
Scaling Computer-Use Grounding via User Interface Decomposition and Synthesis

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Abstract

Graphical user interface (GUI) grounding, the ability to map natural language instructions to specific actions on graphical user interfaces, remains a critical bottleneck in computer use agent development. Current benchmarks oversimplify grounding tasks as short referring expressions, failing to capture the complexity of real-world interactions that require software commonsense, layout understanding, and fine-grained manipulation capabilities. To address these limitations, we introduce OSWORLD-G, a comprehensive benchmark comprising 564 finely annotated samples across diverse task types including text matching, element recognition, layout understanding, and precise manipulation. Additionally, we synthesize and release the largest computer use grounding dataset JEDI, which contains 4 million examples through multi-perspective decoupling of tasks. Our multi-scale models trained on JEDI demonstrate its effectiveness by outperforming existing approaches on ScreenSpot-v2, ScreenSpot-Pro, and our OSWORLD-G. Furthermore, we demonstrate that improved grounding with JEDI directly enhances agentic capabilities of general foundation models on complex computer tasks with state-of-the-art performance, improving from 23% to 51% on OS-World. Through detailed ablation studies, we identify key factors contributing to grounding performance and verify that combining specialized data for different interface elements enables compositional generalization to novel interfaces. All benchmark, data, checkpoints, and code are open-sourced and available at <https://osworld-grounding.github.io>.

1 Introduction

Graphical user interface (GUI) grounding, the ability to accurately map natural language instructions to specific actions (including the positions of on-screen elements), is a cornerstone for computer use agents to effectively interact with GUIs on devices such as mobile phones and desktop computers. It plays a critical role, whether as an isolated component of human-machine interaction, a facilitator of multi-model collaboration agents, or a means to enhance end-to-end models.

Achieving practical GUI grounding requires software commonsense (e.g., understanding the meaning of icons, the functions of components, and specific software knowledge), layout understanding (e.g., interpreting a sidebar on one side or elements under a panel) and fine-grained component manipulation (e.g., adjusting a slider or selecting text on character level). Knowledge and grounding together enable comprehension and interaction. Additionally, rejecting infeasible instructions (e.g., mistaking Thunderbird for Firefox) is necessary to avoid unrecoverable states. Previous work around GUI grounding oversimplify these tasks as short referring expressions. Such descriptions are clear

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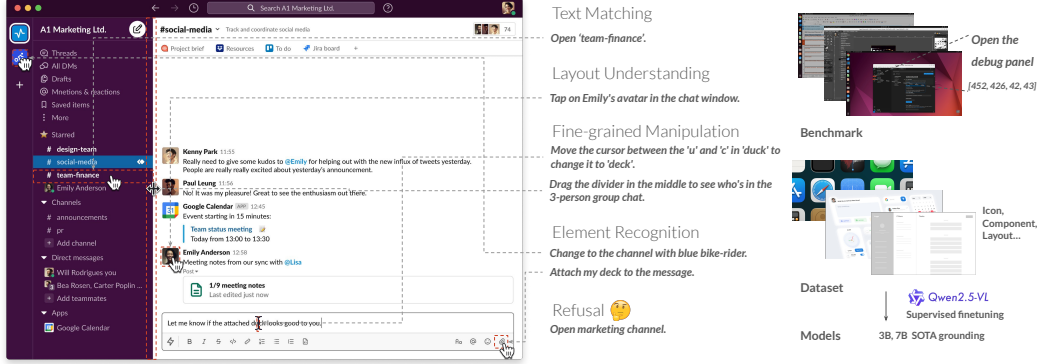


Figure 1: We have developed a comprehensive benchmark comprising 564 examples that cover the diverse task types that previous work has overlooked. Additionally, we synthesize and release the largest computer use grounding dataset containing 4 million examples, and train models that achieve state-of-the-art performance on this dataset.

but leave a gap with real-world requirements. As a result, existing benchmarks like ScreenSpot-v2 [10, 45] show saturation at early stages ($\sim 90\%$) accuracy by recent approaches [32] together with the progress of vision-language models (VLMs) [see 9, 42, 6, *i.a.*], primarily focusing on simple instructions to locate referenced elements in screenshots. Current evaluation approaches either lack nuance in their assessment criteria or artificially inflate difficulty through unnatural conditions, such as ScreenSpot-Pro’s extreme resolutions that rarely occur in typical computing environments. Achieving practical grounding requires software context awareness and fine-grained manipulation capabilities for diverse GUI elements including dropdown menus, tabbed interfaces, scrollbars, and context-sensitive controls that have not been adequately measured or explored. On the data side, the primary capabilities of current grounding models arise from structured text and screenshot correspondences found on webpages (e.g., SeeClick [10], UGround [15], OmniParser [26], OS-Atlas [45], Aria-UI [49]). Alternatively, they rely on manually annotated data (e.g., Aguvius [48], UI-TARS [32]). The former can capture coarse-grained element understanding signals for webpage but lacks fine-grained operational capabilities for UI elements. The latter, due to high manual annotation costs, struggles to scale effectively.

To better assist the community in addressing GUI grounding challenges, we start with benchmarks and data as shown in Figure 1. We develop the OSWORLD-G, comprising 564 finely annotated samples that systematically cover text matching, element recognition, layout understanding, fine-grained manipulation and infeasibility, with annotations for the element types required to solve each task. On the data side, we collect and synthesize the largest-scale open grounding dataset JEDI in the web and desktop domain through multi-perspective decoupling of tasks. Additionally, we train multi-scale models on this dataset to validate its effectiveness.

Our evaluation on ScreenSpot-v2, ScreenSpot-Pro and OSWORLD-G demonstrates that our approach significantly outperforms existing models in aspect of grounding ability. Beyond standalone grounding performance, we show that improved grounding directly translates to enhanced agentic capabilities on complex tasks in OSWorld [46] and WindowsAgentArena [7] benchmarks. Through detailed ablation studies, we identify key factors that most significantly contribute to grounding performance, providing insights for future data collection and training efforts to enhance such abilities. Our case studies verify the effectiveness of our decomposition hypothesis, demonstrating that combining specialized data for different interface elements enables compositional generalization to novel interfaces.

2 Approach

Task Definition A **Multimodal Agent** is an AI system that visually perceives the GUI from the environment. At each step t , it receives a visual observation O_t (e.g., pixel data $\in \mathbb{R}^{H \times W \times C}$) and executes an action a_t based on a natural language instruction I and its current observation (and potentially history). The agent learns a policy $\pi : (O_t, I, \text{state}_t) \rightarrow a_t$ to generate the sequence of actions $A = \{a_1, \dots, a_n\}$, purely from visual perception without access to the GUI’s underlying code

or APIs. An action a_t consists of an action type (e.g., `click`, `move_to`, `type`) and action parameters that typically involve coordinates, represented as either a point (x, y) or a bounding box (x, y, w, h) to specify the target GUI element. **GUI Grounding** represents the core capability enabling the policy π to function effectively at each step t . Given a potentially step-specific interpretation or sub-instruction I_t (derived explicitly or implicitly from I) and the current observation O_t , grounding is the process of mapping these inputs to the specific, executable action a_t . Achieving accurate grounding for each (I_t, O_t) pair is a fundamental objective in training the agent and a key determinant of the policy’s success on the overall task.

