

Human-Computer Interaction

> User

Modeling

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Today's Agenda

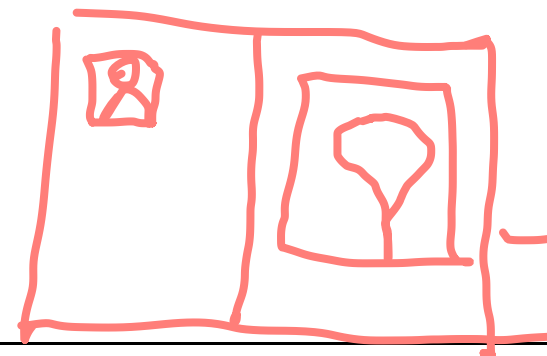
- » Topic overview: User Modeling <
- » Discussion
- » Project Q&A, partner-matching, individual feedback (primarily during office hours)

Topic overview: *User Modeling*

What are models?

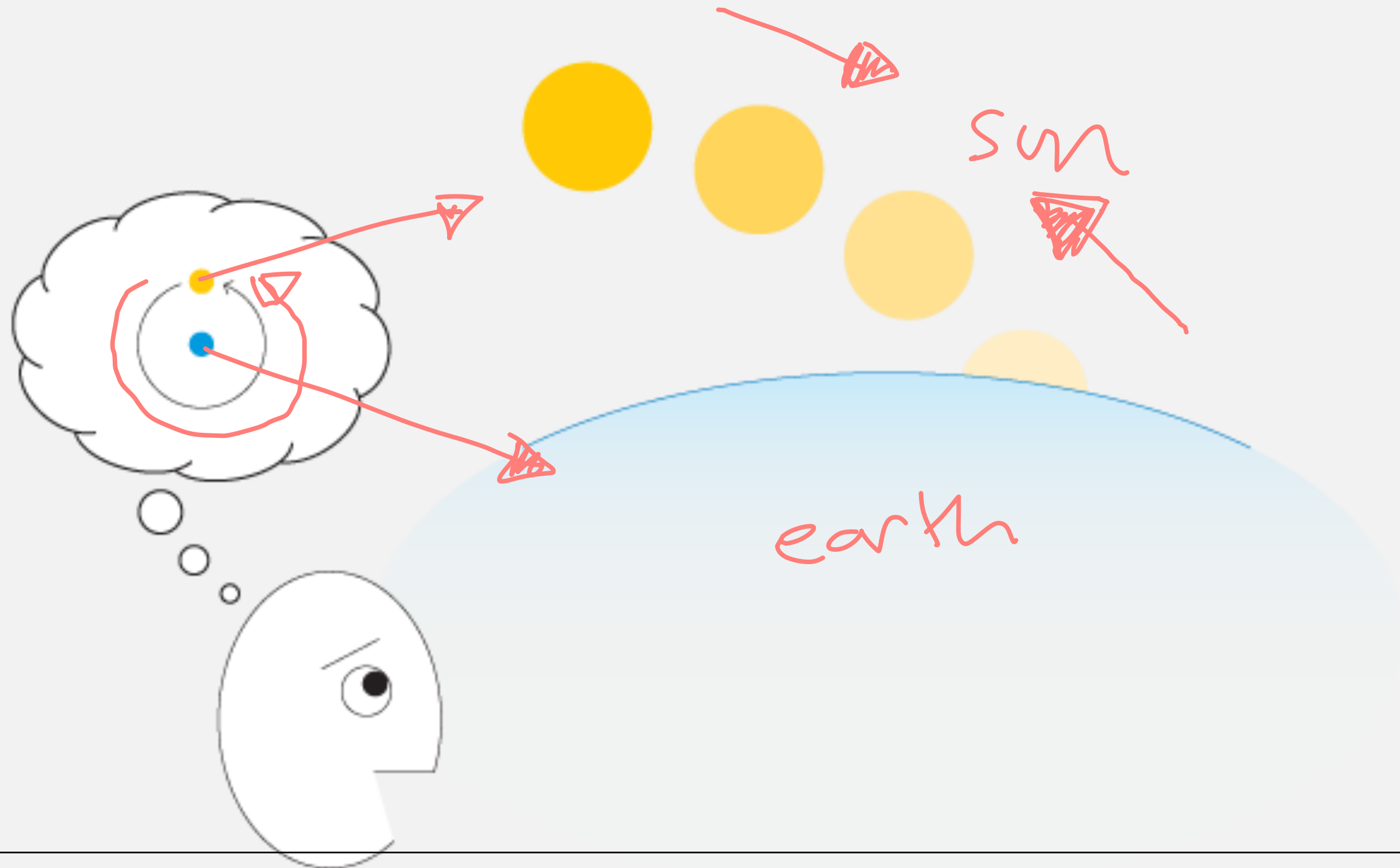
mental models
model representations

Models are ideas about the world—how it might be organized and how it might work. Models describe relationships: parts that make up wholes; structures that bind them; and how parts behave in relation to one another.

