

# Building Interactive Systems

# Modeling Users

**Professor Bilge Mutlu | Spring 2023**

# Recap: **Class Mantras**

*What are the three mantras of this class so far?*

1. Everything is a system.
2. System design must be human-centered.
3. Modeling enables analysis and synthesis.

# What we will cover today

1. Modeling user types
2. Modeling user activities
3. Modeling user goals
4. Reading group discussion

# What do we mean by **modeling**?

What do we model when we model?

- Who is the users?
  - *Archetypes, tendencies, personas*
- What is the user doing?
  - *How, and that, they perform a certain task*
- What is the user's goal?
  - *What are their states, needs, intents?*



# Modeling User Types — Who is the user?

## Definitions

A **user profile** is a dynamic repository used to categorize, characterize, and prioritize a system's target user groups, sub user groups, and uses (applications) of the system.<sup>1</sup>

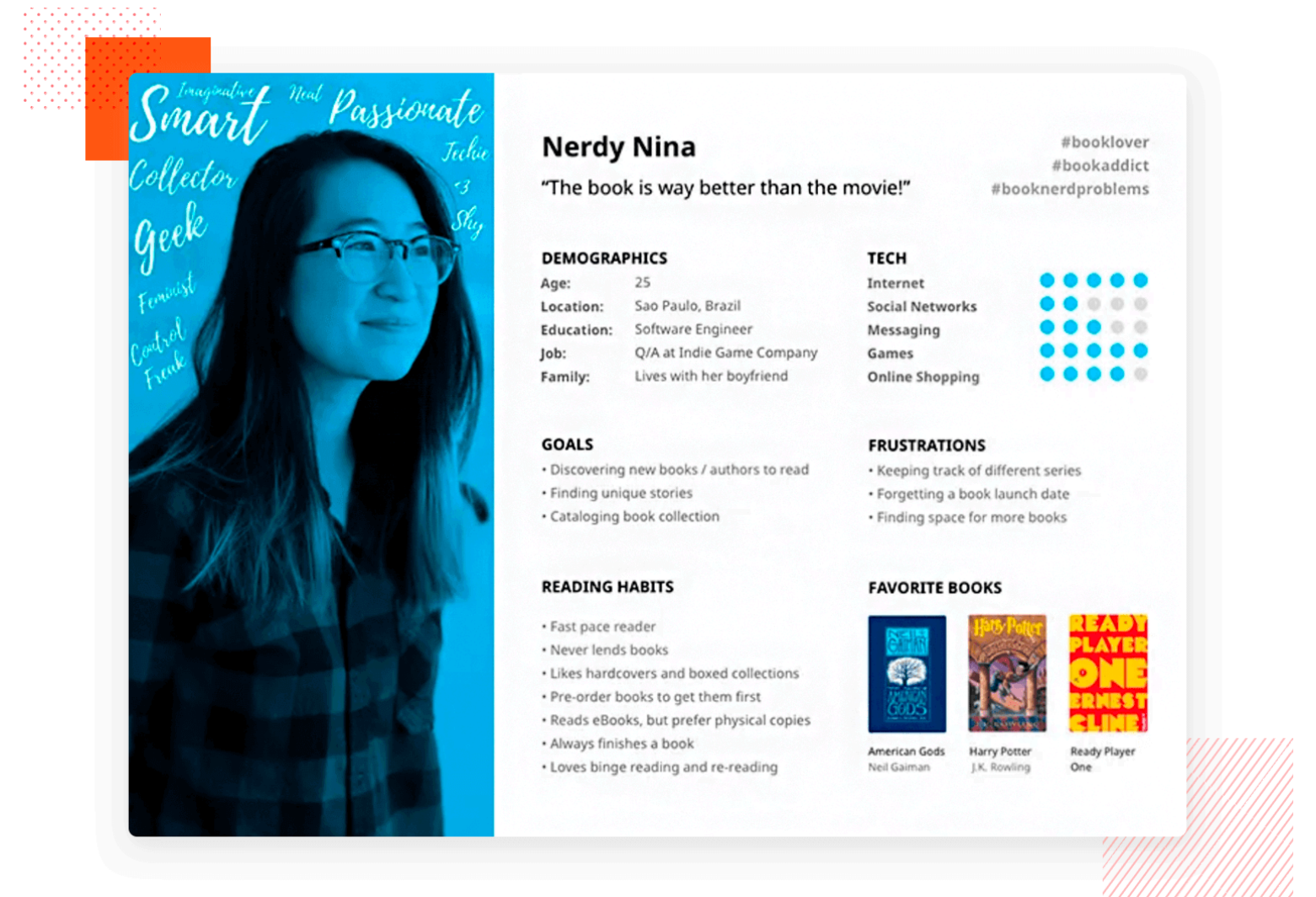
A **persona** consolidates archetypal descriptions of user behavior patterns into representative profiles, to humanize design focus, test scenarios, and aid design communication.<sup>2</sup>

<sup>1</sup> LeRouge et al. (2013). User profiles and personas in the design and development of consumer health technologies. *International journal of medical informatics*.

