

Explorer: Scaling Exploration-driven Web Trajectory Synthesis for Multimodal Web Agents

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Multimodal Web Agents**

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- Our work
 - Automatic web trajectory collection
 - Use website URLs as seeds.

Prior Work

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- **Use web tutorials as a form of supervision** [Ou et al., 2024, Xu et al., 2025]
 - Limited domain diversity
 - Information seeking tasks are under-represented

Ou et al., “Synatra: Turning indirect knowledge into direct demonstrations for digital agents at scale”, NeurIPS 2024.

Xu et al., “Agenttrek: Agent trajectory synthesis via guiding replay with web tutorials”, ICLR 2025.

This Work

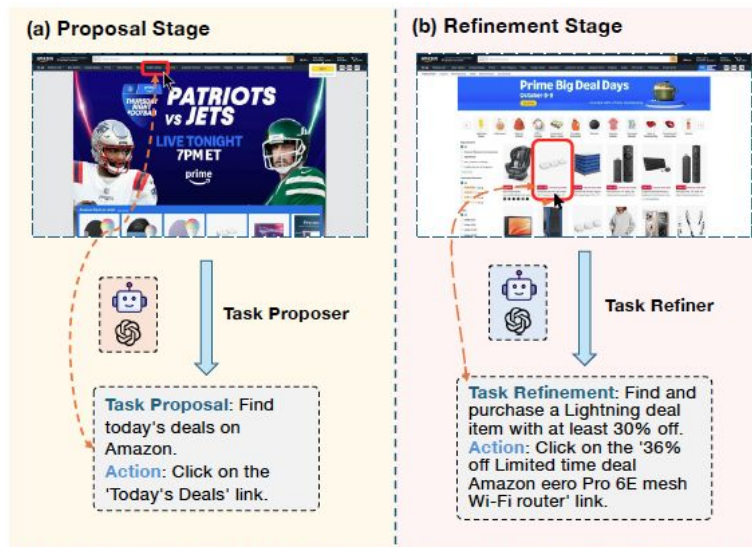
- Leverage **exploration** as a key mechanism for achieving diversity in task intents.
- Explorer dynamically explores web environments to curate diverse, real-world tasks.

Overall System



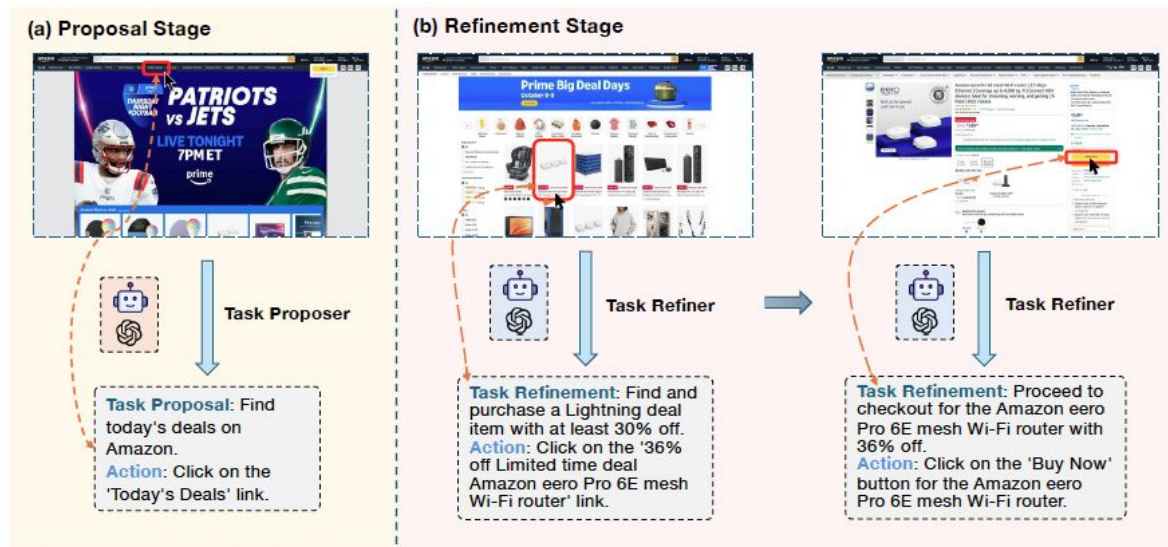
- Generate a high level and abstract version of the real-world tasks.
- The agent proposes and executes the first action toward completing that task.

