# Workflow Complexity for Collaborative Interactions

*Where are the Metrics?* - A Challenge

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# Motivation

- Human-Agent Collaboration
  - Humans and agents working together to achieve goals
  - Agents: Can be embodied, virtual, or hidden (system)
- Humans generate goals and preferences
- Agents generate plans and execute some parts
- Humans need to “understand” the generated plans
  - Interactive collaboration is impossible without this
  - Planner cannot rank/evaluate alternatives without an understanding of the human’s understanding
- Interactions can be modeled as workflows
- Workflow Complexity: Interaction C + Action C

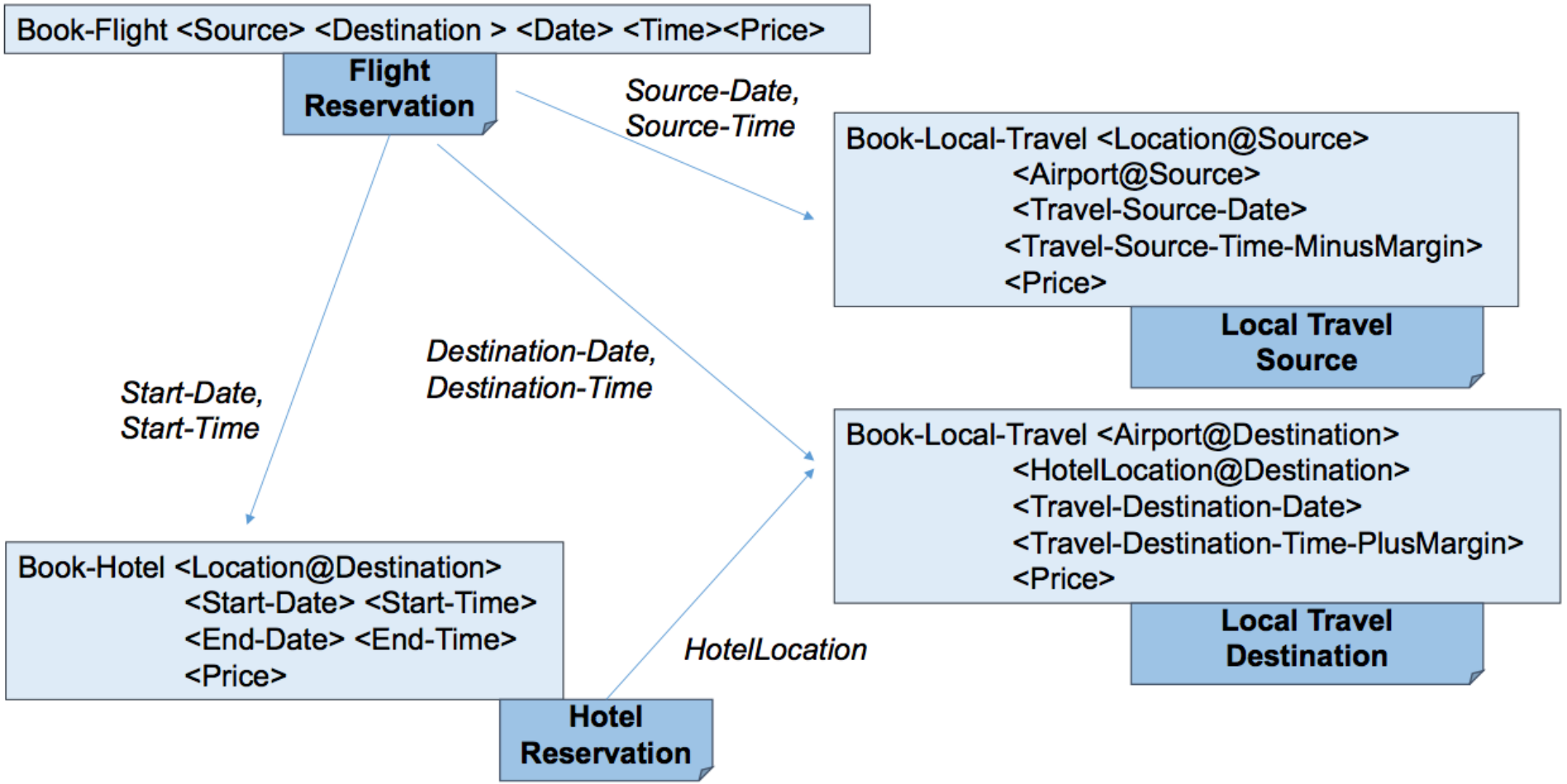
# Prior Work

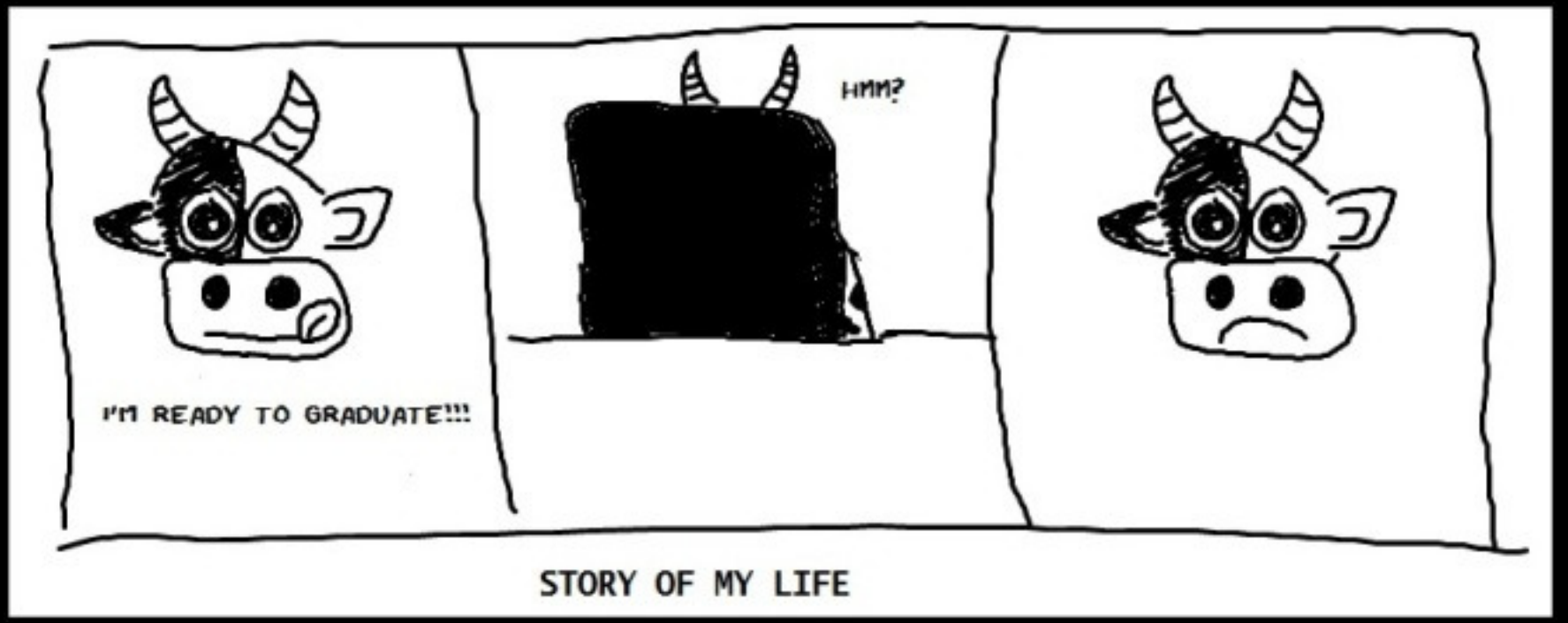
- Workflow Composition:
  - –Srivastava & Koehler, 2003
    - Single agent; no collaboration
- Plan Complexity:
  - –Measuring distance between plans: Roberts et al. 2014, Goldman & Kuter 2015
  - –Diverse plan alternatives: Nguyen et al. 2012
    - Plan metrics (cost, duration, robustness) that are disconnected from humans; plan difference measured as difference in actions
- Human Perception of Complexity:
  - –Liao et al. 2017: Complexity from Interactions
  - –This Work: Complexity from Actions