<sup>2</sup> Hanington & Martin (2019). Universal methods of design expanded and revised: 125 Ways to research complex problems, develop innovative ideas, and design effective solutions. Rockport.

# How personas are developed?

1. Collect rich data on the target users of the system through field research
  2. Identify behavioral patterns and themes that make up commonalities
  3. Synthesize similarities across users into clusters that make up aggregate archetypes
- Surveys hide distinguishing characteristics
  - No more than 3–5 personas per project
  - Represent in page-length descriptions
  - Narrative descriptions; life situation, goals, and behaviors; images



## Affinity diagramming to generate archetypes<sup>2</sup>

## Example persona presentation<sup>3</sup>

<sup>2</sup> Hanington & Martin (2019). Universal methods of design expanded and revised: 125 Ways to research complex problems, develop innovative ideas, and design effective solutions. Rockport.

<sup>3</sup> Justinmind: 30 must-see user persona templates

# Detour: What is **affinity diagramming**?

**Definition:** Affinity diagramming is a process used to externalize and meaningfully cluster observations and insights from research, keeping design teams grounded in data as they design.<sup>2</sup>

Also a method of qualitative, inductive (bottom-up) data analysis.

<sup>2</sup> Hanington & Martin (2019). Universal methods of design expanded and revised: 125 Ways to research complex problems, develop innovative ideas, and design effective solutions. Rockport.



## Affinity diagramming process:<sup>2 4</sup>

1. Place observations on post-it notes
2. Group and label post-it notes
3. Characterize high-level categories



organizing my information

Green notes describe an overarching area of concern within the work practice.

show me what I have to do

Pink notes describe specific issues within an area of concern.

daily to-do lists help me track progress

I want it printed in front of me

don't interrupt me with non-critical stuff

Blue notes describe aspects of an issue revealed by clusters of yellow notes.

U3 302 likes the prioritization format in her day planner

U2 221 prints calendar several times a day and hangs them next to her computer

U5 523 has his email set so only urgent mail is automatically opened

Yellow notes represent a single observation, insight, concern, or requirement firmly rooted in research data. These are the building blocks of the affinity diagram.

U5 518 makes a report for group with day's hot tasks every day

U7 743 transfers meetings from email to wall calendar

U1 12 keeps her inbox behind her so she won't be interrupted

U1 38 checks things off her to-do list as she finishes them

U3 351 likes getting an email with tasks rather than a phone call so she can print it

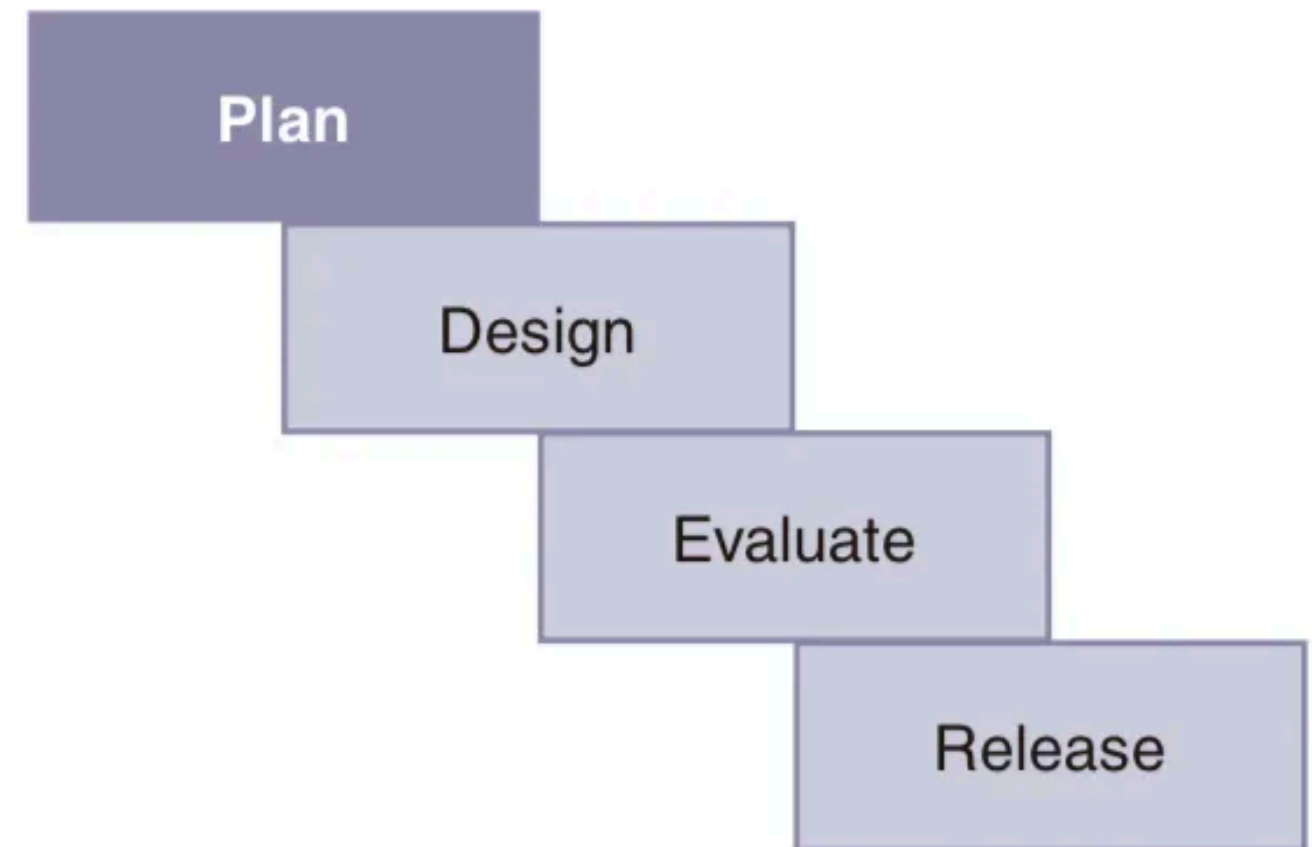
<sup>2</sup> Hanington & Martin (2019). Universal methods of design expanded and revised: 125 Ways to research complex problems, develop innovative ideas, and design effective solutions. Rockport.