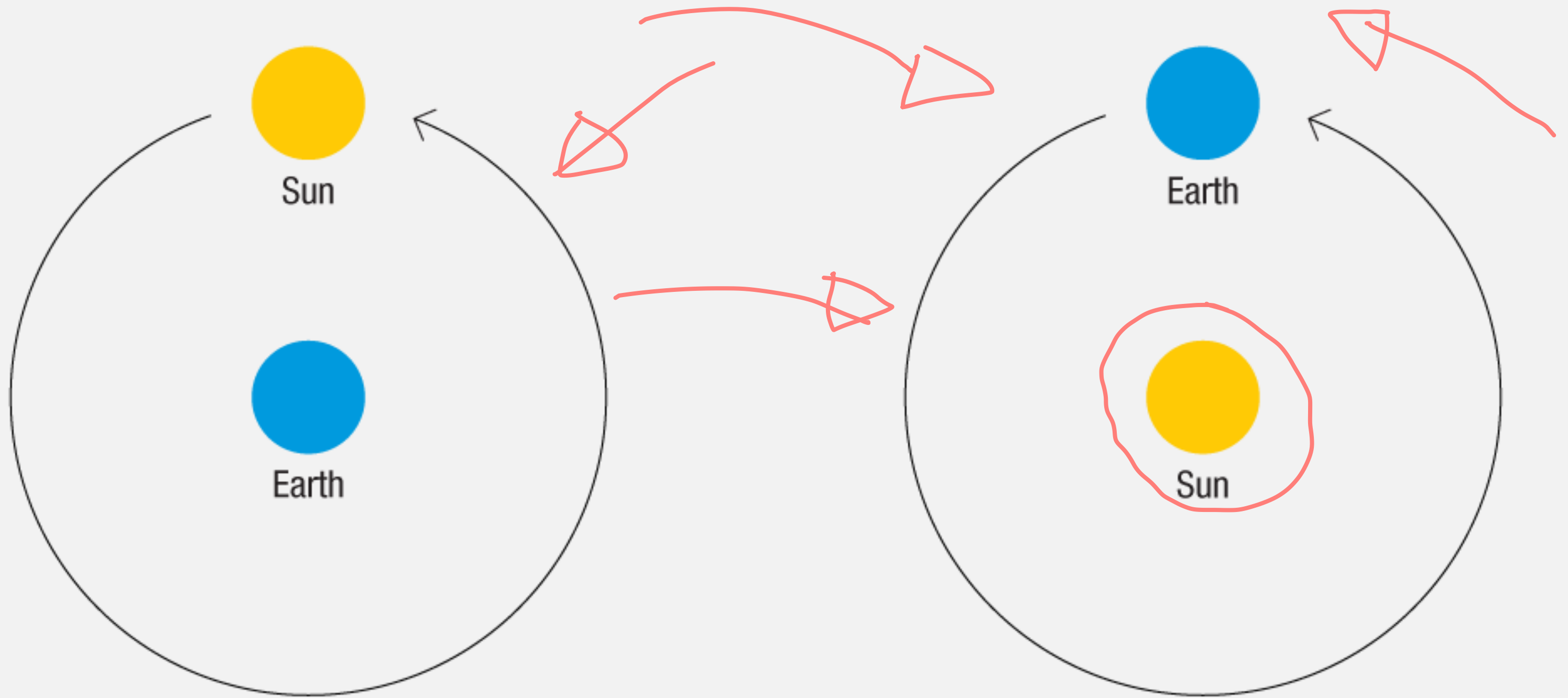


— Dubberly, 2009¹

¹Dubberly, 2009, Models of models

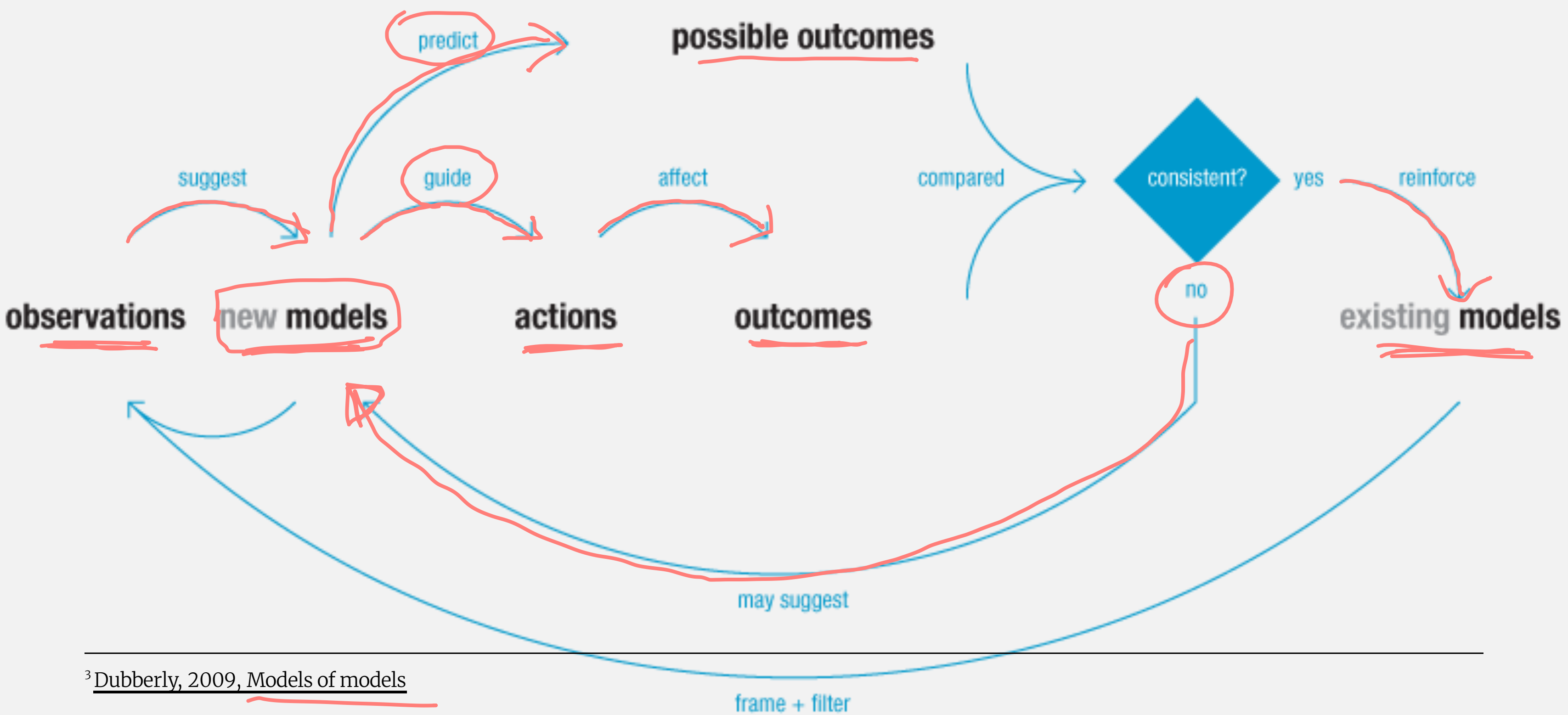


¹Dubberly, 2009, Models of models