# Enterprise Domains Where Workflow Complexity is Important

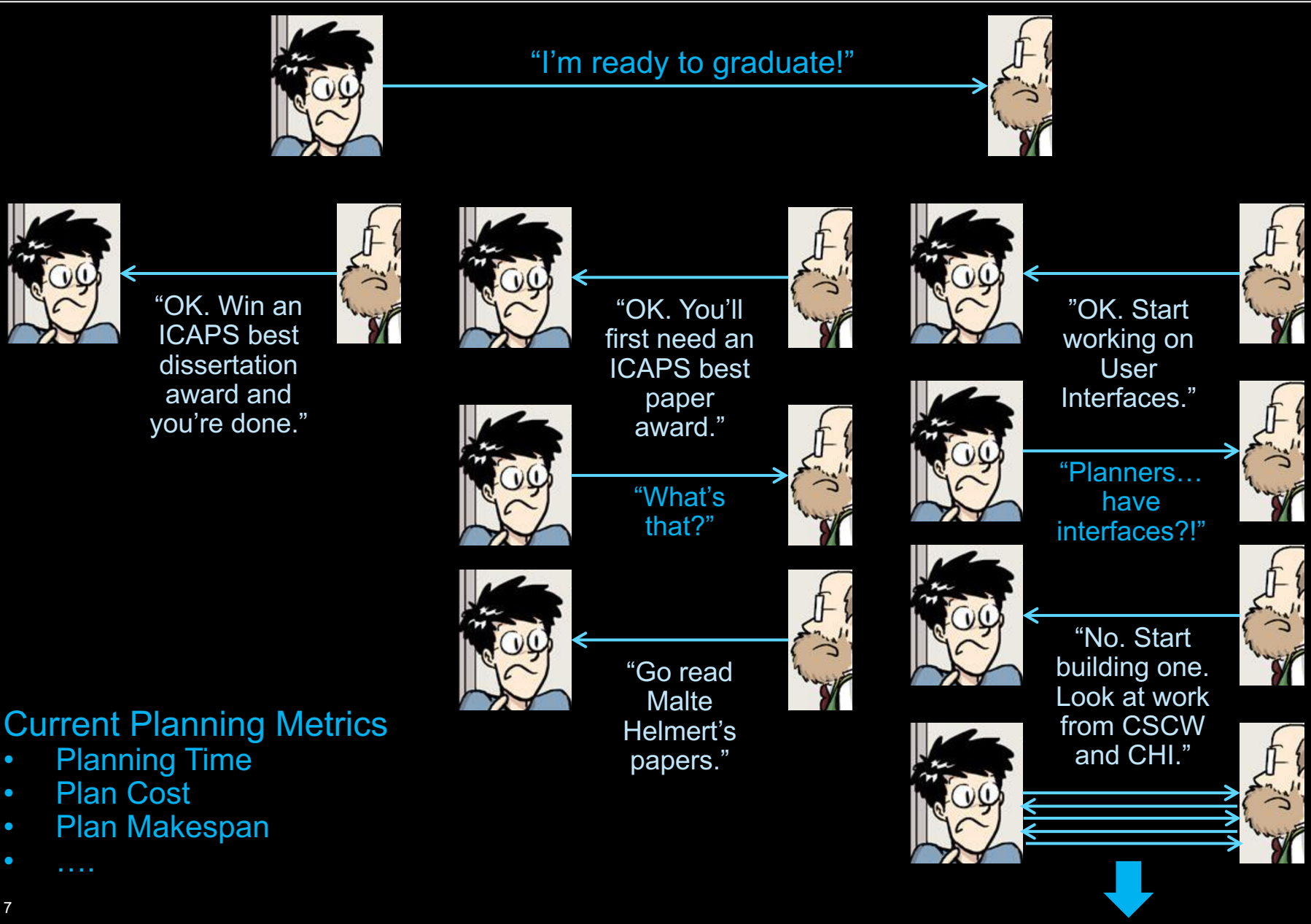
- Travel Planning
- Meeting Scheduling
- Collective Decision
- Human-Robot Teaming
- Medical Decision Making
- Personal Finance

# Workflow Complexity






"I'm ready to graduate!"




## Current Planning Metrics

- Planning Time
- Plan Cost
- Plan Makespan
- ….

# Where are the Metrics?

- Current planning metrics
  - –Planning Time, Plan Cost, Plan Makespan…
- None of these take workflow complexity into account
- **Interaction Complexity** (from Liao et al. 2017)
  - –# dialogs, turns / dialog, utterances / turn, words / utterance etc.
  - –Measures the complexity from “interaction” issues
  - –The same *action(s)* can be communicated in different ways, leading to different interaction complexity
  - –Example: Navigational Directions on different GPS devices

# Where are the Metrics?: Action Complexity

1. Neglect Tolerance
2. Interaction Time
3. Attention Demand
4. Fan Out
5. Compliance

From Chakraborti et al., 2014

From Keller et al., 2007

6. Execution Complexity
7. Parameter Complexity
8. Memory Complexity

# Footprint: Metrics v. Domains

| USECASE \ METRIC | NT | IT | AD | FO | Com | EC | PC | MC |
|---|---|---|---|---|---|---|---|---|
| Travel Booking | L | H | H | H | H | H | M | M |
| Scheduling Meetings | H | M | M | L | H | L | H | H |
| Evaluating Hiring Choices | L | H | H | L | H | M | H | H |
| Human-Robot Teaming | M | H | M | M | L | M | L | L |
| Medical Treatment | H | L | L | L | H | M | H | H |
| Personal Finance | M | M | H | L | H | H | H | H |

L – Low, M – Medium, H – High

If the metric profile of a domain/usecase matches the plans produced by the planner, team success is more likely

# Conclusions

- Human-Agent collaboration is the future of planning
- Current planners lack the ability (for the most part) to reason about the complexity of a plan from a human understanding perspective
- The HCI community regularly studies human-agent interaction issues with user studies and experiments
- How do we use this information for planning?
  - Metrics as a vehicle for distilling knowledge from user studies into planning
  - Planners evaluate candidate plans in terms of new metrics
- Future Work
  1. Post-process plans from existing planners to take cumulative (cannot break down into constituent states/actions) plan complexity metrics into account
  2. Create new planners that can handle workflow complexity metrics directly in the search and plan synthesis process