2.1 OSWORLD-G

2.1.1 Benchmark Construction

We sample screenshots from the rollout of previous models on OSWorld [46], as this is currently one of the most widely adopted benchmark environments for evaluating computer use agents, covering diverse elements, fine-grained components, and rich layouts. The screen size is set to 720p and 1080p. Following ScreenSpot and ScreenSpot-Pro, we annotate these screenshots with instructions and corresponding bounding boxes. Even for fine-grained manipulation tasks such as text editing, we can identify specific pixel regions that are sufficient for creating appropriate bounding boxes. For evaluation, we determine whether the coordinates in the agent’s predicted actions fall within the annotated bounding boxes, and calculate accuracy based on this spatial containment criterion. We utilize the CVAT ² platform to collect annotations of objects corresponding to instructions. Each annotation is performed by individuals highly familiar with the software details and is verified through actual testing in the real software, particularly for edge cases. Following the initial annotations, we conduct multiple verification rounds based on feedback from preliminary experiments. For each example in OSWORLD-G, we assign a fine-grained tag that identifies the element types required to solve the example. Additionally, we provide a refined annotation for each example that rephrases the original instructions to decompose the necessary GUI knowledge needed to complete the task. In total, we collect 564 samples, annotated with 32 different UI-types, each with a paraphrased instruction that requires no software knowledge to execute. The average annotation time per sample is approximately 0.5 human-hours. We provide the annotation workflow in the Appendix A.1.4.

2.1.2 Data Types

Leveraging the fine-grained element type tags, we categorize tasks into capability dimensions that directly reflect core model competencies: *text matching*, *element recognition*, *layout understanding*, *fine-grained manipulation*, and *refusal handling*, as presented in Table 1.

Text Matching & Element Recognition

Most cases in GUI grounding require simply text matching and element recognition as two fundamental capabilities. Text matching involves grounding actions according to explicit textual information provided in instructions (e.g., “Select ‘As Attachment’”). This requires matching the specified text to locate the appropriate screen region. Element recognition encompasses multiple aspects of visual understanding: identifying visual patterns such as icons or images (e.g., “Click on Ellipse icon”), and importantly, recognizing elements based on their implied functionality rather than explicit labels. For example, recognizing a “Save” button by its floppy disk icon, a “Settings” option by its gear icon, or a “Search” function by its magnifying glass symbol—all cases where the agent must associate visual elements with their functional purpose, even when no explicit text label is present.

Table 1: Distribution of examples in the OSWORLD-G benchmark categorized by GUI grounding capabilities and their corresponding interface element types. Full table can be refer to Appendix A.1.1

Capabilities	Element Types	# of Examples
Text Matching	Label	268
Element Recognition	Icon, Image, Button	337
Layout Understanding	Tab, Menu Bar, Dropdown Menu, Panel/Container, ...	252
Fine-grained Manipulation	Slider, Stepper, Text Field, Input Box, Divider, Table, ...	154
Refusal	–	54

²<https://app.cvat.ai/>

Layout Understanding GUIs are typically designed with modular structures. Knowledge of layout hierarchy is critical to locate elements precisely, as visually similar elements may exist across different modules, and describing elements often requires referencing their position within the layout. For instance, instructions like “Close the top notification bar” require correct identification of the notification bar area, as multiple similar close buttons may appear throughout the interface. Other cases require identification of toolbars, panels, pop-up windows, and other common GUI modules.

Fine-grained Manipulation Computer use agent tasks frequently involve text editing operations. Instructions such as “Select the place between the world ‘person’ and the number ‘1’” require precise cursor placement between specific letters, which may occupy only a small portion of the screen. Such actions demand the ability to perform operations with high precision within relatively small screen regions. Beyond text, this capability extends to interaction with compact components like sliders, steppers, table cell and other small elements.

Infeasible Certain tasks may arise from hallucinated or incorrect low-level user instructions or automated planning suggestions. An example could be an instruction like, “Click to open the Firefox browser,” when the shown screenshot does not contain a Firefox icon or any visible reference to it. A distinct subset of OSWORLD-G tasks with 54 examples explicitly highlights these infeasible scenarios. These tasks are valuable for evaluating a system’s ability to reject impossible instructions gracefully, preventing errors and ensuring safer, more robust interactions.

2.2 JEDI Data Construction

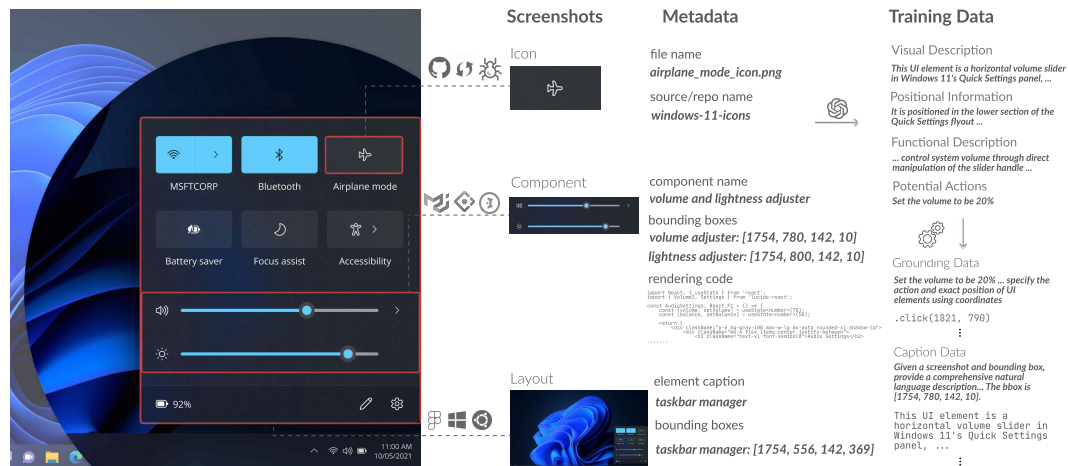


Figure 4: An overview of the synthetic data generation pipeline, demonstrating how screenshots and metadata are collected and synthesized, and subsequently converted into training data.

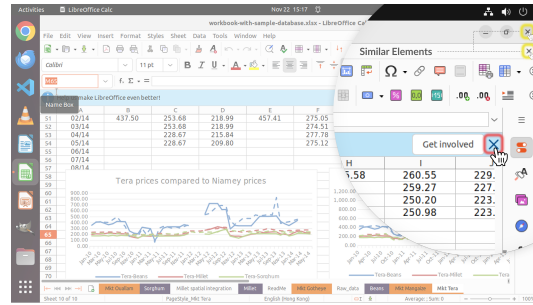


Figure 2: Example of layout understanding case in OSWORLD-G.

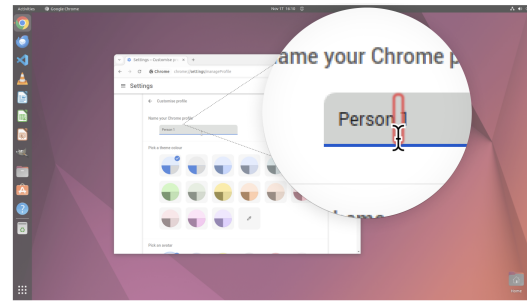


Figure 3: Example of fine-grained manipulation case in OSWORLD-G.

To enable robust GUI grounding, we construct the world’s largest multimodal dataset tailored for computer-use grounding scenarios, containing 4 million newly synthesized examples. Our grounding data collection process centers on gathering pairs of *screenshots* and *metadata* (information such as filename, rendering code, element bounding box, *etc.*), which are then further transformed into *training data* which contains queries and corresponding answers for VLMs to learn from it. Previous methods in Figure 4 provides an overview of this pipeline.

2.2.1 Icon

Icons are essential visual elements in graphical user interfaces that convey functionality through compact, recognizable imagery. To create a comprehensive collection of icons and corresponding metadata for grounding, we employ three complementary data collection strategies.

GitHub Repositories and Specialized Icon Websites Many open-source software projects archive their design icons within GitHub repositories. To acquire a varied collection, we systematically mine repositories containing the key term such as “icon” applying filtering criteria including star count, quantity of icon images, and temporal relevance. This yield icons representing various design paradigms such as flat design, fluent design, and skeuomorphism. To supplement our collection with production website icons, we implement a targeted web crawling pipeline that identifies and extracts icon elements from popular websites across various categories, capturing both visual assets and associated metadata including class names, aria labels, and contextual information. We leverage these icons by generating detailed descriptions through LLMs and creating training scenarios where models identify target icons based on textual descriptions. This comprehensive approach provides access to contemporary icons in their natural context, allowing us to capture emerging design patterns not yet available in open-source repositories.