Overall System



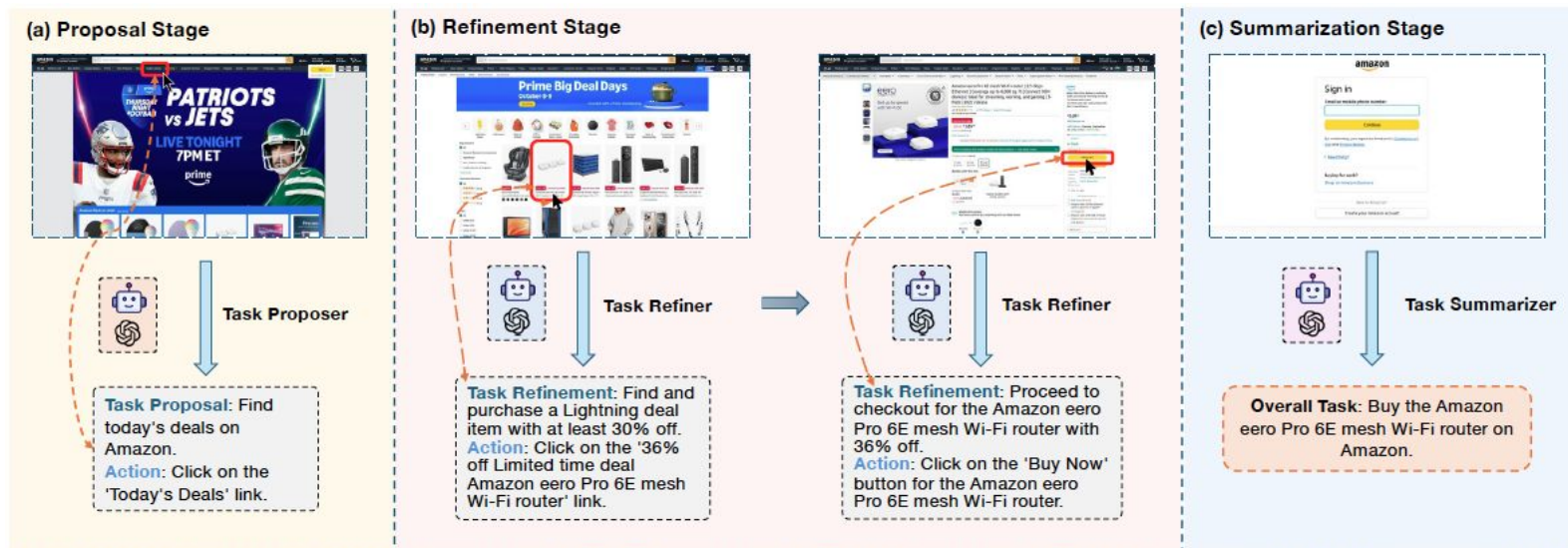
- **Input:** Initial task proposal or refined task description from previous step
- **Output:** Next action + updated refined task description
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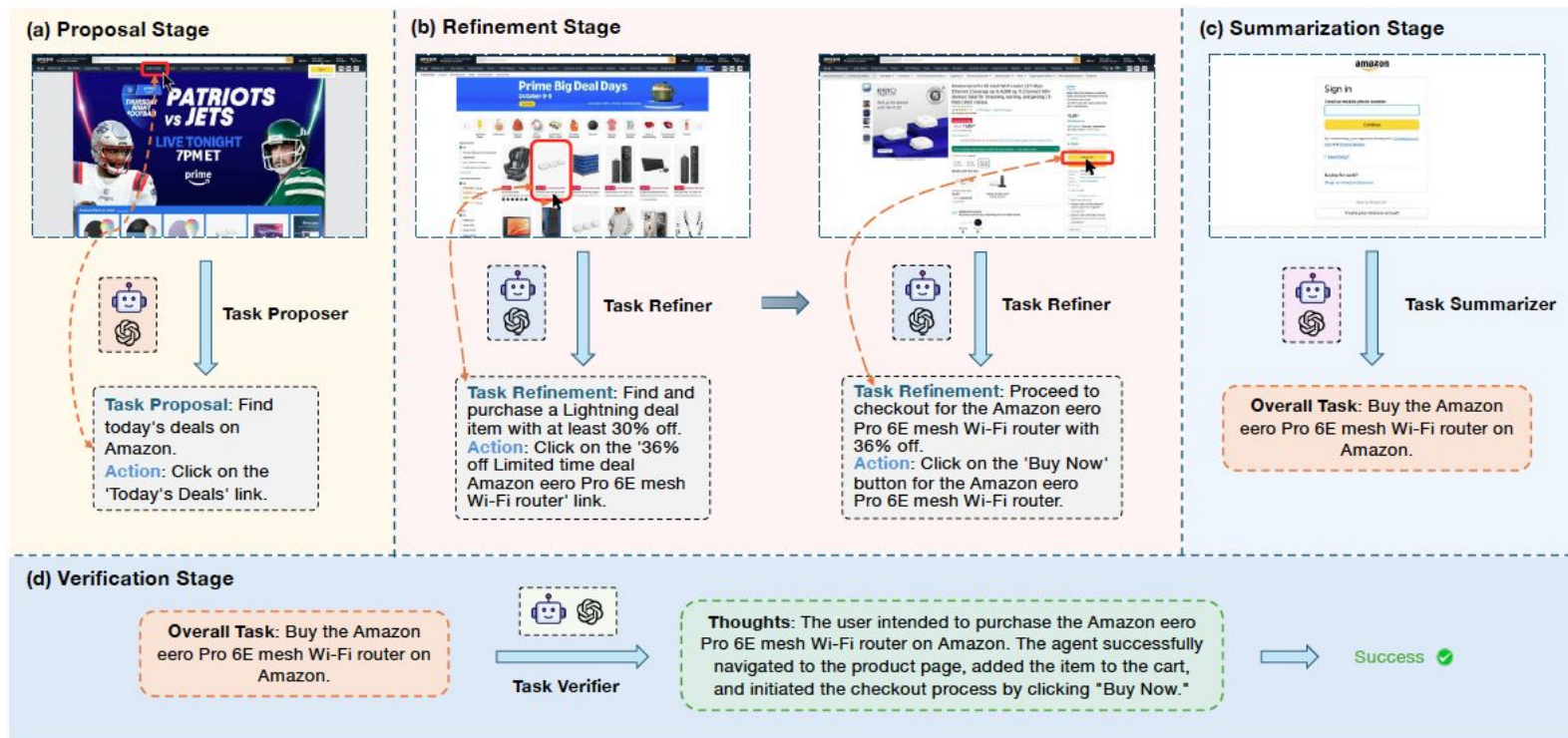