<sup>4</sup> Muzli - Design Inspiration

# How do we use personas in system design?

Personas can be used across four stages of system design:<sup>5 6</sup>

1. Planning the system by testing requirements
2. Scenario-based design
3. Evaluating system design, e.g., walkthroughs
4. Communication across teams



<sup>5</sup> Pruitt & Adlin (2010). [The persona lifecycle: keeping people in mind throughout product design](#). Elsevier.

<sup>6</sup> UX Design Collective: [A Personas Guideline, From What They Are to How To Use](#)

# Modeling User Activities — **What is the user doing?**

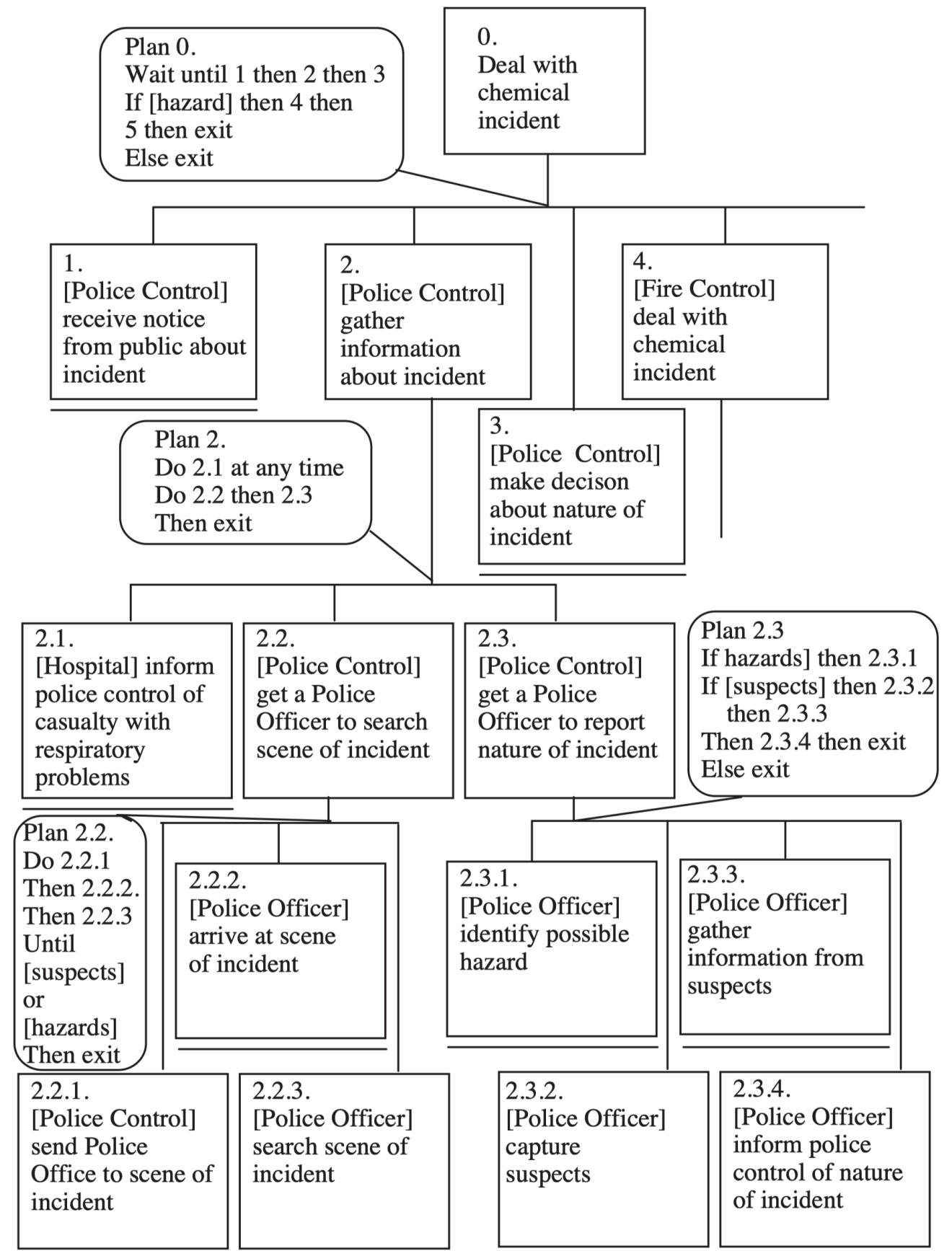
**Definition:** Building models of user tasks, activities, actions, and behaviors in order to enable an interactive system to track them.