Reverse Engineering Software To address the gap in desktop software icons, we employ reverse engineering techniques using specialized tools like IconsExtract to extract icons directly from executable files, DLLs, and system libraries across Windows, macOS and Ubuntu. We target a diverse range of software including Windows system applications and commonly used desktop applications. This method provide access to thousands of production-quality icons representing real-world software functionality.

2.2.2 Component

A *component* refers to a functional unit composed of icons, UI elements, and text, collectively enabling specific modes of computer-based interaction. Components serve as fundamental interaction units essential for user engagement in digital environments.

Synthesis Process We collect screenshots and associated metadata primarily through a code-and-rendering pipeline. By leveraging mainstream production-level UI component libraries commonly used in front-end development (e.g., Material UI), we select components and use their example code as the base code. We then employ LLMs to synthesize functional cases for specific tasks (such as a slider for air conditioning control) using the base code as context. We render these within a React application to obtain visual screenshots and extract corresponding metadata, such as the element position tree, built-in component names, and coordinates. This approach allows us to generate diverse component examples with precise ground truth source code.

Real-world Augmentation We observe that common interactive behaviors such as scrolling a webpage, clicking a cell in spreadsheet or resizing a text box in slides are underrepresented in code-based libraries. To address this gap, we further source real-world screenshots from existing websites and applications. For these, we utilize HTML parsing and application-specific tools (e.g., python-pptx) to extract structured metadata. All the implementation details can be found in the Appendix A.2.3.

2.2.3 Layout

A *layout* refers to the spatial arrangement of UI elements and components within an application or across the entire operating system. Layout understanding is crucial for tasks that require reasoning about the overall structure of the screen, enabling agents to interpret and interact with complex, multi-element interfaces at the application or system level.

Prototype Designs UI prototype platforms such as Figma³ provide numerous website and application design templates, including authentic specifications for production applications like VSCode, Zoom, and Microsoft 365. These designs offer valuable ground truth information, as each element includes designer-specified bounding boxes, component types, and functional descriptions. By using the official APIs of these platforms, we exported the designs as high-quality images while preserving their structured metadata, including hierarchical relationships between elements and positional data.

Real-World Application Screenshots To further improve scalability and diversity, we supplement our dataset with raw screenshots captured from real-world applications running on operating systems. We collect these screenshots by leveraging agent rollout data from OSWorld and WindowsAgentArena. Subsequently, we utilize the object detection model from OmniParser-v2 to generate bounding boxes for interface elements, thereby obtaining the necessary metadata.

2.2.4 Data Processing

After obtaining screenshots (icons, components, layouts) and metadata (filenames, paths, rendered source code, UI designer annotations, *etc.*), we convert them into an image-text-to-text multimodal question-answering format, creating richer and more natural language-oriented data suitable for VLM training. Our processing approach remain consistent across the different data types. We employ a VisualSketchpad [17]-like prompting methodology with models such as GPT-4o and Claude to generate enriched annotations based on the original screenshots and metadata, describing both appearance and functionality. We construct two complementary training formats: (1) *grounding format*, where the model receives a screenshot with instructions and must predict actions or relevant bounding boxes; and (2) *description format*, where the model receives a screenshot with bounding boxes and must provide descriptive information. For screenshots with multiple potential query-answer pairs, we compress them into single conversation to improve training efficiency.

2.2.5 Supplementary Training Data

To enhance the model’s ability to identify and reject infeasible actions, we construct a refusal part in our dataset by mismatching existing instructions with unrelated screenshots, yield over 2.6 million examples. We further sample and manually inspect a subset of these examples to verify that the vast majority indeed reflects truly infeasible actions. In addition, we integrate and unify new datasets from previous work (human-labeled or synthesized) such as SeeClick, OS-Atlas, follow the practice from Aguis [48]. We observe that synthetic data obtained directly from the Internet such as SeeClick, OS-Atlas contain noisy examples, we use UI-TARS-72B to filter them and keep the labeled and predicted matching part of the data. Full data statistics in Table 9.

3 Experiments

We first adapt previous benchmarks for testing our data effectiveness. We adapt different sizes of the latest Qwen2.5-VL [6] as our backbone model, set the maximum pixel limit to approximately 1080p. Model finetuning takes approximately 20 hours for the 3B model, and 30 hours for the 7B model, conducted using cluster of 128 CPU cores, 512GB memory, and 64 NVIDIA H100 GPUs.

3.1 Grounding Ability

We select several benchmarks for GUI grounding. The most commonly used benchmarks in the past include ScreenSpot-v2 (Table 2), ScreenSpot-Pro (Table 3), which focuses on high-resolution and professional software charts, UI-Vision [29] (Table 4), which focuses on fine-grained evaluation of computer use agents in real-world desktop environments, and OSWORLD-G (Table 5), which we use to evaluate model performance on fine-grained and functional components.

The results show that fine-tuning existing open-source models on our data achieves state-of-the-art performance, surpassing other dedicated computer use model such as Operator (unpublished data and model) and UI-TARS (unpublished data) with a small model size. On OSWORLD-G, we observe that models generally achieve the highest accuracy on examples involving text matching, outperforming their abilities in element recognition and layout understanding, with the lowest performance observed in fine-grained manipulation tasks. Notably, although we included refusal data during training to encourage the model to reject instructions referring to elements not present on the screen, the model rarely produces refusal responses. Similarly, in all models except Gemini-2.5-Pro, especially those specifically trained for computer-use tasks, refusal predictions are consistently absent.

³<https://www.figma.com/>

Table 2: Comparison of various planners and grounding methods on ScreenSpot-v2. The highlighted column presents the overall average performance across all categories

Planner	Grounder	Mobile		Desktop		Web		Avg
		Text	Icon/Widget	Text	Icon/Widget	Text	Icon/Widget	
-	SeeClick	78.4	50.7	70.1	29.3	55.2	32.5	55.1
	OS-Atlas-Base-7B	95.2	75.8	90.7	63.6	90.6	77.3	85.1
	UI-TARS-7B	96.9	89.1	95.4	85.0	93.6	85.2	91.6
	UI-TARS-72B	94.8	86.3	91.2	87.9	91.5	87.7	90.3
	Operator	47.3	41.5	90.2	80.3	92.8	84.3	70.5
	Qwen2.5-VL-3B	93.4	73.5	88.1	58.6	88.0	71.4	80.9
	Qwen2.5-VL-7B	97.6	87.2	90.2	74.2	93.2	81.3	88.8
	Qwen2.5-VL-32B	97.9	88.2	98.5	79.3	91.2	86.2	91.3
GPT-4o	OS-Atlas-Base-7B	96.2	83.4	89.7	69.3	94.0	79.8	87.1
	OmniParser-v2	95.5	74.6	92.3	60.9	88.0	59.6	80.7
	JEDI-3B	96.6	81.5	96.9	78.6	88.5	83.7	88.6
	JEDI-7B	96.9	87.2	95.9	87.9	94.4	84.2	91.7

Table 3: Comparison of models on ScreenSpot-Pro. The highlighted column presents the overall average performance across all categories.