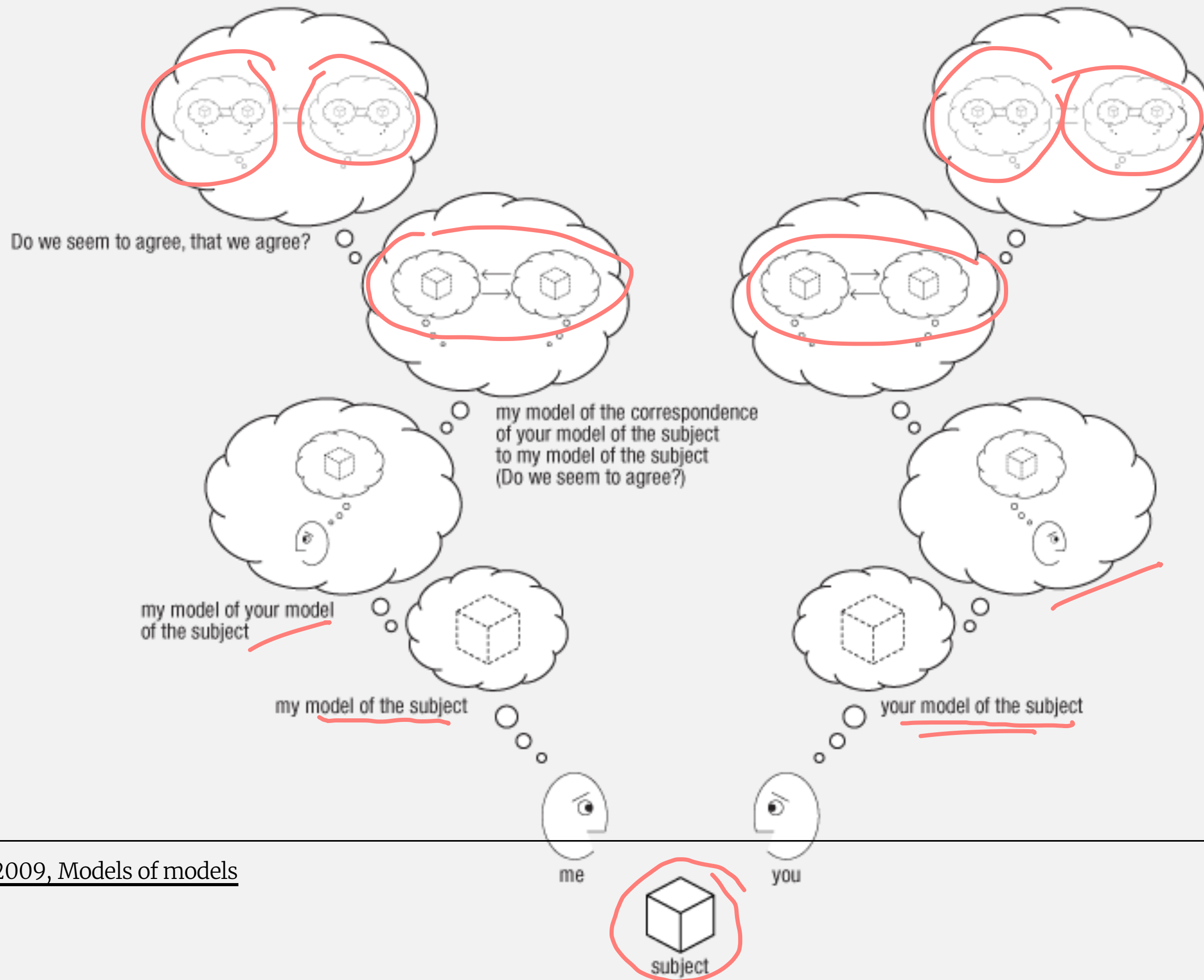


²Dubberly, 2009: **Left:** Ptolemaic, geo-centric model (150 AD); **Right:** Copernican, helio-centric model (1543 AD)

How do we build models? What for?



