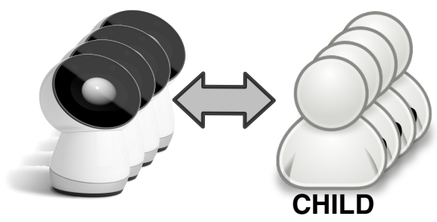
Data Collection & Evaluation (Sec. 4)



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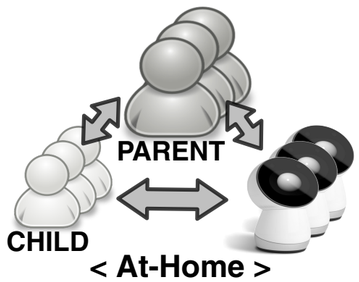

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Data & Query

Result

Cloud Computing
(Robot Cognitive Architecture & Child ASR)
& Corpus Storage

Robot Cognitive Architecture

Dialogic Co-Reading (Sec. 3.1)

D_{ex} Features

Gaze-lock behavior
Tablet input
Affect

D_{aff} Features

Speech
Quiz Result
Affect

Reading Content Personalization (Sec. 3.4.1)

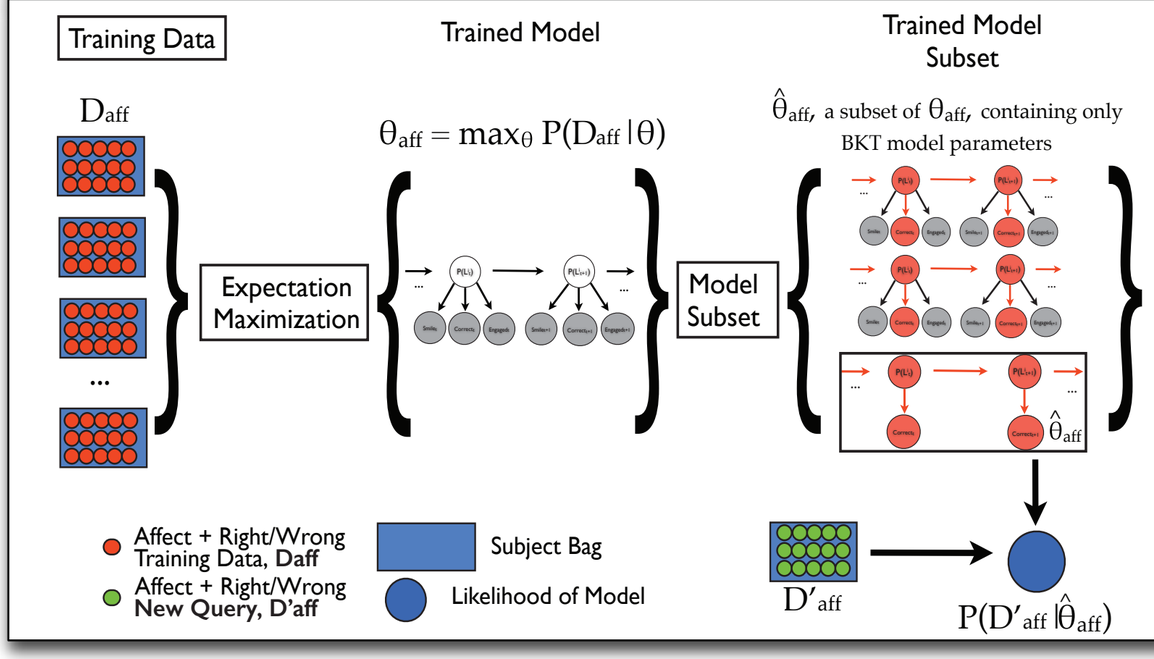
Find a set of tasks, $\mathcal{A}' \subset \mathcal{A}$, and the sequence they appear on the tablet, $\mathcal{S}_{\mathcal{A}'}$, such that

$$\{\mathcal{A}', \mathcal{S}_{\mathcal{A}'}\} = max_{\{\mathcal{A}', \mathcal{S}_{\mathcal{A}'}\}} \mathcal{G}(D_{aff}, D_{ex}, \mathcal{A}', \mathcal{S}_{\mathcal{A}'}),$$

where $\mathcal{G}$ is learning gain.

TinkRbook Corpus ($\mathcal{A}$)

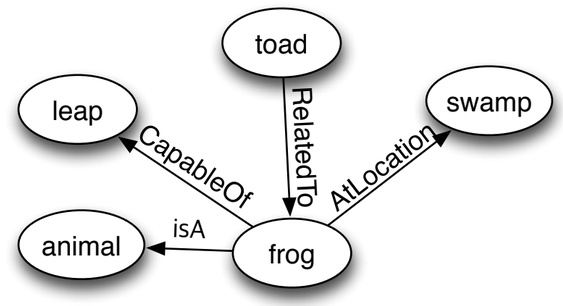
Reading Skill Assessment: Affect-BKT (Sec. 3.3.2)



Dialogic Story Retell (Sec. 3.1)

Oral Language Skill Assessment (Sec. 3.3.1)

- **Semantic Concept Net**: vocabulary and relations
- **IPSyn**: Noun/Verb/Sentence syntax complexity



Dialogic QnA Personalization (Sec. 3.4.3)

Concept Net

Input: child's story retell
- update child Knowledge Base, $\mathcal{K}_p$, *p = 1...N*
- compute Mapping $\mathcal{K}_p \rightarrow \mathcal{K}_T$ and compute coverage score for each concept in $\mathcal{K}_p$.
- using Mapping $\mathcal{K}_p \rightarrow \mathcal{K}_T$ and coverage score, generate question using concepts and relations.

Input: child's concept question
- parse child question (*q*) & extract concepts and relations.
- compute Mapping $q \rightarrow \mathcal{K}_{robot}$ and retrieve the closest (w_i, w_j, r) and generate answer.

Story Memory Network

Input: storybook corpus, child story retell
- model syntactic flow
- capture semantic coherence
- self-supervised memory retrieval
- generate questions using Named Entity (characters) and Verb (events)

C : a set of concepts
R : a set of relations
$\mathcal{K} = \{(w_i, w_j, r)\}, \quad w_i, w_j \in C, \quad r \in R$

Language Complexity Personalization (Sec. 3.4.2)

Storybook Corpus
For each storybook in corpus,
- precompute Noun/Verb/Sentence IPSyn scores.
- precompute $\mathcal{K}_s$ and coverage of Mapping $\mathcal{K}_s \rightarrow \mathcal{K}_T$.

Given child's Language Skill Assessment,
- Sort storybooks by IPSyn and $\mathcal{K}_p \rightarrow \mathcal{K}_s$ coverage.

Storybook Corpus

Training Data

Real-time ASR

Training Data

Automatic Child Speech Recognition (Sec. 3.2)