Agent Model	Development			Creative			CAD			Scientific			Office			OS			Avg		
	Text	Icon	Avg	Text	Icon	Avg	Text	Icon	Avg	Text	Icon	Avg	Text	Icon	Avg	Text	Icon	Avg	Text	Icon	Avg
SeeClick [10]	0.6	0.0	0.3	1.0	0.0	0.6	2.5	0.0	1.9	3.5	0.0	2.0	1.1	0.0	0.9	2.8	0.0	1.5	1.8	0.0	1.1
Qwen2-VL-7B [42]	2.6	0.0	1.3	1.5	0.0	0.9	0.5	0.0	0.4	6.3	0.0	3.5	3.4	1.9	3.0	0.9	0.0	0.5	2.5	0.2	1.6
ShowUI-2B [23]	16.9	1.4	9.4	9.1	0.0	5.3	2.5	0.0	1.9	13.2	7.3	10.6	15.3	7.5	13.5	10.3	2.2	6.6	10.8	2.6	7.7
CogAgent-18B [16]	14.9	0.7	8.0	9.6	0.0	5.6	7.1	3.1	6.1	22.2	1.8	13.4	13.0	0.0	10.0	5.6	0.0	3.1	12.0	0.8	7.7
Aria-UI [49]	16.2	0.0	8.4	23.7	2.1	14.7	7.6	1.6	6.1	27.1	6.4	18.1	20.3	1.9	16.1	4.7	0.0	2.6	17.1	2.0	11.3
Claude [3]	22.0	3.9	12.6	25.9	3.4	16.8	14.5	3.7	11.9	33.9	15.8	25.8	30.1	16.3	26.9	11.0	4.5	8.1	23.4	7.1	17.1
Operator [30]	50.0	19.3	35.1	51.5	23.1	39.6	16.8	14.1	16.1	58.3	24.5	43.7	60.5	28.3	53.0	34.6	30.3	32.7	45.0	23.0	36.6
OS-Atlas-7B [45]	33.1	1.4	17.7	28.8	2.8	17.9	12.2	4.7	10.3	37.5	7.3	24.4	33.9	5.7	27.4	27.1	4.5	16.8	28.1	4.0	18.9
UGround-V1-7B [15]	-	-	35.5	-	-	27.8	-	-	13.5	-	-	38.8	-	-	48.8	-	-	26.1	-	-	31.1
UI-TARS-2B [32]	47.4	4.1	26.4	42.9	6.3	27.6	17.8	4.7	14.6	56.9	17.3	39.8	50.3	17.0	42.6	21.5	5.6	14.3	39.6	8.4	27.7
UI-TARS-7B [32]	58.4	12.4	36.1	50.0	9.1	32.8	20.8	9.4	18.0	63.9	31.8	50.0	63.3	20.8	53.5	30.8	16.9	24.5	47.8	16.2	35.7
UI-TARS-72B [32]	63.0	17.3	40.8	57.1	15.4	39.6	18.8	12.5	17.2	64.6	20.9	45.7	63.3	26.4	54.8	42.1	15.7	30.1	50.9	17.5	38.1
Qwen2.5-VL-3B	38.3	3.4	21.4	40.9	4.9	25.8	22.3	6.3	18.4	44.4	10.0	29.5	48.0	17.0	40.9	33.6	4.5	20.4	37.8	6.6	25.9
Qwen2.5-VL-7B	51.9	4.8	29.1	36.9	8.4	24.9	17.8	1.6	13.8	48.6	8.2	31.1	53.7	18.9	45.7	34.6	7.9	22.4	39.9	7.6	27.6
Qwen2.5-VL-32B	74.0	21.4	48.5	61.1	13.3	41.1	38.1	15.6	32.6	78.5	29.1	57.1	76.3	37.7	67.4	55.1	27.0	42.3	63.2	22.5	47.6
JEDI-3B	61.0	13.8	38.1	53.5	8.4	34.6	27.4	9.4	23.0	54.2	18.2	38.6	64.4	32.1	57.0	38.3	9.0	25.0	49.8	13.7	36.1
JEDI-7B	42.9	11.0	27.4	50.0	11.9	34.0	38.0	14.1	32.2	72.9	25.5	52.4	75.1	47.2	68.7	33.6	16.9	26.0	52.6	18.2	39.5

Table 4: Comparison of models on element grounding tasks in UI-Vision. The highlighted column presents the overall average performance across all categories.

Model	Basic Overall	Functional Overall	Spatial Overall	Final Avg
Claude-3.7-Sonnet [1]	9.48	7.73	7.60	8.27
Qwen-2.5VL-7B	1.24	0.79	0.51	0.85
MiniCPM-V-8B [51]	7.11	5.30	1.45	4.34
ShowUI-2B	8.07	7.67	2.07	5.94
Aria-UI	12.2	14.0	3.98	10.1
UGround-v1-7B	15.4	17.1	6.25	12.9
OSAtlas-7B	12.2	11.2	3.67	9.02
Aguvis-7B	17.8	18.3	5.06	13.7
UI-TARS-7B	20.1	24.3	8.37	17.6
SeeClick	9.42	4.68	2.07	5.39
UI-TARS-72B	31.4	30.5	14.7	25.5
JEDI-3B	22.3	25.2	9.35	18.7
JEDI-7B	32.3	30.5	12.8	24.8

Table 5: Performance comparison of models on OSWORLD-G across multiple capability dimensions. The highlighted column presents the overall average performance across all categories.

Agent Model	Text Matching	Element Recognition	Layout Understanding	Fine-grained Manipulation	Refusal	Overall
OS-Atlas-7B	44.1	29.4	35.2	16.8	7.4	27.7
UGround-V1-7B	51.3	40.3	43.5	24.8	0.0	36.4
Aguvis-7B	55.9	41.2	43.9	28.2	0.0	38.7
UI-TARS-7B	60.2	51.8	54.9	35.6	0.0	47.5
Seed1.5-VL [38]	73.9	66.7	69.6	47.0	18.5	62.9
UI-TARS-72B	69.4	60.6	62.9	45.6	0.0	57.1
Gemini-2.5-Pro	59.8	45.5	49.0	33.6	38.9	45.2
Operator	51.3	42.4	46.6	31.5	0.0	40.6
Qwen2.5-VL-3B	41.4	28.8	34.8	13.4	0.0	27.3
Qwen2.5-VL-7B	45.6	32.7	41.9	18.1	0.0	31.4
Qwen2.5-VL-32B	63.2	47.3	49.0	36.9	0.0	46.5
JEDI-3B	67.4	53.0	53.8	44.3	7.4	50.9
JEDI-7B	65.9	55.5	57.7	46.9	7.4	54.1

3.2 Agentic Ability

We hope that the data and benchmark we provide will ultimately serve as a critical signal in fostering the agentic capabilities required, rather than merely enhancing specific grounding abilities. We evaluate our approach on the computer use benchmarks in online environments, namely OSWorld [46, 47] and WindowsAgentArena [7]. We employ foundation models like GPT-4o or o3 as the planner model, which receives high-level instructions and, at each step, predicts the next low-level natural language instruction based on the current observation and action history. Our JEDI model then takes these low-level instructions and predicts the concrete actions to execute. To control for confounding variables, we do not introduce any specialized agent architecture or model scheduling [2].

The results demonstrate that, when using our model as the grounding component, a simple agent with foundation models that are not specialized in computer use tasks can achieve state-of-the-art performance, surpassing previous approaches that used 72B-scale models for grounding, and matching the performance of specialized models. Additionally, our agent system exhibits a similar trend to Operator, with performance improving as deployment scale increases. These findings suggest that, given the current reasoning capabilities of large language models, supplementing them with enhanced grounding ability—either through additional data or external systems—can be a starting point to build highly effective agentic systems.

Table 6: Success rate on the OSWorld and WindowsAgentArena benchmarks. JEDI with GPT-4o results are the average success rate of 4 runs with standard deviation. More detailed performance see A.6.