Input: Entire action and screenshot history

Output: Overall task description that aligns with the trajectory

Overall System

- **Input:** Entire action and screenshot history, markdown rep. of last page
- Serve as a critic to evaluate whether the trajectory successfully completes the specified task



Key Advantages

- Explores the space of all possible tasks in the web environment -> better diversity
- The generated tasks respect real-world constraints - product availability, available color options, and other specifications, ensuring practical applicability.

Website Selection

- **similarweb.com**
 - Top 100 URLs from similarweb.com corresponding to the high-traffic portion of the web with transactional tasks like booking flights, restaurant reservations, etc.
- **Tranco** [Pochat et al., 2019]
 - Includes 1M URLs representing the head portion of the web.
 - Combines multiple website ranking sources (e.g., Alexa, Cisco, Majestic).
 - Uses a time-weighted aggregation to provide a more stable ranking.

Dataset Statistics

Metric	Value
# Total trajectories	175K
# Success trajectories	94K
# Unique URLs	49K
Average steps per trajectory	7.7
Average elements per image	46.3
# Tokens	830M
# Elements	33.3M
# Images	720K
Cost per trajectory	\$0.15
Cost per successful trajectory	\$0.28

Table 3: Dataset statistics for Explorer. The number of unique URLs, average steps per trajectory, average elements per image, and number of tokens, elements, and images correspond to the successful trajectories.