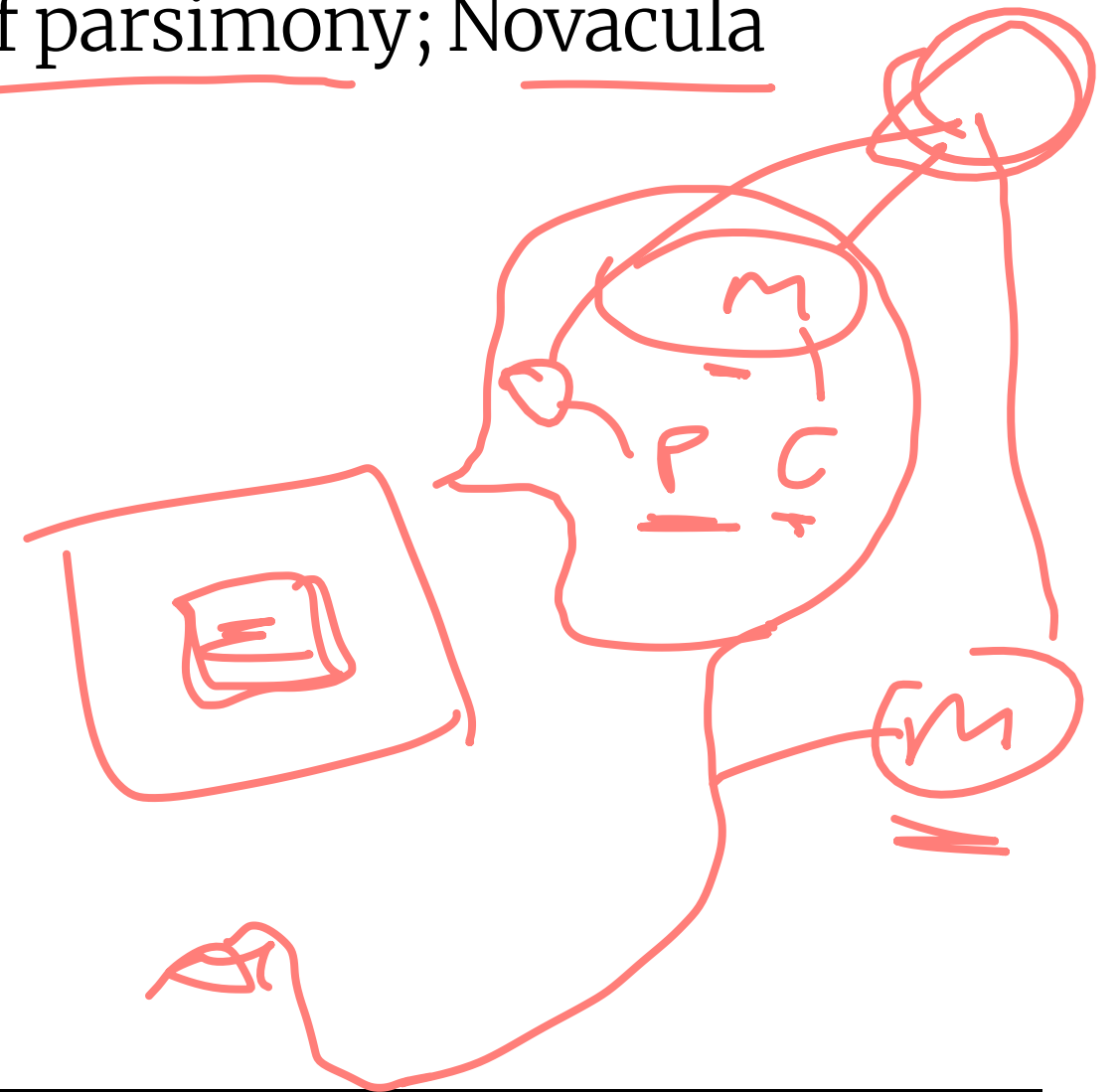
³Dubberly, 2009, Models of models



⁴Dubberly, 2009, Models of models

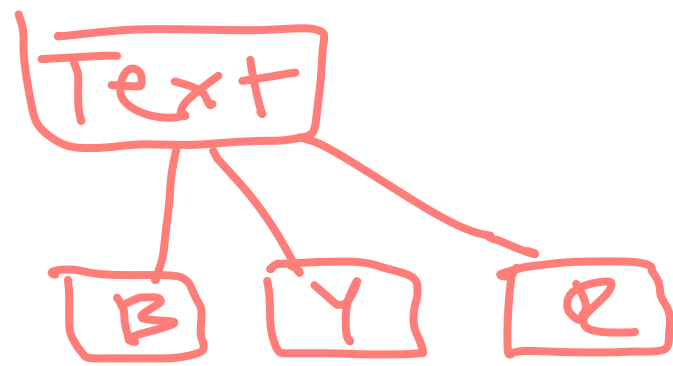
Good models involve...

1. **Fit**: How does the model fit the observation?
2. **Least means**: Is a simpler model conceivable? (Law of parsimony; Novacula Occami)
3. **Consistency**: Is the model internally consistent?
4. **Predictive value**: How well does the model predict?⁵

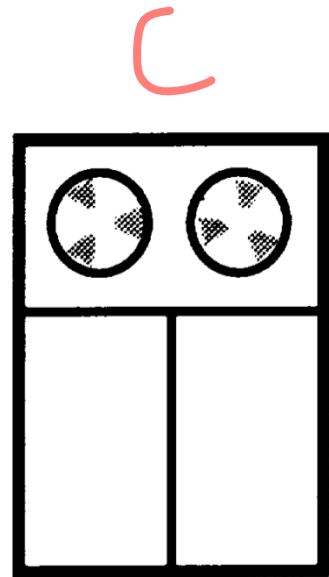
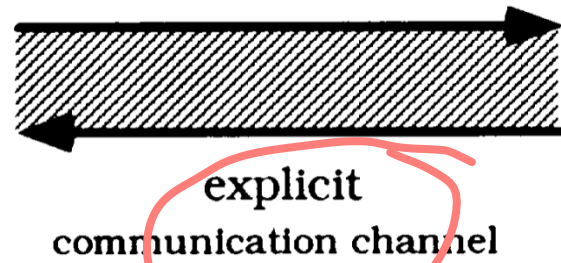
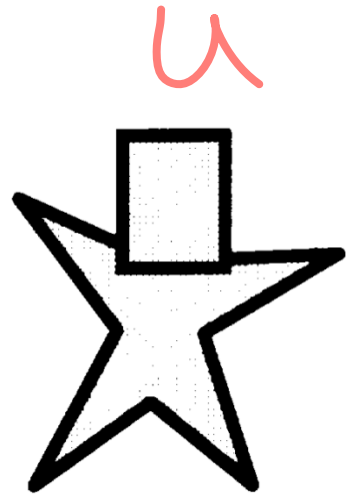


⁵Dubberly, 2009, Models of models

Why do we need models in HCI?