Planner	Grounding	OS SR	WAA SR
	GPT-4o	5.0	9.4
	Kimi-VL [39]	8.2	10.4
	UI-TARS-72B	22.7	-
	o3	23.0	-
	Operator [30]	32.6	-
	OpenCUA-32B [43]	34.8	-
	Claude 4 Sonnet	43.9	-
GPT-4o	Aguvis-72B	17.0	-
GPT-4o	JEDI-3B	24.0 ± 1.05	33.03 ± 1.64
GPT-4o	JEDI-7B	27.0 ± 1.81	33.7 ± 0.82
o3	JEDI-7B	51.0	-

4 Analysis

4.1 Effectiveness of Knowledge

GUI grounding also requires knowledge and even reasoning. We aim to investigate the performance of pure grounding when almost no additional knowledge is required. To this end, we assume that the instruction recipient possesses minimal prior experience with GUI interactions, and we re-annotate the entire benchmark to minimize the background knowledge needed to understand each instruction. This is achieved by relying on easily identifiable universal features such as color and shape. For example, the instruction “Open the filter function for search settings.” is refined, based on the screenshot, to “Click the button that includes an icon of a funnel on the right of the ‘search settings’ bar.” We conduct experiments on several models and present the performance comparison before and after instruction refinement in Figure 5. First, we observe that model performance generally improves after instruction refinement. This suggests that if we can supplement models with relevant interaction experience or provide more precise expressions—either manually or via upstream models—grounding performance can be enhanced. Second, after instruction refinement, our model achieves performance comparable to the largest state-of-the-art model, UI-TARS-72B. This indicates that, with appropriate data such as our JEDI dataset, smaller models are already sufficient in terms of pure grounding ability, and further advantages may lie in the supplementation of background knowledge.

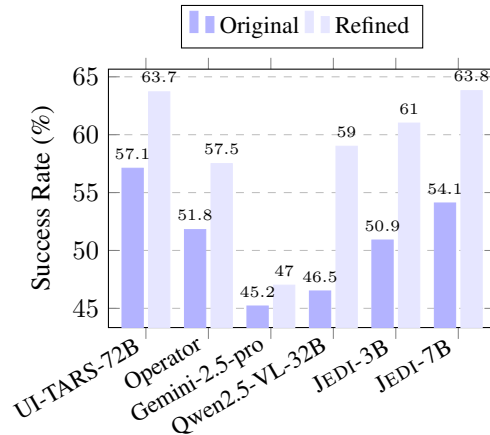


Figure 5: Success rates of various models on the OSWORLD-G benchmark with original and refined instructions.

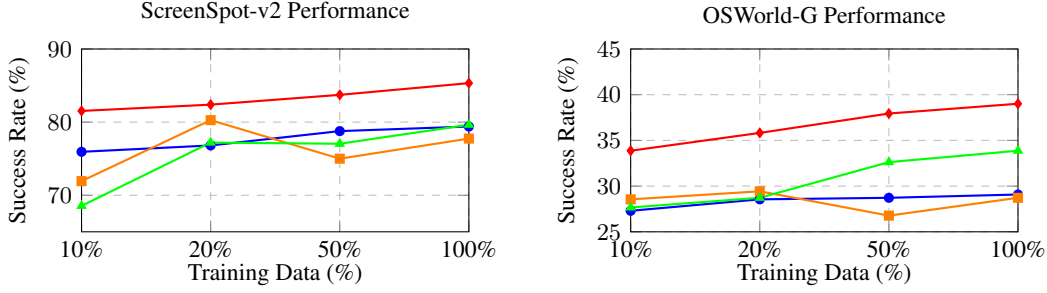
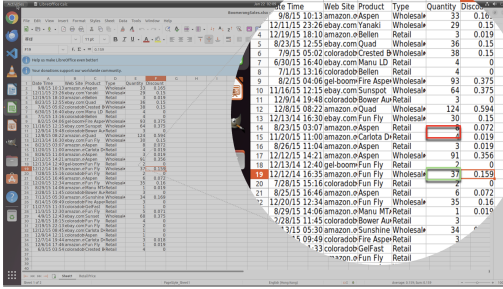


Figure 6: The effect of training data percentage on Qwen2.5-VL-3B model performance across different UI elements. Blue line: Icon; Orange line: Component; Green line: Layout; Red line: All. Left: ScreenSpot-v2 benchmark; Right: OSWORLD-G benchmark.

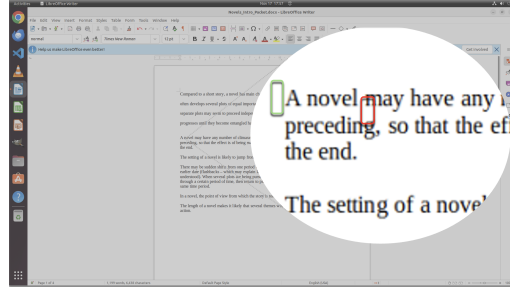
4.2 Performance as Data Scaling

We aim to investigate whether collecting data through our pipeline enables further performance improvements as the data scale increases. We sample data of icon, component, and layout at proportions of 10%, 20%, 50%, and 100%. For each data proportion, we train the models for the same number of steps, ensuring that all models are sufficiently trained to allow a fair comparison of final performance under equal computational resources. The results are shown in Figure 6. First, we observe that as the data scale increases, model performance continues to improve, with no sign of saturation. This suggests that further scaling up the data using our proposed approach can yield additional gains. Second, we note that scaling up a single data type (e.g., component) can lead to performance fluctuations. In contrast, scaling up mixed data types results in more stable improvements, indicating that combining data from multiple sources is beneficial.

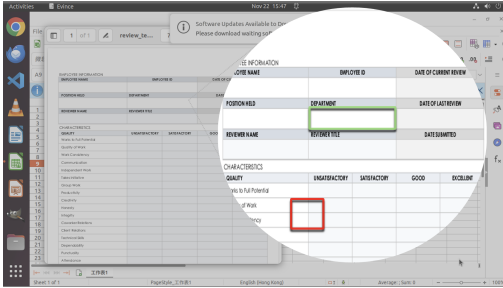
4.3 Case Study



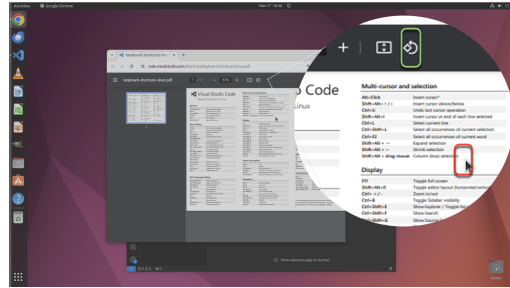
(a) Instruction: Click on the quantity of product in 12/12/14 16:35.



(b) Instruction: Place the cursor before the capital 'A' in the paragraph about novel climaxes.



(c) Instruction: Fill up the middle space of the second blank line in the visualized information form.



(d) Instruction: Button to rotate the pdf.

Figure 7: Qualitative comparison showing JEDI’s enhanced fine-grained operation and GUI understanding compared to Qwen2.5-VL-7B-Instruct across four cases. The green square represents the click position of JEDI, while the red square indicates the click position of Qwen.

We conducted a detailed comparison of JEDI-7B and Qwen2.5-VL-7B-Instruct using OSWORLD-G. To illustrate the improvements of JEDI, we selected representative cases where their results differed,

as shown in Figure 7. In each subfigure, the green square represents the click position of JEDI, which is the correct grounding action, while the red square indicates the erroneous click position of Qwen. In these examples, JEDI showcases exceptional fine-grained operational capabilities and comprehension skills in locating and matching information. As illustrated in the subfigure 7a, JEDI successfully identifies the target cell without an explicit location (like “E19”) by using information from both the timestamp and the table header. Similarly, by understanding the paragraph text and accurately identifying relative positions, JEDI effectively addresses the case presented in the 7b. Furthermore, as illustrated in the 7c, by learning from web page layouts, JEDI exhibits generalization to desktop environments, accurately locating the specified blank cell based on the positional description. Additionally, benefiting from training on extensive icon data, JEDI successfully associated the icon (a counter-clockwise arrow) with its corresponding function (“rotate”), as depicted in the 7d. Further analysis of additional examples can be found in Appendix A.5.1 and A.5.2.