Usually involves building quantitative or computational models of qualitative observations.

Modeling methods can be *manual* (e.g., hierarchical task analysis) or *automated* (e.g., hierarchical task networks).

# Hierarchical Task Analysis

**Definition:** A hierarchical task analysis (HTA), which describes the activity or workflow to be analyzed in terms of a hierarchy of goals, sub-goals, operations, and plans.<sup>7</sup>



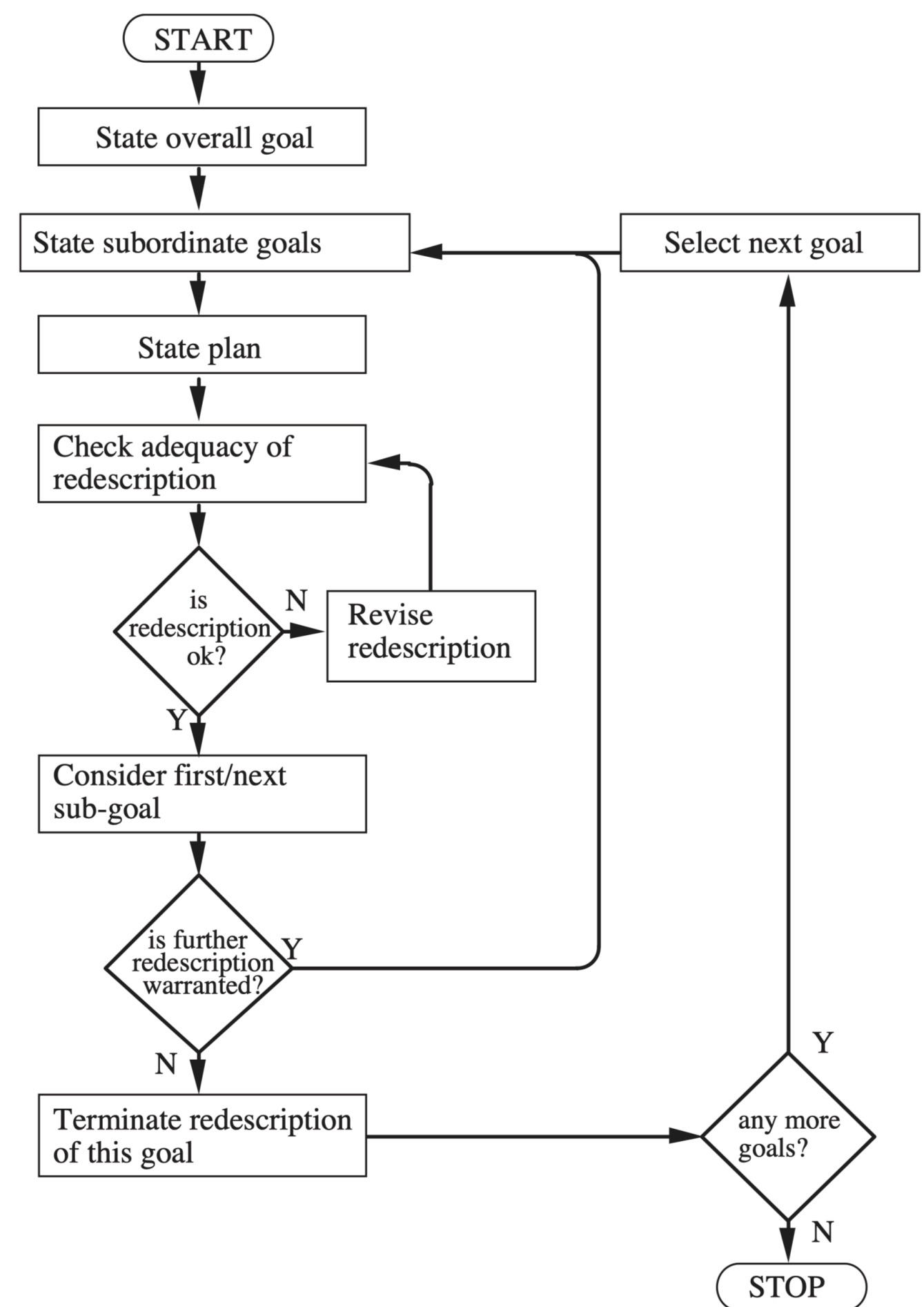
<sup>7</sup> Stanton (2006). *Hierarchical task analysis: Developments, applications, and extensions. Applied ergonomics.*