Action Type	Description	Count
click [elem]	Click on elem.	415K
type [elem] [text]	Type text	62K
select [elem] [text]	Select text from dropdown list.	5K
goto [url]	Go to url.	26K
search_google [query]	Search for query on Google.	4K
scroll [up/down]	Scroll up or down.	213K

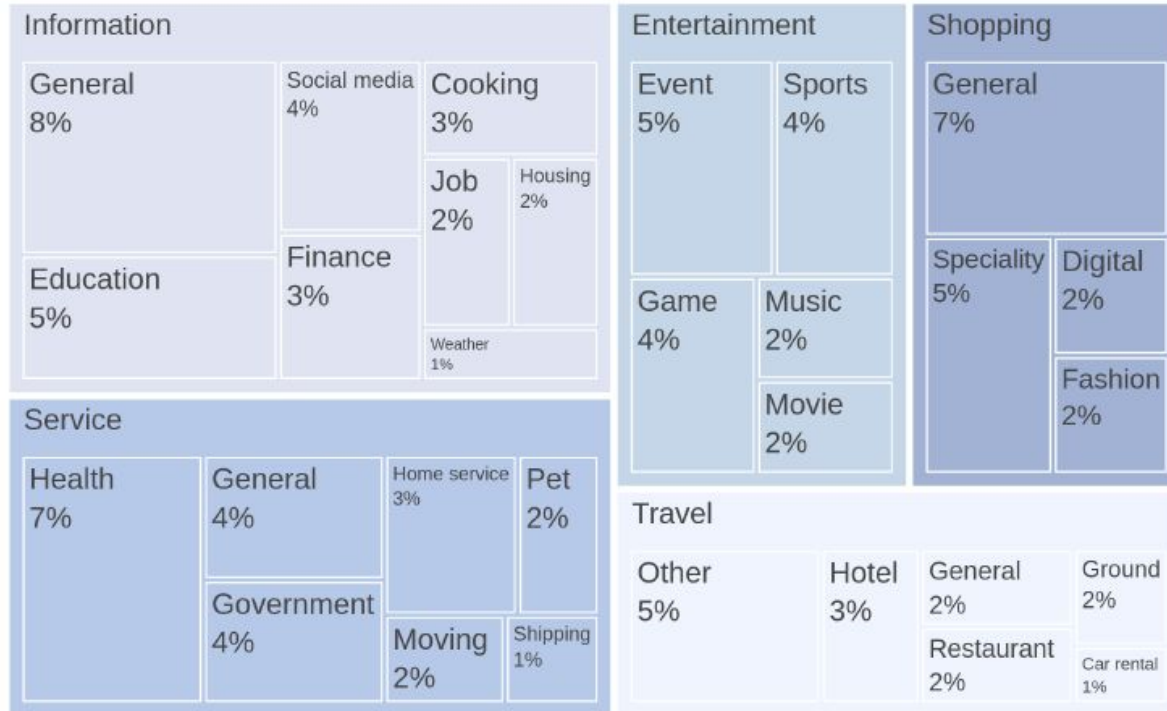
Table B.5: Action space for web navigation in Explorer.

Dataset Statistics

	# Trajectories	# Websites	Modality
RUSS (Xu et al., 2021)	80	22	HTML
Mind2Web (Deng et al., 2023)	2350	137	HTML + Screenshot
WebLINX (Lu et al., 2024)	969	155	HTML + Screenshot
GUIAct (Chen et al., 2024a)	2482	121	Screenshot
OpenWebVoyager (He et al., 2024b)	1165	48	A11y tree + Screenshot
AgentTrek (Xu et al., 2024a)	10.4K	127	A11y tree + HTML + Screenshot
NNetnav (Murty et al., 2024)	6K	4	A11y tree + Screenshot
Explorer	94K	49K	A11y tree + Screenshot (raw + SoM) + HTML

Table 1: Comparison to existing web agent benchmarks.

Dataset Diversity



Task Examples

Information

View the detailed 7-day weather forecast for Toronto, ON on The Weather Network website.
Convert 100 US Dollars to Euros using the XE currency converter.
Find directions from Seattle, WA to Bellevue, WA using Bing Maps.

Service

Research the French Bulldog breed on the American Kennel Club website, including its popularity and family life traits.
Find the nearest Penske truck rental location in Anaheim, California, and start the reservation process for a truck.
Explore and purchase a subscription for the UpToDate Pro Suite on the Wolters Kluwer website.