5 Related Work

Digital Agents Multimodal agents can be broadly categorized into digital and physical agents [34, 35, 14]. Existing digital agent research focuses on establishing environments for mobile and web interaction [34, 24, 28, 40, 50, 56, 33, 53, 19, 13, 41], with subsequent works extending to real-world computer interaction scenarios [46, 7]. Recent advances include enhanced GUI understanding through visual encoding architectures [16, 6], reinforcement learning frameworks introduced to web/mobile operations [31, 5], agentic-frameworks [55, 15, 2, 49, 25] and joint visual-language modeling [45, 48, 32]. However, current methods face precision limitations on grounding due to homogeneous synthetic training data [10, 15, 49, 36], which overlook the systematic support for fine-grained component operations (e.g., slider adjustments, nested menu selections), finally limits the upper policy execution as well as further learning. Furthermore, the sources of data which could be beneficial for enhancing GUI interaction abilities are underexplored.

GUI Grounding GUI grounding remains a core challenge for digital agents executing actions in real world environment. Recent approaches have shifted from relying on textual information such as HTML/accessibility information to pure visual solutions [10, 55, 15, 26, 23, 52]. However, both existing training data and evaluation paradigms suffer from oversimplification—whether through screenshot-text pairings or manual annotations—failing to capture the complexity of natural language instructions and action execution, particularly in tasks requiring understanding of expressed intent rather than simple referencing, screen-level comprehension (such as identifying active windows), and fine-grained operations (like sliders and drag-and-drop), thus hindering meaningful assessment and advancement in these critical areas. We point out the problems by proposed benchmark and bridging these gaps through multiple aspects of synthetic data. The comparison with previous work is shown in Table 8.

6 Conclusion

We highlight overlooked GUI grounding challenges such as fine-grained manipulation and layout understanding, introducing OSWORLD-G with 564 annotated samples for evaluation. We set up multiple pipelines to construct a dataset containing 4 million examples to address these challenges. Our models trained on this dataset achieve competitive results on ScreenSpot-v2, ScreenSpot-Pro, and OSWORLD-G, while also boosting agent performance in OSWorld and WindowsAgentArena. These results demonstrate the effectiveness of addressing previously identified gaps in GUI grounding research.

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7 Limitations

In this work, we mainly discuss the data synthesis methods while figuring out the essential factors. Screen capture data can be extracted from internet images and videos by neural networks, which can further expand the dataset. This approach can significantly expand the screenshot metadata, thus enlarging the grounding data. Due to resource restrictions, we leave this for further scaling through industrial efforts. Rejecting infeasible actions is crucial, as it helps prevent errors and mitigates the risks associated with incorrect instructions. Refusal modeling in GUI grounding remains a significant challenge, as models show limited improvement due to the inherent limitations in pretraining and the hallucination phenomenon in VLMs. While we find this problem has inherent complexity and challenges, this provides direction for future in-depth research and optimization. On the other hand, based on our enhanced grounding model, we can construct human-like traversers that interact in the digital world with or without specific purposes, similar to how humans navigate digital environments. This approach can further collect interaction data to improve grounding capabilities and even enhance model knowledge. We also leave these explorations for future work.

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A Appendix

A.1 OSWORLD-G Statistics

A.1.1 Data Types

We categorize the examples into five categories that requires different grounding capabilities. And the classification can be refer to their corresponding element types in the Table 7.

Table 7: Full table of distribution of examples in the OSWORLD-G benchmark categorized by GUI grounding capabilities and their corresponding interface element types.

Capabilities	Element Types	# of Examples
Text Matching	Label	268
Element Recognition	Icon, Image, Button	337
Layout Understanding	Tab, Banner/Notification, Accordion/Collapsible Panel, Pagination Control, Toolbar, Menu Bar, Dropdown Menu, List, Grid, Tree View, Dialog/Modal, Panel/-Container, Sidebar, Drawer	252
Fine-grained Manipulation	Slider, Stepper, Divider, Toggle/Switch, Accordion/Collapsible Panel, Checkbox, Radio Button, Color Picker, Date Picker, Table, Text Field/Input Box, Search Bar, Text Filed, Input Box	154
Refusal	–	54

A.1.2 Comparison with Previous Work

We show the comparison between OSWORLD-G and previous work in Table 8.

Table 8: Comparison between OSWORLD-G and previous benchmarks.

Benchmarks	Platforms	# of Examples	# of Annotated UI-Types	Instruction Annotation		Fine-grained Actions	Refusal Cases
				Visual	Functional		
ScreenSpot-v2	Mobile, Desktop, Web	1272	2 (Icon, Text)	✗	✓	✗	✗
ScreenSpot Pro	Desktop	1581	2 (Icon, Text)	✗	✓	✗	✗
OmniAct	Desktop, Web	9802	3 (Icon, Text, Color)	✗	✓	✗	✗
OSWORLD-G	Desktop	564	32	✓	✓	✓	✓

A.1.3 Data Examples

We show examples of text matching type and element recognition type in Figure 2 (layout understanding), 3 (fine-grained manipulation), 8 (text matching, element recognition and refusal instruction).

Layout Understanding Layout understanding tasks require models to comprehend the hierarchical structure of interface elements. In the example shown in Figure 2, closing the top notification bar requires recognizing that such bars typically appear at the top region of the editing area in Libreoffice Calc.

Fine-grained Manipulation Fine-grained manipulation tasks demand high-precision actions within small or tightly packed screen regions. In the example in Figure 3, selecting the position between the word "person" and the number "1" requires the model to operate at a character-level granularity.

Text Matching Text matching tasks involve grounding actions based on explicit textual cues in the instruction. As shown in Figure 8a, choosing "As Attachment" requires the model to locate and match this phrase within the screenshot.

Element Recognition Element recognition tasks require identifying visual patterns such as icons or images. In the example in Figure 8b, clicking on the ellipse icon involves recognizing the ellipse shape visually within the interface.

Refusal Instruction Refusal instruction tasks assess whether the model can recognize when an action is infeasible. In the example in Figure 8c, the instruction refers to "Cindy Williams," who is not visible on the screen. Therefore, clicking on her email address is not possible, and the model is expected to refrain from taking action.

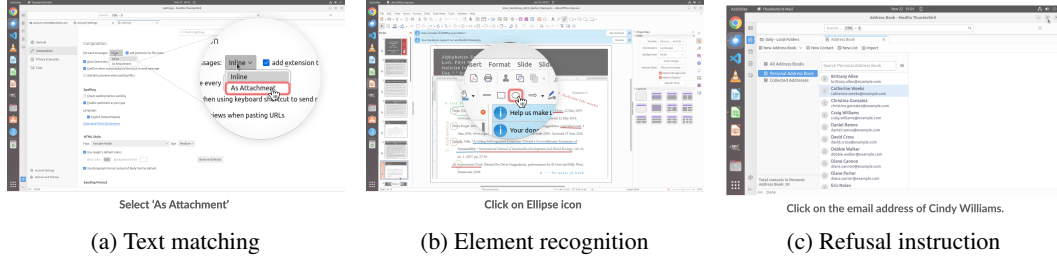


Figure 8: Examples in OSWORLD-G that require text matching and element recognition abilities.

A.1.4 Annotation Details

The annotation process for OSWORLD-G comprised the following systematic steps:

1. **Failure Case Collection:** We systematically gathered grounding failure cases from state-of-the-art model trajectories, categorizing each failure according to its primary grounding capability requirements.
2. **Expert Annotation:** Annotators with extensive experience in various software applications performed initial precise annotations. Using the collected failure cases as guidance, they crafted descriptive low-level instructions that were designed to be unambiguous and map uniquely to specific screen actions.
3. **Bounding Box Annotation:** For each instruction-screenshot pair, corresponding bounding boxes were carefully annotated to indicate the precise regions of interest.
4. **Quality Verification:** We conducted multi-round verification procedures, leveraging predictions from strong models to resolve cases with inconsistent annotation results.

All examples in OSWORLD-G were annotated following this rigorous process to ensure high-quality and consistent annotations.