HTA process:<sup>7</sup>

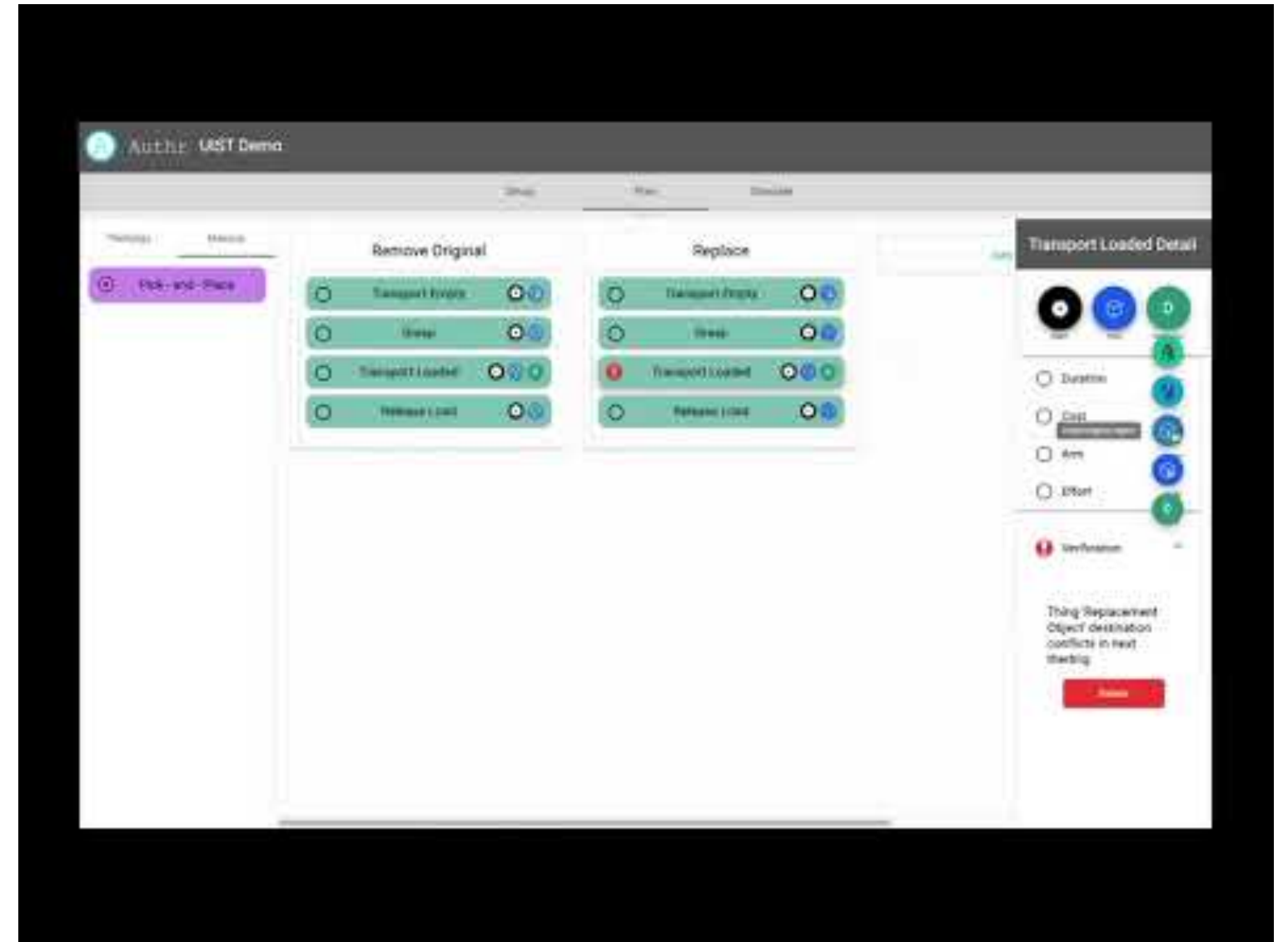
1. Define the purpose of the analysis
2. Define the boundaries of the system
3. Access a variety of sources of information about the system
4. Describe the system goals, sub-goals
5. Keep a small number (i.e., 3–10) of immediate sub-goals under any super-ordinate goal
6. Link goals to sub-goals; describe the conditions under which sub-goals are triggered
7. Stop re-describing the sub-goals when you judge the analysis is fit-for-purpose
8. Try to verify the analysis with subject-matter experts
9. Be prepared to revise the analysis

<sup>7</sup>Stanton (2006). *Hierarchical task analysis: Developments, applications, and extensions*. *Applied ergonomics*.