Entertainment

Find the Basscon presents: Darren Styles EDM event on Eventbrite, save it, and share it on Twitter.
View the details of the Photography Competition Winners - Season X and share the article on Twitter.

Shopping

Browse through the fall home decor section on the Target website to explore a variety of fall-themed home decor items.
Purchase a three-seat fabric sofa, specifically the UPPLAND Sofa, from IKEA's website.

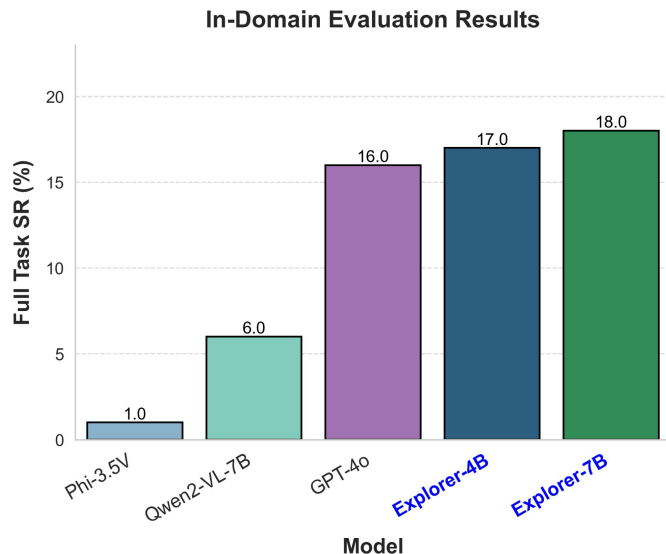
Travel

Search for flights from Seattle to New York, select travel dates, and explore various flight options.
Find the weight of baggage allowance for economy class on qatarairways.

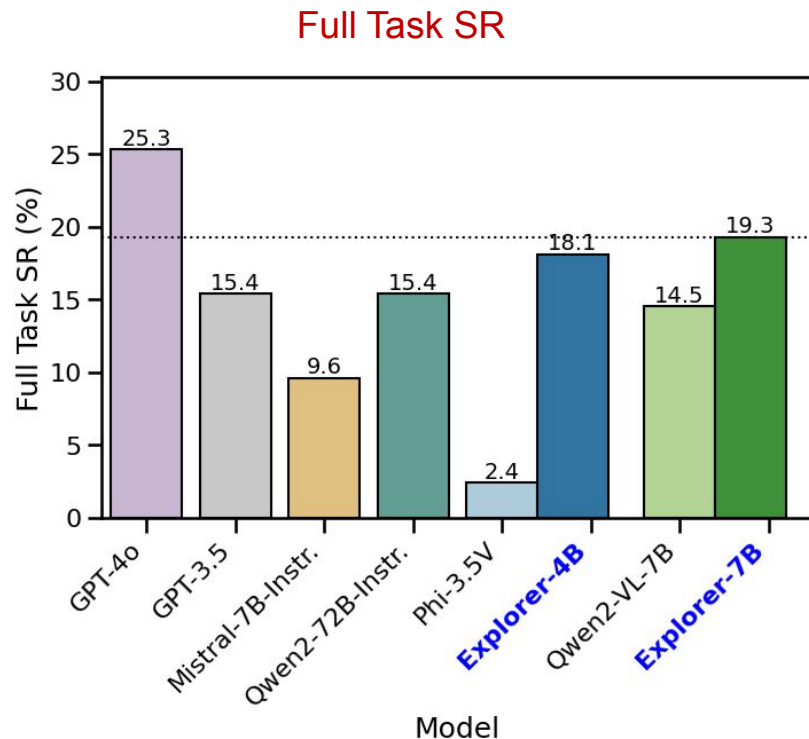
Evaluation

In-domain Evaluation Results

- Evaluation set (in domain): 100 trajectories
- The fine-tuned Explorer models achieve significant improvements over their pre-trained counterparts