A.2 JEDI Statistics

A.2.1 Overview

Table 9 provides an overview of the statistics for JEDI. To enhance the quality of our dataset, we made several improvements upon AGUVIS, where we name it AGUVIS++. First, we manually filter out low-quality annotations and samples unrelated to computer use scenarios. We then augment the dataset by incorporating OS-Atlas data. For synthetic data sources such as SeeClick and OS-Atlas, which inherently contain rendering artifacts and alignment issues, we employ UI-TARS⁴ model for quality control—comparing predicted outputs against ground truth values to ensure deviations remained within acceptable thresholds. In-house data is annotated by human workers. We ask them to use computers while recording timestamps of their actions and capturing screenshots from their screens as observations. These are later used with models like GPT to construct input instructions.

Table 9: Data statistics of our dataset. The ‘# Line’ indicates the compression of multiple query-answer pairs to improve training efficiency.

Data Source	# Image	# Line	# Turn	Sampling
JEDI				

Continued on next page

⁴<https://huggingface.co/ByteDance-Seed/UI-TARS-72B-DPO>

Table 9 – continued from previous page

Data Source	# Image	# Line	# Turn	Sampling
Icon Captioning	267,102	403,584	251,837	All
Icon Grounding	202,399	202,419	202,419	All
Component Manipulation (Rule-based)	29,303	40,653	40,653	All
Component Manipulation (Generated)	60,085	529,749	1,192,687	All
Layout Captioning (App)	5,117	17,721	366,774	All
Layout Grounding (App)	5,117	25,133	916,539	All
Layout Captioning (OS)	2,901	14,351	258,334	All
Layout Grounding (OS)	2,901	26,190	774,546	All
JEDI Refusal				
Refusal Data (Various Sources)	165,235	2,666,124	2,666,124	Random:5%
AGUVIS++ [48]				
SeeClick [10]	66,426	69,634	525,442	All
WebUI [44]	57,389	57,389	143,187	All
GUIEnv [8]	70,394	327,972	327,972	All
GUIAct (web single) [8]	17,545	17,572	17,572	All
Widget Captioning [22]	14,409	101,426	101,426	All
RicoSCA [21]	18,146	173,212	173,212	All
UI RefExp [4]	4,646	15,624	15,624	All
RICO Icon [11]	16,133	16,133	32,091	All
OmniACT [18]	6,720	6,720	6,720	All
DocVQA Grounding [27, 48]	9,756	34,060	34,060	All
MM-Mind2Web [12]	7,351	7,351	7,351	All
GUIAct (web multi) [8]	13,262	65,740	65,740	All
AitZ [54]	12,002	11,914	11,914	All
AndroidControl [20]	54,678	54,678	54,678	All
Guide [37]	12,422	12,422	12,422	All
OS-Atlas [45]	303,472	303,472	303,472	All
In-house Data				
Additional In-house Annotated and Augmented Data	1,392,009	1,392,016	1,486,289	All

A.2.2 Icon Statistics

The Source Statistics of icon data in JEDI are detailed in Table 10.

Table 10: Data sources for icon collection in the JEDI dataset. Due to the diverse and scattered nature of these sources, they are presented here collectively rather than being broken down in the overall dataset overview.

Data	Source	Link
Ubuntu 2204	Crawl	https://github.com/ubuntu/yaru/tree/master/icons
Snap Store	Crawl	https://snapcraft.io/store
Windows XP	Reverse engineering	-
Windows Vista	Reverse engineering	-
Windows 7	Reverse engineering	-
Windows 10	Reverse engineering	-
	Crawl	https://learn.microsoft.com/en-us/windows/apps/design/style/segoe-ui-symbol-font
Windows 11	Reverse engineering	-
	Crawl	https://github.com/microsoft/fluentui-system-icons/tree/main/assets
Miscrosoft App Store	Crawl	https://apps.microsoft.com/apps?hl=en-gb&gl=US
macOS Ventura	Reverse engineering	-
macOS Sonoma	Reverse engineering	-
macOS Sequoia	Reverse engineering	-
macOS icon Collection	Crawl	https://macosicons.com/
Apple App store	Crawl	
iOS App store	Crawl	
Calculator	Crawl	https://github.com/microsoft/calculator/tree/main/src/Calculator/Assets
Audacity	Crawl	https://github.com/audacity/audacity/tree/master/au3/libraries/lib-theme-resources
Google	Crawl	https://fonts.google.com/icons
VSCode	Crawl	https://github.com/microsoft/vscode-icons
LibreOffice	Crawl	https://github.com/LibreOffice/core/tree/master/icon-themes
GitHub	Crawl	https://github.com/primer/octicons/tree/main/icons
GIMP	Crawl	https://github.com/GNOME/gimp
VLC	Crawl	https://github.com/videolan/vlc
PhotoShop	Reverse engineering	-

A.2.3 Component Statistics

The following Table 11 provides a detailed list of the component libraries we use, along with the contribution of each component to the JEDI dataset.

Table 11: Statistics of Material UI Components

Component Type	Conversations	Images
material (Total)	385,493	31,309
no-ssr	321	24
box	560	47
textarea-autosize	445	37
click-away-listener	764	45
links	886	35
floating-action-button	689	51
bottom-navigation	6,709	535
popper	3,258	169
modal	1,699	71
speed-dial	3,974	630
accordion	1,840	82
rating	9,409	869
use-media-query	7,285	113
dividers	2,318	83
skeleton	2,103	85
alert	7,290	1,378
typography	511	38
button-group	2,474	102
radio-buttons	3,020	115
steppers	5,252	869
container	625	37
badges	2,991	108
cards	3,881	160
progress	4,448	231
icons	4,663	173
image-list	2,389	96
popover	658	41
toggle-button	7,919	1,183
checkboxes	8,447	1,148
buttons	4,545	206
selects	5,122	194
backdrop	214	16
menus	15,498	1,839
transitions	1,794	92
masonry	7,932	106
text-fields	3,964	285
portal	134	26
dialogs	9,478	1,445
breadcrumbs	3,693	110
switches	7,050	1,050
stack	2,371	82
paper	5,993	97
tooltips	5,648	266
timeline	7,893	219
chips	13,440	1,951
transfer-list	2,100	295
tabs	52,425	2,917
snackbars	6,891	1,477
app-bar	17,474	2,096
table	11,536	839
lists	17,377	2,094
drawers	15,942	1,846
grid-legacy	5,979	149
pagination	12,497	197
slider	27,843	2,210

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Table 11 – continued from previous page

Component Type	Conversations	Images
autocomplete	10,356	322
avatars	5,634	154
grid	7,842	174
mantine (Total)	27,814	762
InputValidation	577	14
DndTable	118	6
ButtonProgress	45	6
ActionToggle	852	17
HeaderMenu	62	3
AutocompleteLoading	17	3
AuthenticationImage	34	3
NavbarMinimalColored	97	4
PasswordStrength	98	4
HeaderTabs	75	3
NavbarLinksGroup	5,322	56
ArticleCard	185	7
HeroBullets	111	4
InputWithButton	73	4
FeaturesGrid	121	4
CardsCarousel	79	4
UsersRolesTable	94	4
ContainedInputs	89	6
FeaturesImages	140	5
NavbarMinimal	64	3
HeroImageBackground	102	7
TableSelection	245	6
CardGradient	718	15
HeroContentLeft	95	6
ButtonCopy	52	5
FeaturesCards	128	4
TableReviews	140	3
UserCardImage	202	7
StatsGrid	214	7
NavbarSearch	141	5
ArticlesCardsGrid	144	6
ProgressCard	60	4
NotFoundImage	22	3
ProgressCardColored	1,852	28
UserInfoAction	138	8
ImageCheckboxes	263	9
StatsCard	111	5
ImageActionBanner	60	4
HeaderSearch	81	4
CustomSwitch	32	3
FaqSimple	97	4
HeaderSimple	63	4
ForgotPasswordInput	37	4
DndList	167	6
ArticleCardFooter	118	4
CarouselCard	94	4
CommentSimple	107	5
StatsGroup	78	3
StatsControls	124	5
DoubleHeader	70	5
TableOfContentsFloating	74	4
FaqWithImage	71	4
CardWithStats	250	8
EmailBanner	146	6
LeadGrid	145	7
Subgrid	73	4
SliderIcon	132	3
UserButton	72	4