# Modeling Tools

Example modeling tool: Authr<sup>8</sup> <sup>9</sup>

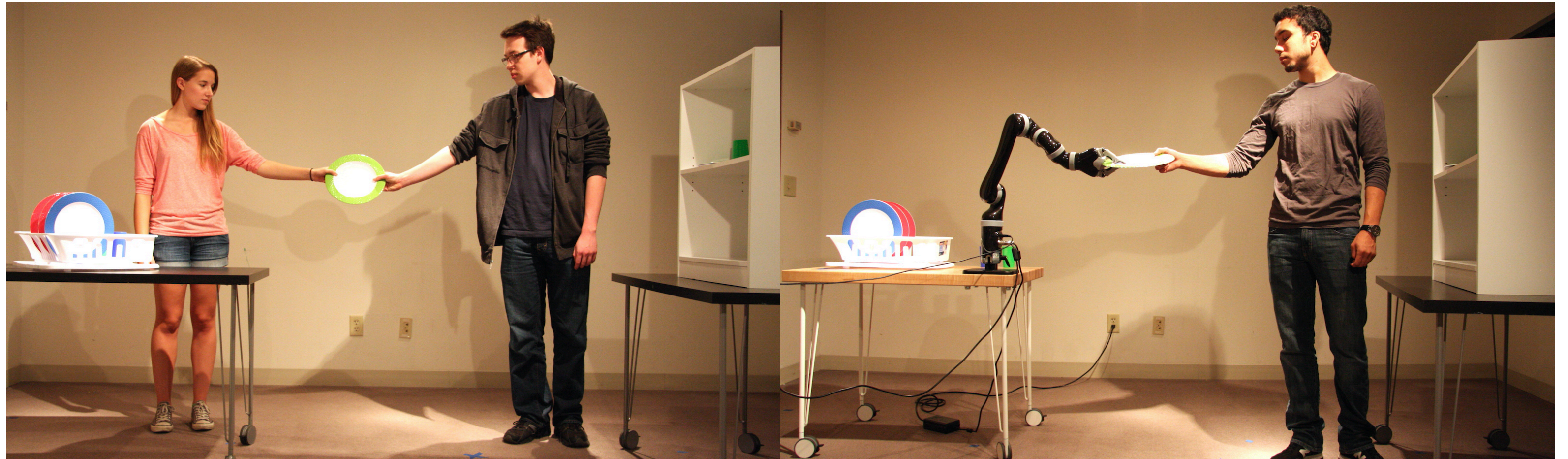


<sup>8</sup> Schoen et al. (2020). Authr: A Task Authoring Environment for Human-Robot Teams. *UIST*.

<sup>9</sup> Using Authr to construct HTAs



# Modeling User Activities<sup>10</sup>

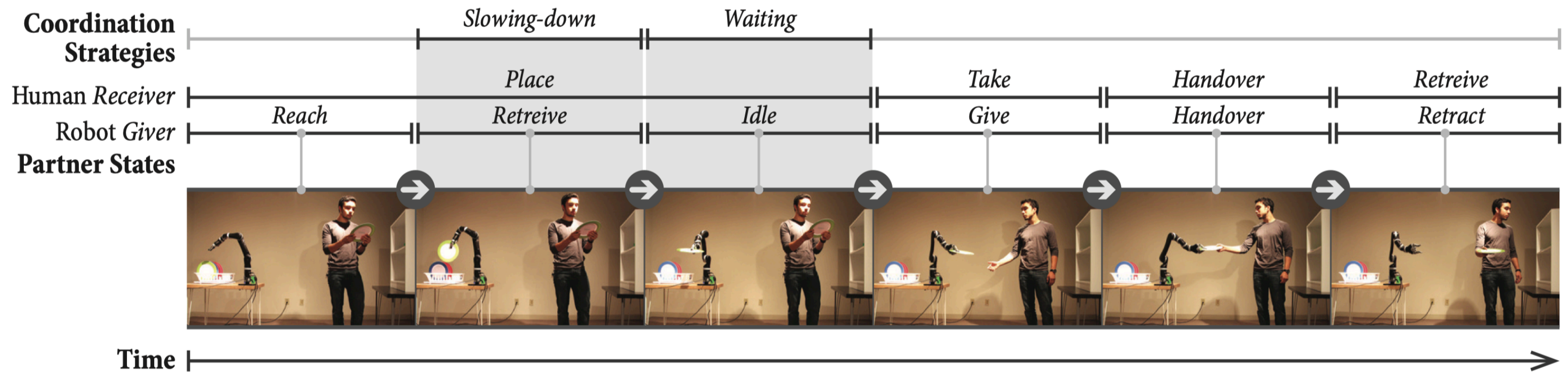


<sup>10</sup> Huang et al. (2015). Adaptive Coordination Strategies for Human-Robot Handovers. In *Robotics: science and systems*.



# DATA COLLECTION

## UNLOADING DISHES



# **SYNCHRONIZED COORDINATION**

## **ROBOT-HUMAN HANDOVERS**

# Modeling User Goals — **What is the user's goal?**

**Definition:** Modeling action-goal/intent relationships in order to recognize, track, predict user goal/intent from observations of behavior.