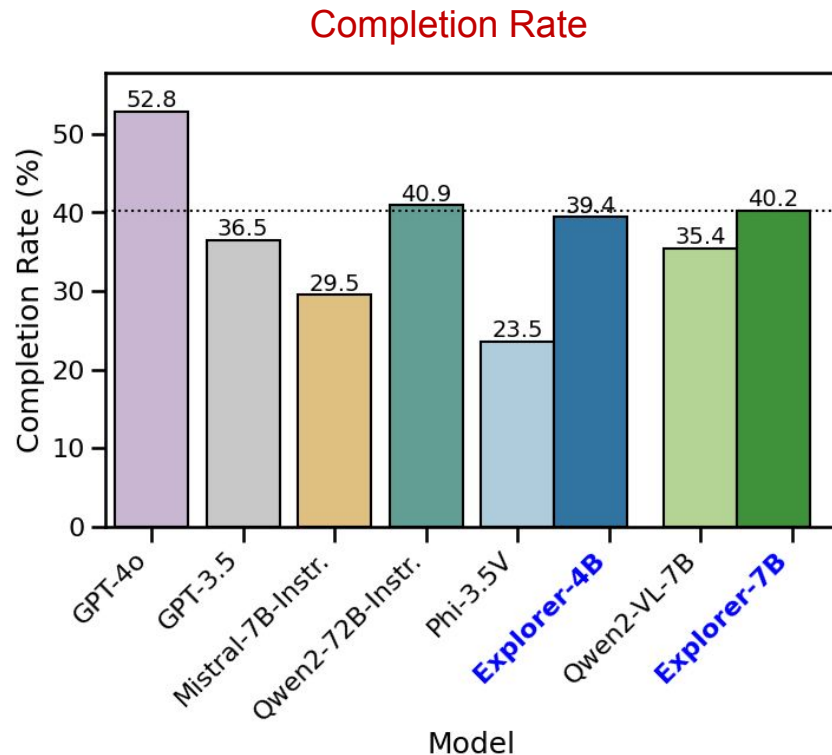


Mind2Web-Live Results



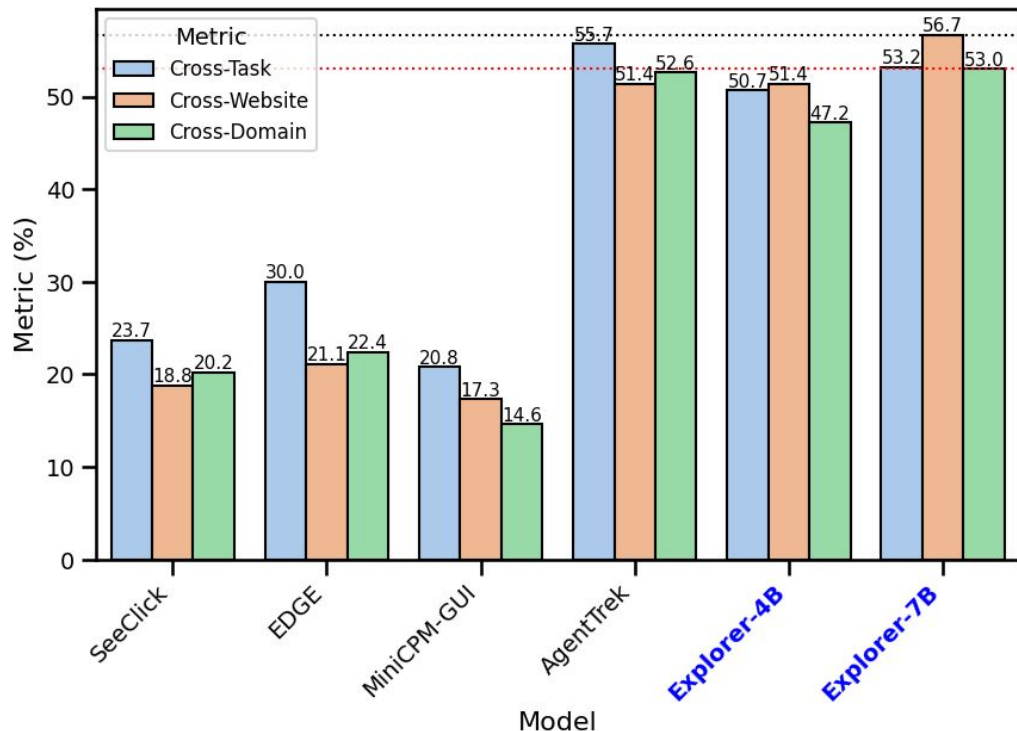
- Improvement over base pre-trained models
- Improvement over higher capacity LLMs
- Best M2W-Live performance for model of this size