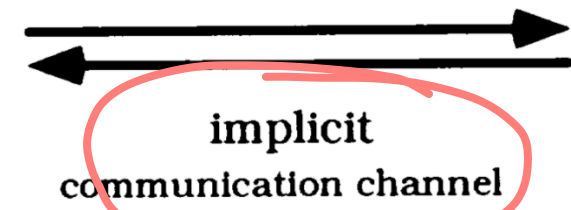


#2 use models

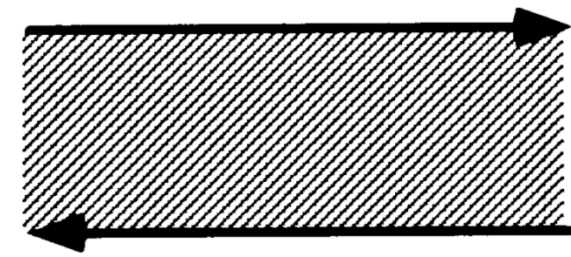


human knowledge

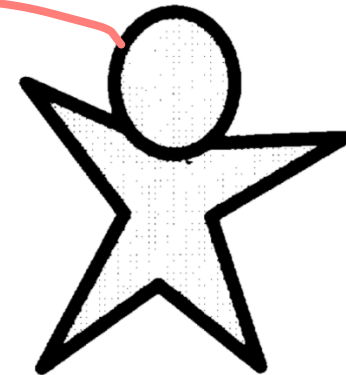
Knowledge about
 problem domain
 communication processes
 communication agent



knowledge base



#1 mental models



explicit communication channel

⁶Fischer, 2001, User modeling in human-computer interaction: **Left:** human-computer dyad, **Right:** knowledge-based HCI

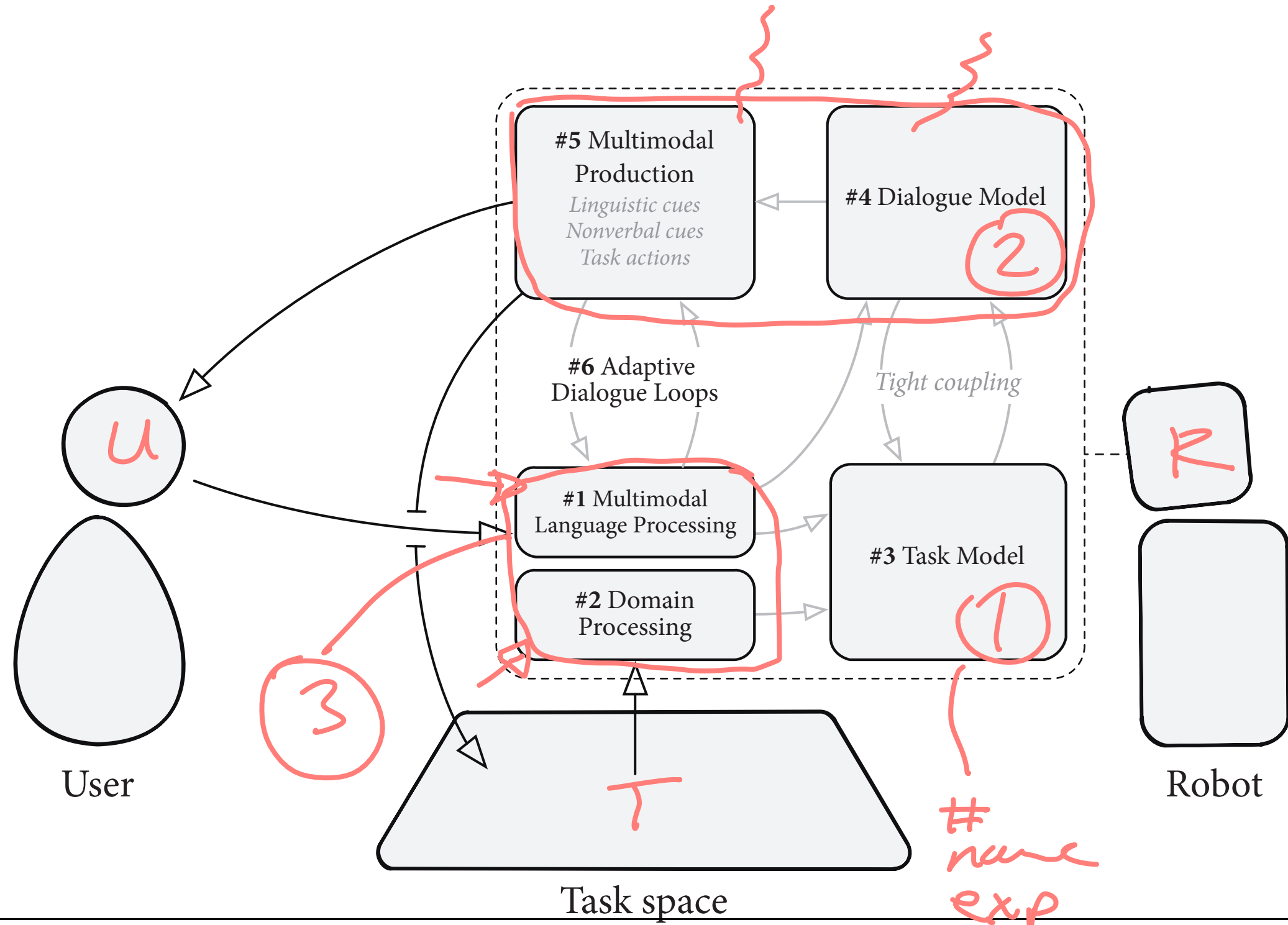
Implicit communication requires computer to have...