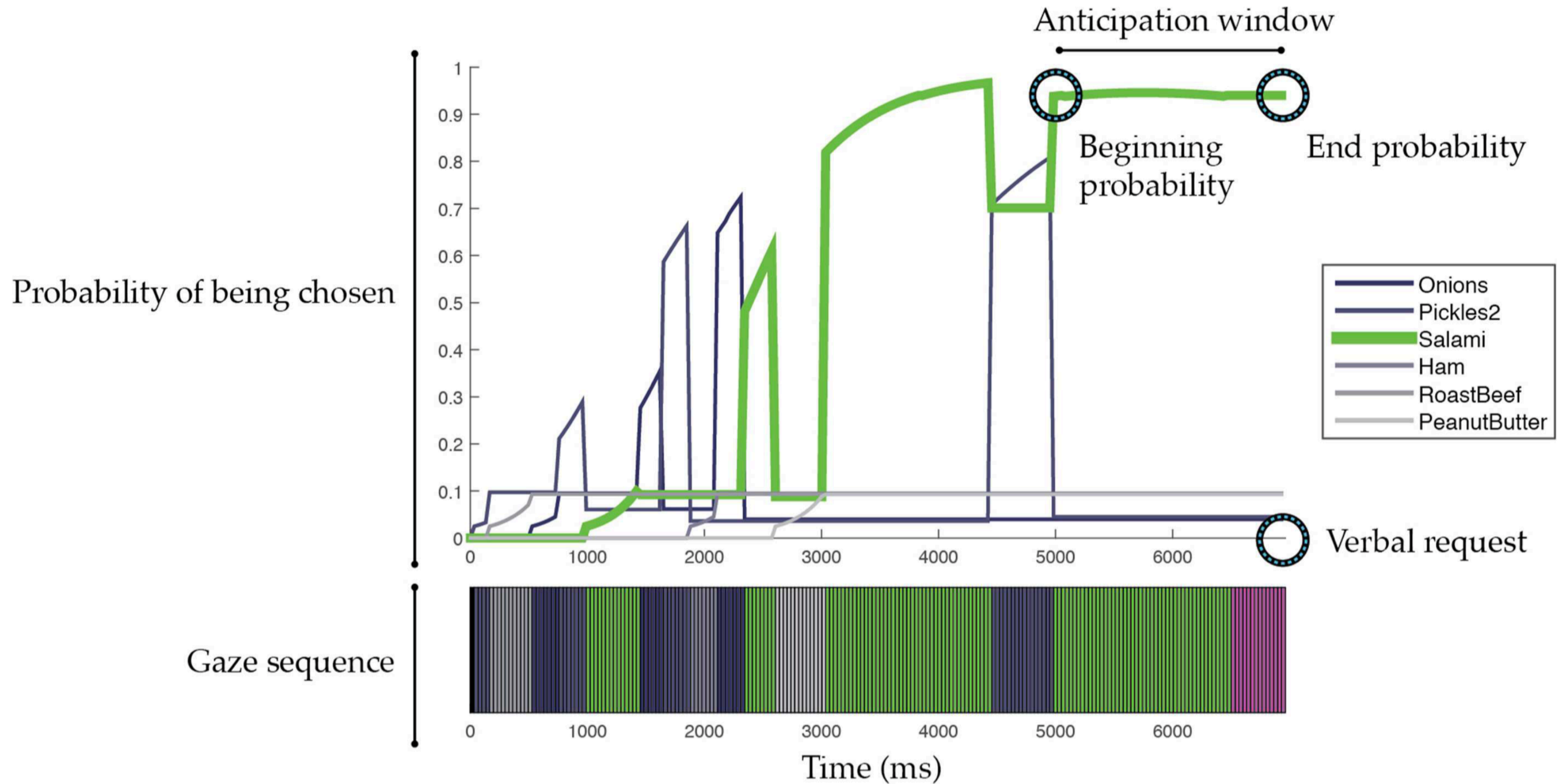


SVM classifier, using features:

1. **Feature 1:** Number of glances toward the ingredient before the verbal request (Integer)
2. **Feature 2:** Duration (in milliseconds) of the first glance toward the ingredient before the verbal request (Real value)
3. **Feature 3:** Total duration (in milliseconds) of all the glances toward the ingredient before the verbal request (Real value)
4. **Feature 4:** Whether or not the ingredient was most recently glanced at (Boolean value)

Performance:

- 76.36% accuracy with a baseline of 4.35–11.11%
- Anticipation window of 1831 msec