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Multimodal-Mind2Web Results



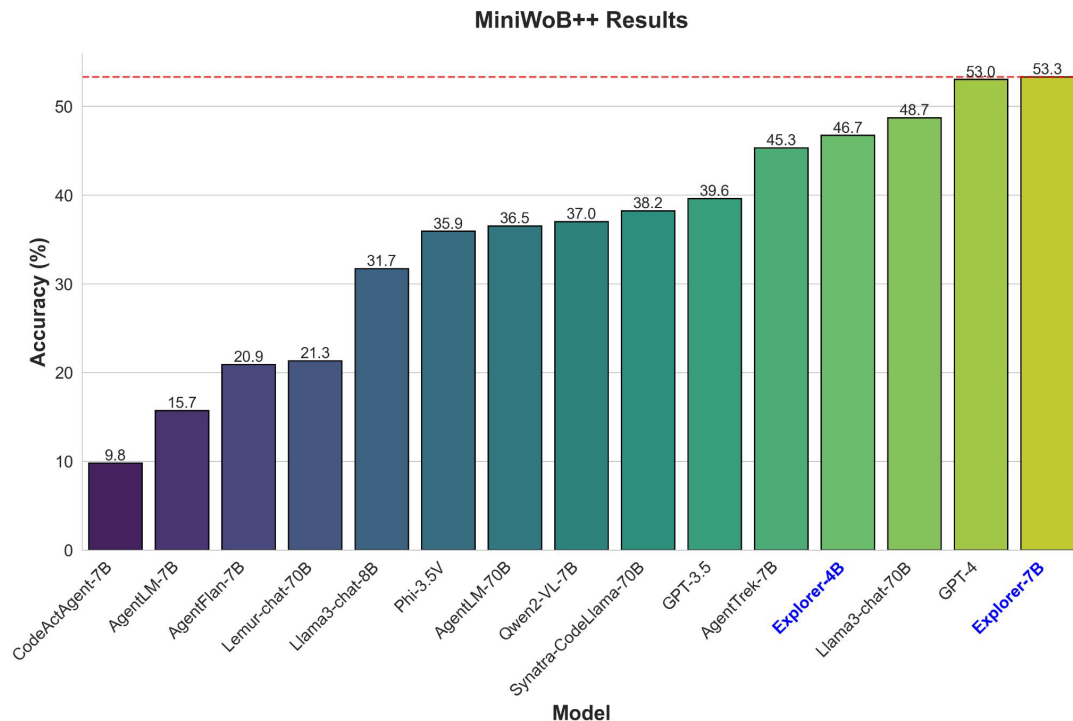
- Syn+M2W setting
- **Baselines:**
 - **EDGE:** Synthesizes QA data on webpages to improve the GUI grounding.
 - **ScribeAgent-Large** and **MiniCPM-GUI:** Human-annotated trajectory data on synthetic task proposals
 - **AgentTrek:** Synthesizes web trajectory data using tutorials

