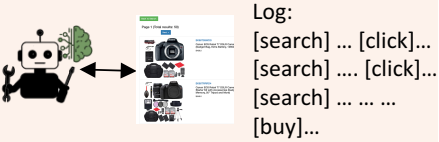# Environments and Tasks

Env. 1: Bundled Web Shopping

Task: Buy me a camera bundle

Sub-Task 1:

"Buy a Camera Body; Budget=800usd; Buy the cheapest one; my options are:

A. A Nikon D5600 DSLR camera….; B. A Canon EOS Rebel T7 DSLR camera…; C. …"

[Constraint: cheapest price]

Log:
[search] … [click]…
[search] …. [click]…
[search] … … …
[buy]…

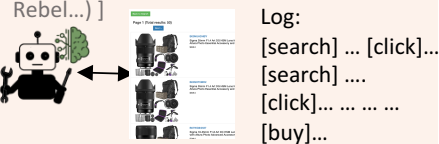Agent: "bought Canon EOS Rebel …".

Subtask. 2:

"Buy me Camera Lens; Buy the highest-rated one; my options are:
A Canon EF 24mm f/1.4L II USM …; B. A Sigma 35mm F1.4 Art DG HSM lens for Canon …; C. A AF-P DX 70-300mm f/4.5-6.3G ED for Nikon… ; D……

[Constraint: highest rating; compatible with the camera body (Canon EOS Rebel…)]

Log:
[search] … [click]…
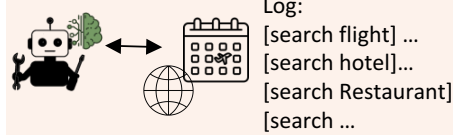[search] ….
[click]… … …
[buy]…

Subtask 3: Buy me …

…

Env. 2: Group Travel Planning

Task: Plan a group travel with shared/distinct preferences

Sub-Task 1:

"I am Tracy. A 5-day travel itinerary; Single-person trip; from Orlando; touring 2 cities in Texas; Date 03/10/25-03/04/25; Budget: 3,100.

[Constraint: trip length, destination, …]

Log:
[search flight] …
[search hotel]…
[search Restaurant]
[search …

Agent: Tracy's itinerary …

Subtask. 2:

"I am Chelsea. I'm joining Tracy for this trip. I like luxury hotels. So I can spend $150 more than Tracy's first-day accommodation. I have plan for the second day. So I will try Chelsea's second-day lunch restaurant in my third day; I want to try Korean BBQ with rating 4.5 and above in my third day."

[Constraints: (join shared activities); (Plan individual activities based on preferences]

Log:
[search flight] …
[search hotel]…
[search Restaurant]
[search …
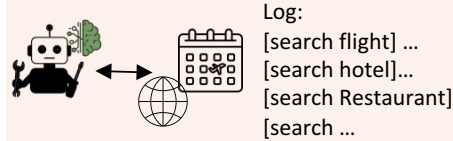
Subtask 3: I'm Emily ….

…

Env. 3: Progressive Web Search

Task: Find a person name satisfying all conditions

Sub-Task 1:

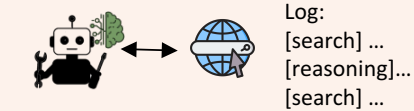"What is the name of the person who completed their PhD in 1989?"

[Constraints: PhD, 1989]

Log:
[search] …
[reasoning]…
[search] …

Agent: [Name list]

Sub-Task 2:

"Among them, what is the name of the person who published a book in 2014?"

[Constraints: publish book, 2014]

Log:
[search] …
[reasoning]…
[search] …

Agent: [Name list]

Sub-Task 3:

Among them what is the name of the person who was a keynote speaker at a conference in 2012?

[Constraints: keynote speaker, conf. 2002]

Log:
[search] … …

Subtask 4: What is the name of ….

…

Env. 4 (Math): Formal Reasoning

Task: Express the upper bound of the run-time v.s. sample size tradeoffs implied for linear-memory algorithms for Tensor PCA
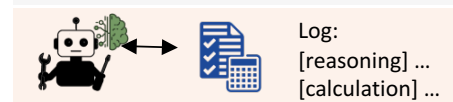
Sub-Task 1:

"[necessary definitions] for In Hermite Decomposition for Tensor PCA, express $\frac{d\mu_v}{d\mu_0}(X) =$? For any $X \in \otimes^k \mathbb{R}^d$"

Log:
[reasoning] …
[calculation] …

Agent: [reasoning Trace]

$$\frac{d\mu_v}{d\mu_0}(X) = \sum_{i=0}^{\infty} \frac{\lambda^i}{\sqrt{i!}} \cdot H_i\left(\frac{\langle X, V^{\otimes k}\rangle}{\sqrt{d^k}}\right)$$

For any $X \in \otimes^k \mathbb{R}^d$

Sub-Task 2:

"[necessary definitions] Use the previous derivation to calculate the following terms in terms of the integrated Hermite polynomials: $E_0[\overline{H_i}(X;S) \cdot \overline{H_j}(X;S)]$"

Log:
[reasoning] …
[calculation] …

Agent: [reasoning Trace]
$E_0[\overline{H_i}(X;S) \cdot \overline{H_j}(X;S)] = 0$

Subtask 3: …

…

Env. 4 (Phys.): Formal Reasoning

Task: Find the independent null constraints on the spectral density for Higgs scattering
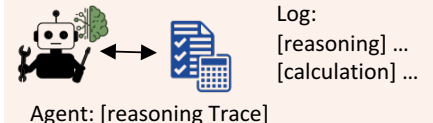
Sub-Task 1:

"[necessary definitions] For singlet scalar scattering, there exists a set of non-trivial constraints on $\rho_\ell(\mu)$ from the sum rule and crossing symmetry. What are the independent null constraints?"

Log:
[reasoning] …
[calculation] …

Agent: [reasoning Trace]
$B_{ijkl}(s,t) = B_{ikjl}(t,s)$

Sub-Task 2:

"For scalar doublets, what are the independent null constraints on $\rho_\ell^{1122}(\mu)$, $\rho_\ell^{1212}(\mu)$, and $\rho_\ell^{1221}(\mu)$?"

Log:
[reasoning] …
[calculation] …

Agent: [reasoning Trace]
$$c_{ijkl}^{m,n} = [\rho_\ell^{ijkl}(\mu) + (-1)^m \rho_\ell^{ilkj}(\mu)] \sum_{p=0}^{n} \frac{L_\ell^p H_{m+1}^{n-p}}{\mu^{m+n+1}}$$

Subtask 3: …

…