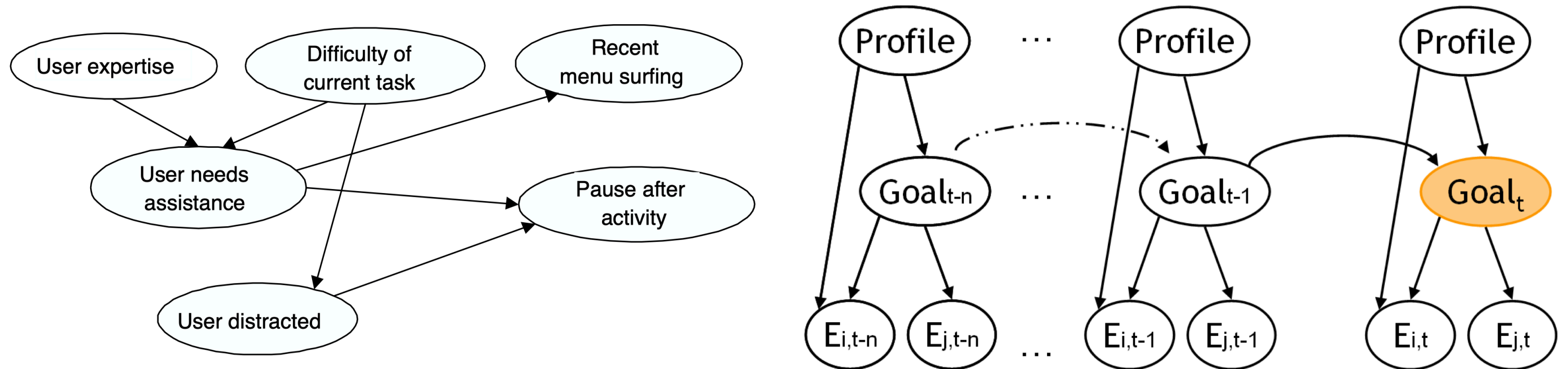






# Bayesian User Models<sup>12 13</sup>

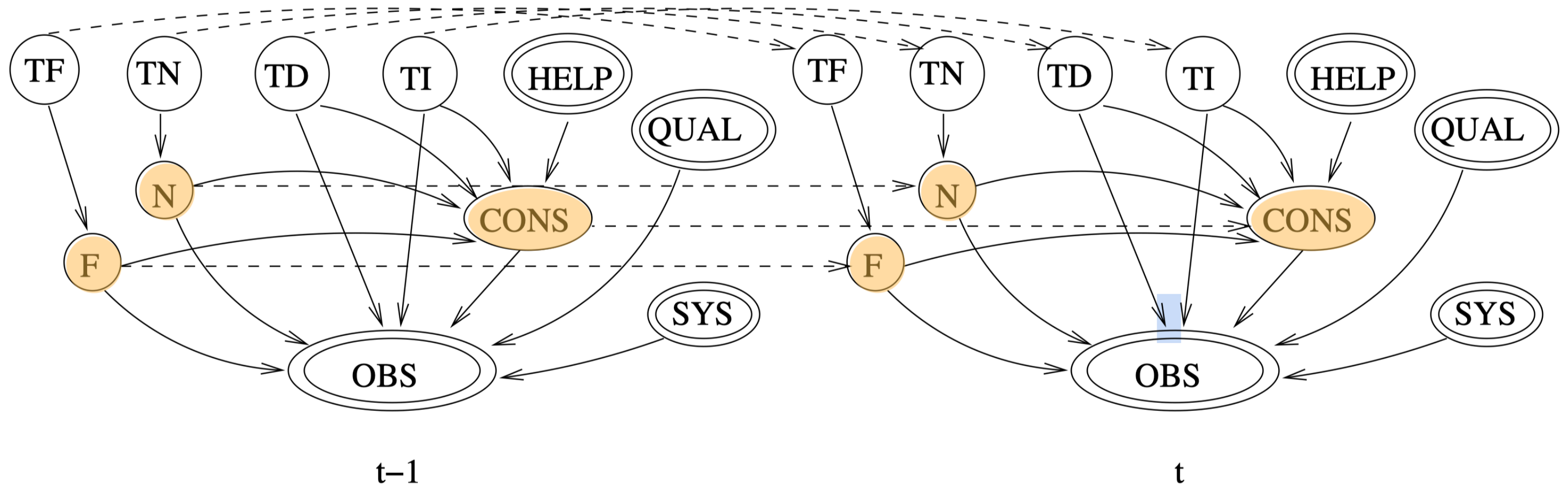
Decision networks used to model factors that affect whether users need help and goals based on past states.



<sup>12</sup> Horvitz et al. (2013). The Lumiere project: Bayesian user modeling for inferring the goals and needs of software users. In *Proceedings of the Fourteenth Conference on Uncertainty in Artificial Intelligence*.

<sup>13</sup> Rohrbach & Schmidt (2008). Intelligent User Interfaces: Modelling the User. *University Lecture Artificial Intelligence*.

DBNs can predict user states, e.g., frustration (F), neediness (N):<sup>13 14</sup>



<sup>13</sup> Rohrbach & Schmidt (2008). *Intelligent User Interfaces: Modelling the User*. University Lecture Artificial Intelligence.

<sup>14</sup> Hui & Boutilier (2006). *Who's asking for help? A Bayesian approach to intelligent assistance*. In *Proceedings of the 11th international conference on intelligent user interfaces*.

# How do we build user models?

## What we need:

- Observations
- Modeling decisions
- Tools, methods

## Questions to consider:

- What are we modeling? User types, activities, goals?
- What data is available to us?
- What is the goal? Tracking, prediction, adaptation, proactive help?

# Reading Group Discussion

# INTEGRATE Projects

- Semester-long project that brings together sensing, modeling, decision-making, interaction
- Teams of 5 that will be formed on Wednesday
- First milestone in two weeks