1. Knowledge about the problem domain
(E.g., what is the user doing?) ←
2. Knowledge about communication processes
(E.g., when can I communicate with the user?)
3. Knowledge about the communication agent⁷
(E.g., what does the user know?) ← Madison

⁷Fischer, 2001, User modeling in human-computer interaction

Common models:

1. Knowledge about the problem domain → task models
2. Knowledge about communication processes → dialogue models
3. Knowledge about the communication agent → user models



⁸Mutlu et al., 2014, Enabling human-robot dialogue

What are some example models?

Example observation → model⁹

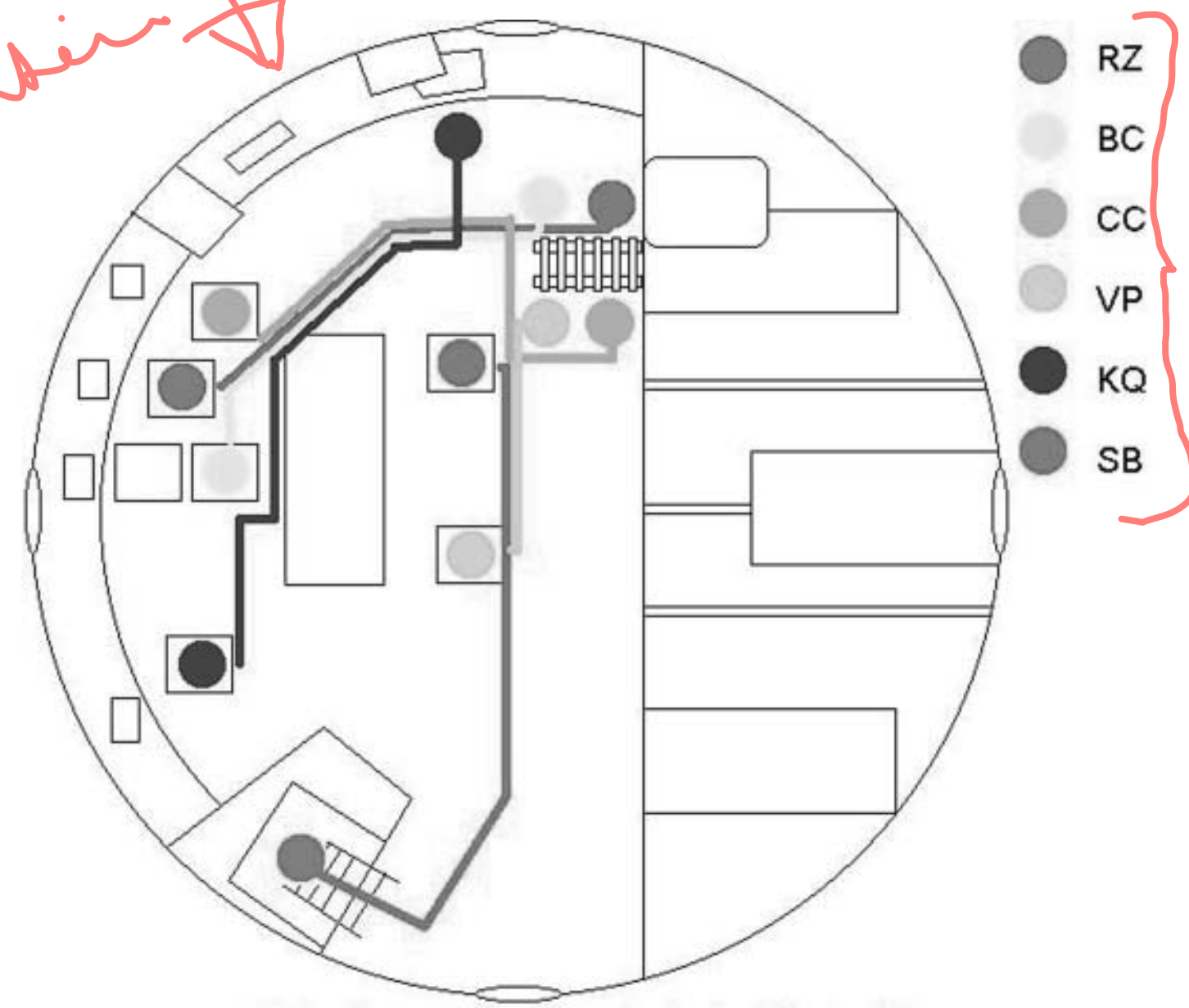
RZ requests weather info from **BC**. (They need it to decide whether to go for EVA).

