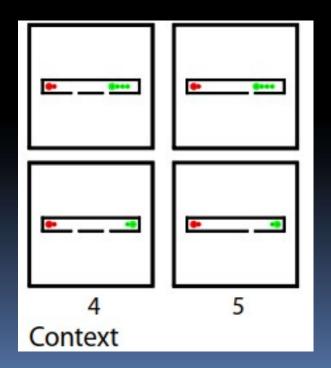# MODEL 3: Bayesian inference

Target intentions = {

Red *approaching* Green, Red *avoiding* Green,

<roles swapped>, Cant-tell}
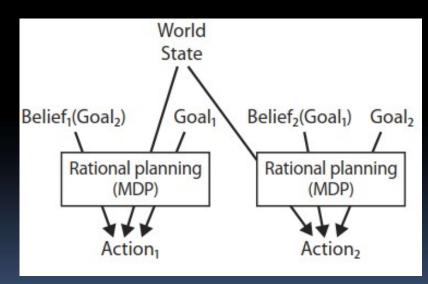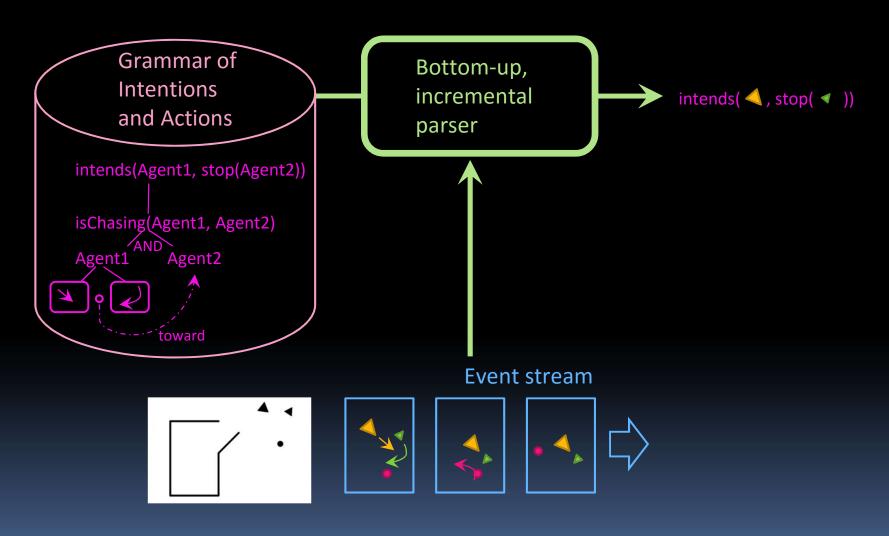
Josh Tenenbaum

Chris Baker

Rebecca Saxe

Noah Goodman

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Context

World State

Belief$_1$(Goal$_2$)   Goal$_1$ Belief$_2$(Goal$_1$)   Goal$_2$

Rational planning (MDP)   Rational planning (MDP)

Action$_1$ Action$_2$

How to Compare the Models?

Proposed design objectives
1. Be capable of recognizing intentions or physical causes
2. Form hypotheses as the action unfolds, not at end
3. Maintain competing hypotheses until evidence is decisive
4. Scenarios should have representative richness such as obstacles
5. Model folk psychology, not scientific theories like Newtonian motion
6. Allow for gradual augmentation to the model
7. Use known psychological cues such as spatial context
8. The system should formulate hypotheses, not be provided them

A New Schema-Matching Model

Grammar of Intentions and Actions

intends(Agent1, stop(Agent2))

isChasing(Agent1, Agent2)

AND

Agent1   Agent2

toward

Bottom-up, incremental parser

intends(◀ , stop(◀))

Event stream

https://github.com/David-dp-/intentionperception-wayang

Suggestion for this audience

Build consensus on design objectives for IR in HRI.

Suggestions for HRI

1. Create a software-only chatbot version of your target application before starting hardware design (or in parallel).

   1. For sensors, use mocked data in combination with testing by scripted actors

   2. Delaying software development will kill your project in the end

   3. If hardware design fails, you still have a strong project (or even a sellable product)

Suggestions for HRI, part 2

2. Save time by using industry-standard packages. For example, script the chatbot using VoiceXml and the JVoiceXml open-source platform.

3. This will not be adequate, but it will reveal where the substantive challenges are. Your contribution is to find and adapt research projects for those challenges.

   1. For example, make an intention-perception system tractible and capable of learning.

   2. This may seem obvious or pedantic, but I see several projects not doing this.

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Thanks for your attention

david@intentionperception.org