Multimodal-Mind2Web Results

Outperforms existing web trajectory synthesis baselines

Model	Train Data	Cross-Task			Cross-Website			Cross-Domain			Avg.
		Ele. Acc	Op. F1	Step SR	Ele. Acc	Op. F1	Step SR	Ele. Acc	Op. F1	Step SR	
In-Context Learning											
GPT-3.5		19.4	59.2	16.8	14.9	56.5	14.1	25.2	57.9	24.1	18.3
GPT-4		40.8	63.1	32.3	30.2	61.0	27.0	35.4	61.9	29.7	29.7
SeeAct (Zheng et al., 2024)		46.4	73.4	40.2	38	67.8	32.4	42.4	69.3	36.8	36.5
Supervised Fine-Tuning											
SeeClick-9.6B (Cheng et al., 2024)	Syn. + M2W	26.3	86.2	23.7	21.9	82.9	18.8	22.1	84.1	20.2	20.9
EDGE-9.6B (Chen et al., 2024b)	Syn. + M2W	–	–	30.0	–	–	21.1	–	–	22.4	24.5
MiniCPM-GUI-3.1B (Chen et al., 2024a)	Syn. + M2W	23.8	86.8	20.8	20.3	81.7	17.3	17.9	74.5	14.6	17.6
Scribe-Agent-L.-32B (Shen et al., 2024)	Syn. traj.	38.0	52.9	35.6	34.1	52.7	32.5	39.4	54.7	37.3	35.1
AgentTrek-7B (Xu et al., 2024a)	Syn. + M2W	60.8	88.9	55.7	57.6	88.1	51.4	56.0	87.5	52.6	53.2
Explorer-4B	Syn. traj.	36.5	82.9	33.2	44.1	87.7	39.3	42.5	86.3	39.8	37.4
Explorer-4B	M2W	48.1	88.0	44.8	49.1	87.2	45.0	46.9	87.7	44.6	44.8
Explorer-4B	Syn. + M2W	53.4	88.1	50.7	55.6	89.5	51.4	49.8	88.8	47.2	49.8
Explorer-7B	Syn. traj.	43.6	86.6	39.6	48.7	87.7	44.5	47.6	87.2	44.7	43.0
Explorer-7B	M2W	51.8	88.0	48.3	56.3	89.7	52.0	50.9	88.9	48.1	49.5
Explorer-7B	Syn. + M2W	56.5	90.3	53.2	60.5	90.7	56.7	55.7	90.4	53.0	54.3

MiniWoB++ Results



- Zero-shot evaluation setting
- Explorer outperforms GPT-4 and general-purpose agent baselines.
- Explorer-4B surpasses Synatra-CodeLlama-7B and AgentTrek-7B despite using a much smaller model.

Data Scaling

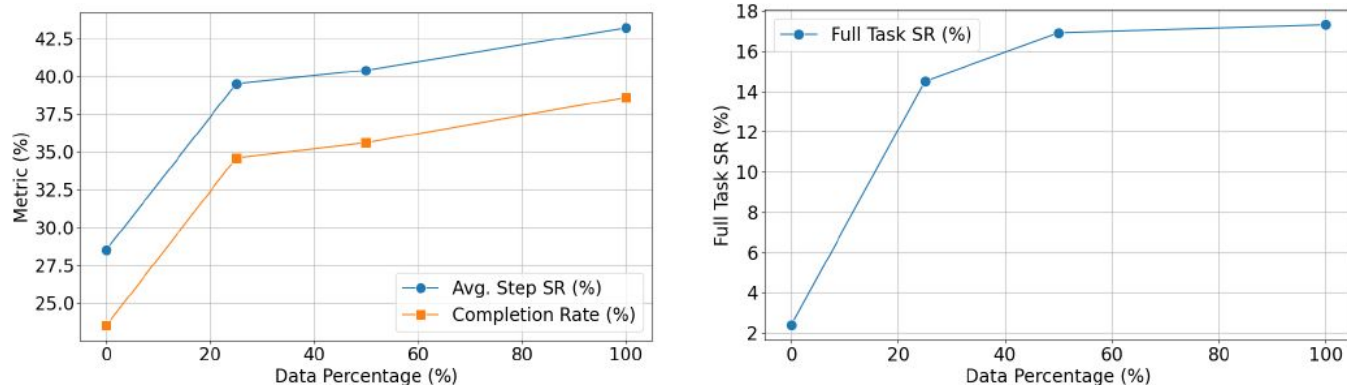


Figure 3: Experiments with data scaling using Explorer-4B on Mind2Web-Live. We experiment with using 100%, 50%, and 25% of the trajectory data. All results are averaged over three runs. All metrics exhibit improvement with increase in data scale.

- Subsample the original trajectory dataset to utilize 50% and 25% of its original size
- Increasing the dataset size further leads to gradual improvements across all reported metrics.
- Increase in the overall task success rate is more gradual compared to the stepwise metrics.

Conclusion

- A scalable framework for synthesizing diverse web trajectories.
- Our framework generates contextually grounded trajectories that adapt to real-world constraints, improving both task relevance and generalization.
- Explorer outperforms existing web agent baselines by a significant margin on both online and offline web agent benchmarks.

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Thank You!