BC gets **up** from his **chair**, **walks** to workstation area, to his **laptop** (in a subarea), and checks weather report (for ~7 min; **sitting** facing **laptop**). After

BC is done, he **walks back to** wardroom table area, approaches his chair area, and **sits down** on his **chair**. He then communicates the weather data to **RZ**. Shortly after **BC** goes to check the weather, **RZ** gets **up** from his **chair**, **walks** to water tank area, **climbs** the **water tank ladder**, and **checks water level** (by looking into the **water tank**—standing on the ladder at the upper rim of **water tank** level, facing it).

```
workframe CheckWaterLevel
when (unknown(current.timeToFillWaterTank))
detectable DetectWaterLevel {
  detect((WaterTank.waterLevel = 0))
  then continue;}
do { Getup();
  Walk(GalleyLadderArea);
  Upladder(WaterTankArea);
  CheckWaterLevel();
  Downladder(GalleyLadderArea);
  Walk(WardroomTableArea);
  conclude((current.waterLevelChecked = true)); }
```

data
translation

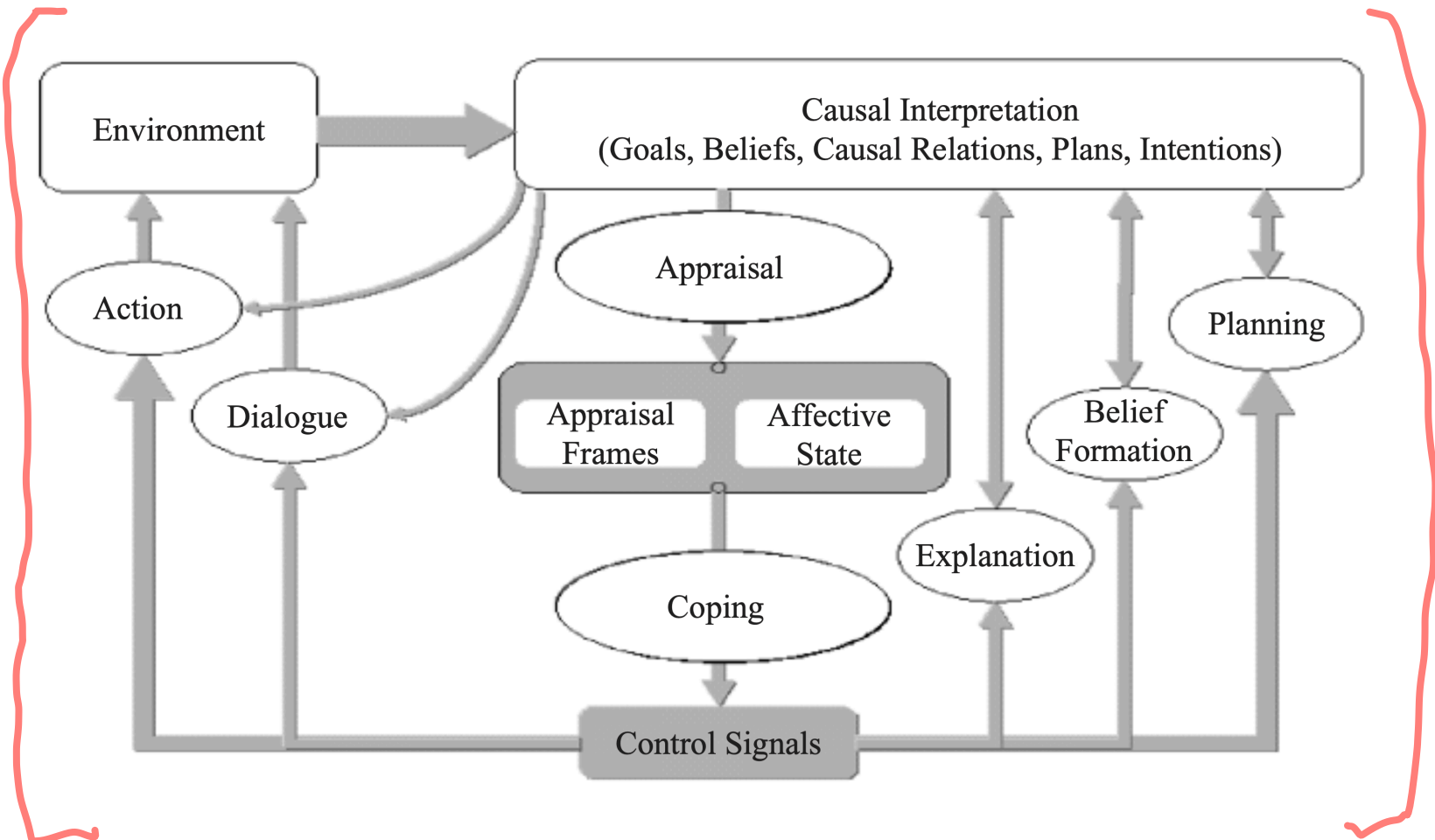


model

⁹Clancey et al., 2006, Cognitive Modeling of Social Behaviors

Example model → action¹⁰

high-level model → action node edge



```

Backtrace (consq, plan structure):
1. parent = A, where consq is an effect of action A
2. DO
  2.1 node = parent
  2.2 coerce(authority(node), performer(node), node) = unknown
      coerce(authority(node), performer(node), consq) = unknown
      responsible(consq) = performer(node)
  2.3 Search dialog history on node and apply dialog inference rules
  2.4 IF coerce(authority(node), performer(node), node) THEN
  2.5   apply plan inference rules on node
  2.6   IF coerce(authority(node), performer(node), consq) THEN
  2.7     responsible(consq) = authority(node)
  2.8 parent = P, where P is the parent of node in plan structure
  WHILE parent ≠ root of plan structure AND
        coerce(authority(node), performer(node), consq)
3. RETURN responsible(consq)
  
```

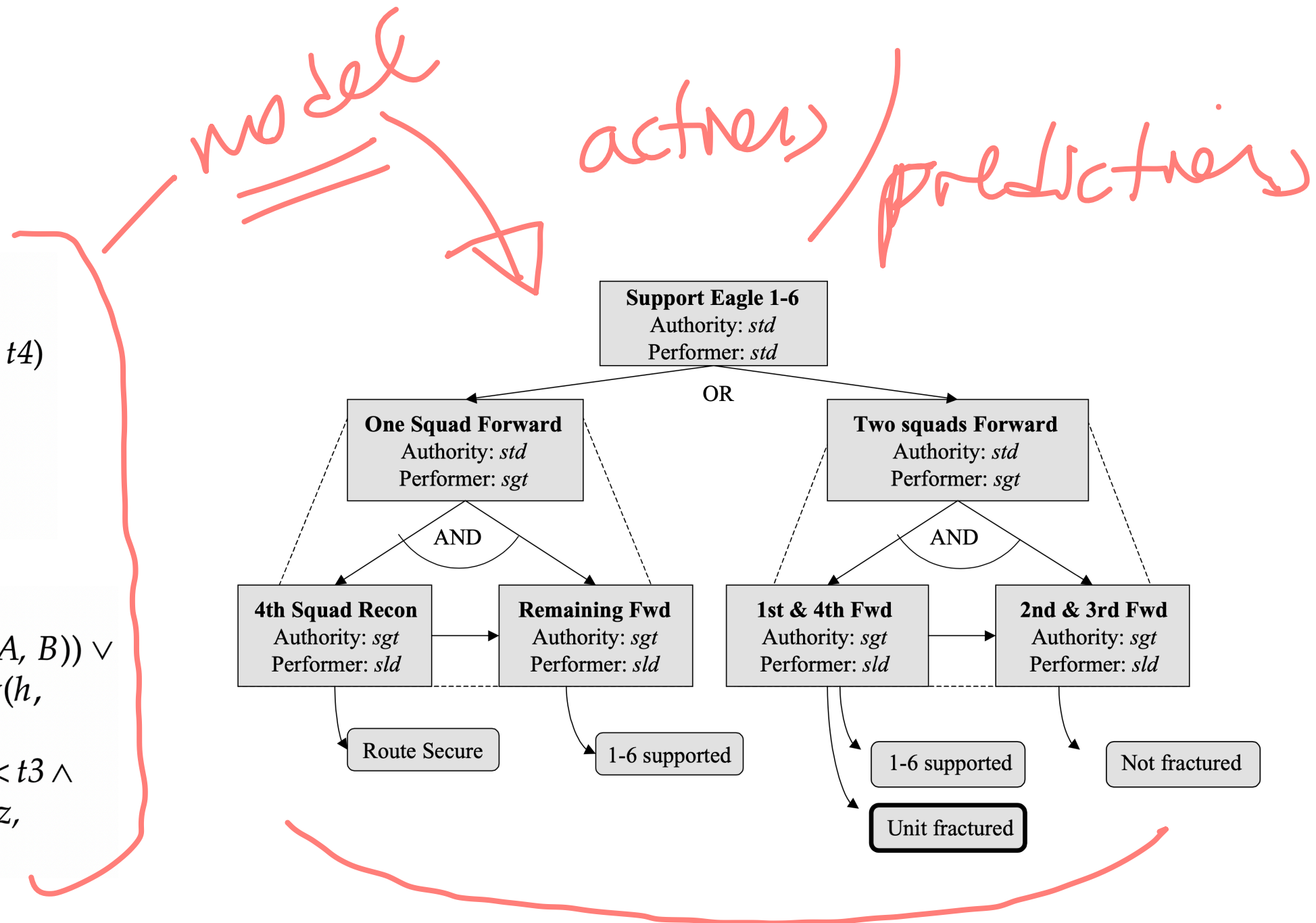
¹⁰Gratch et al., 2006, Modeling Social Emotions and Social Attributions

Rule 6: $\text{believe}(z, \text{want/intend}(s, p), t1) \wedge \text{accept}(h, p, t2) \wedge \neg \text{superior}(s, h) \wedge t1 < t2 < t4 \wedge \neg(\exists t3)(t2 < t3 < t4 \wedge \text{believe}(z, \neg \text{intend}(h, p), t3)) \Rightarrow \text{believe}(z, \text{intend}(h, p), t4)$

Rule 7: $\text{believe}(z, \text{want/intend}(s, p), t1) \wedge \text{accept}(h, p, t2) \wedge \text{superior}(s, h) \wedge t1 < t2 < t4 \wedge \neg(\exists t3)(t2 < t3 < t4 \wedge \text{believe}(z, \neg \text{coerce}(s, h, p), t3)) \Rightarrow \text{believe}(z, \text{coerce}(s, h, p), t4)$

Rule 9: $\text{counter-propose}(h, \text{do}(h, A), \text{do}(h, B), t1) \wedge t1 < t3 \wedge \neg(\exists t2)(t1 < t2 < t3 \wedge \text{believe}(z, \neg \text{know}(h, \text{alternative}(A, B)) \vee \neg \text{know}(s, \text{alternative}(A, B)), t2)) \Rightarrow \text{believe}(z, \text{know}(h, \text{alternative}(A, B)) \wedge \text{know}(s, \text{alternative}(A, B)), t3)$

Rule 10: $\text{counter-propose}(h, p, q, t1) \wedge t1 < t3 \wedge \neg(\exists t2)(t1 < t2 < t3 \wedge \text{believe}(z, \text{want}(h, p) \vee \neg \text{want}(h, q), t2)) \Rightarrow \text{believe}(z, \neg \text{want}(h, p) \wedge \text{want}(h, q), t3)$



¹⁰Gratch et al., 2006, Modeling Social Emotions and Social Attributions

Discussion Questions



user's mental model
↕
interface model

- » What are some real-world examples of models?
- » What are some real-world examples of models driving action?
- » What are some examples of models being updated over time?
- » What are limitations of these models?
- » What other user-modeling related resources have you found?
- » ...