Continued on next page

Table 11 – continued from previous page

Component Type	Conversations	Images
NavbarSegmented	54	4
NavbarSimple	103	4
NothingFoundBackground	116	11
FeaturesTitle	181	5
HeroImageRight	132	5
UsersStack	240	4
FooterLinks	208	5
NotFoundTitle	19	3
ContactUs	398	12
ButtonMenu	261	17
GradientSegmentedControl	102	5
ArticleCardVertical	99	7
NavbarSimpleColored	99	4
CurrencyInput	43	5
SliderLabel	196	3
ArticleCardImage	48	4
FeaturesAsymmetrical	76	3
FooterSocial	157	8
HeaderMegaMenu	91	4
StatsRingCard	74	5
TableSort	108	4
AuthenticationTitle	77	3
TableScrollArea	92	3
CommentHtml	147	7
AuthenticationForm	195	15
GetInTouch	305	8
HeroTitle	57	3
DropzoneButton	24	4
ServerOverload	124	8
SliderMarks	32	4
GetInTouchSimple	109	4
SliderWhite	64	4
StatsRing	138	4
StatsSegments	149	5
HeroText	117	8
FloatingLabelInput	19	4
CookiesBanner	48	4
TaskCard	1,383	19
ForgotPassword	49	3
InputTooltip	40	4
TableOfContents	119	4
CheckboxCard	15	4
ServerError	35	5
FaqWithBg	74	4
SplitButton	76	3
LanguagePicker	100	5
BadgeCard	38	3
SwitchesCard	1,339	16
FeaturesCard	91	4
ImageCard	115	8
DoubleNavbar	110	4
FaqWithHeader	151	8
UserMenu	136	4
UserInfoIcons	103	4
NavbarNested	167	7
SliderInput	113	4
StatsGridIcons	186	5
FooterSimple	137	4
UsersTable	2,927	23
SocialButtons	325	10
SliderHover	84	4
FooterCentered	58	2

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Table 11 – continued from previous page

Component Type	Conversations	Images
DndListHandle	76	2
ActionsGrid	122	4
GridAsymmetrical	172	2
ant-design (Total)	473,723	16,837
switch	1,484	94
watermark	1,849	83
skeleton	1,913	99
divider	2,038	98
tooltip	3,525	194
rate	5,492	135
auto-complete	4,359	203
tour	2,174	114
checkbox	6,531	255
splitter	4,878	254
time-picker	6,642	276
collapse	5,191	225
qr-code	2,711	160
menu	6,182	215
segmented	6,088	238
flex	3,386	113
notification	6,090	208
alert	6,124	199
list	7,470	190
button	8,060	329
timeline	5,727	163
carousel	1,997	120
modal	9,508	379
drawer	7,818	275
steps	9,873	338
affix	1,105	66
card	7,331	345
progress	9,485	274
mentions	3,829	190
typography	3,405	203
tree-select	5,515	248
descriptions	6,732	236
message	3,626	156
transfer	7,308	193
popover	3,009	163
empty	1,105	89
badge	8,339	292
radio	6,888	239
spin	1,825	126
float-button	3,457	215
image	3,765	217
cascader	6,992	372
popconfirm	2,156	153
calendar	10,389	141
form	10,818	679
config-provider	3,167	143
app	663	35
statistic	2,345	96
back-top	454	29
breadcrumb	3,964	130
input-number	5,420	286
space	6,426	240
avatar	5,120	150
icon	2,898	135
slider	9,588	231
tabs	36,465	609
upload	3,270	373
anchor	4,524	165

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Table 11 – continued from previous page

Component Type	Conversations	Images
tag	5,118	214
tree	16,354	433
input	7,012	478
select	15,055	550
color-picker	6,342	410
pagination	9,673	221
layout	6,604	188
dropdown	9,035	301
grid	13,957	241
date-picker	20,445	739
table	44,891	844
result	744	42
chakra (Total)	330,074	11,784
mark	288	24
loader	488	35
bleed	420	35
aspect	1,045	74
center	964	60
skeleton	1,097	80
fieldset	834	45
locale	424	26
list	1,758	64
theme	787	41
separator	1,751	83
editable	1,684	111
code	1,630	72
float	1,669	83
visually	1,725	50
box	2,337	118
segmented	2,405	110
spinner	1,921	110
simple	2,256	58
link	1,910	92
for	1,057	33
hover	1,231	63
blockquote	1,770	109
flex	1,653	74
alert	2,702	143
accordion	3,855	160
steps	3,763	168
timeline	2,784	85
stat	3,082	123
switch	3,285	173
radiomark	680	28
text	1,250	69
highlight	2,075	97
drawer	13,309	272
menu	5,395	193
tooltip	11,407	448
toggle	846	56
collapsible	325	24
button	5,358	252
container	672	27
checkmark	624	29
badge	2,590	91
close	446	34
show	636	47
field	1,850	124
card	3,155	108
empty	987	70
textarea	2,550	183
action	673	30

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Table 11 – continued from previous page

Component Type	Conversations	Images
image	1,173	83
password	2,104	68
toaster	9,295	231
rating	9,917	195
pin	2,384	147
qr	2,394	141
status	1,879	60
group	1,453	66
popover	5,154	200
file	1,644	168
prose	2,275	90
tabs	23,088	397
native	1,429	67
em	215	23
kbd	8,119	197
portal	218	26
dialog	5,663	220
select	6,850	232
tag	4,416	150
clipboard	1,444	93
grid	1,784	45
table	10,317	210
heading	1,719	86
presence	1,450	77
stack	2,259	86
breadcrumb	3,537	116
radio	13,935	496
progress	11,892	359
format	2,572	134
pagination	16,881	254
icon	3,051	139
checkbox	13,930	464
input	3,568	224
avatar	11,467	403
wrap	3,186	56
number	3,941	206
slider	14,841	302
color	10,339	560
data	888	29

A.2.4 Layout Statistics

We collected layout data from two primary sources: the UI design community Figma and through rollouts across operating systems. Statistics can be found in the following Tables 12 13. The number of elements shown in the following table is not the exact number in the final dataset. These elements are filtered in later processing stage.

Table 12: Statistics of OS Layout Data

Rollout Environments	Screenshots	Elements
OSWorld (Ubuntu)	2000	183889
WindowsAgentArena (Windows)	903	74445
Total	2903	258334

Table 13: Statistics of Layout Data Collected from Figma Community Design Templates

Design Templates	Images	Elements
[Freebie]-Home-Rent-App-UI-Design-(Community)	3	59

Continued on next page

Table 13 – continued from previous page

Design Templates	Images	Elements
(Variants)-macOS-Big-Sur-UI-Kit-for-Figma-(Community)	10	685
10-Real-Chat/Messaging-Pages—Facebook, Reddit, Snapchat-&-more-(Community)	10	1269
10-Real-Dashboard-Pages—AirBnB, Basecamp, Github, &-more-(Community)	10	2214
10-Real-Homepages—AirBnb, Github, and-more-(Community)	10	2162
10-Real-Notification-Pages—AirBnB, Dropbox, Notion, &-more-(Community)	10	1103
10-Real-Pricing-Pages—Basecamp, Dribbble, &-more-(Community)	10	3554
10-Real-Search-Results-Pages—Github, Loom, Notion-&-more-(Community)	11	1714
10-Real-Sign-Up-Pages—Calendly, Dribbble, &-more-(Community)	11	570
10-Real-User-Settings-Pages—Calendly, Github, Behance, &-more-(Community)	13	1006
11-Real-Sign-In-Pages—AirBnB, Calendly, &-more-(Community)	12	557
20-Modals, Popups, Alerts-(Community)	13	135
AWS-Admin-Redesign-by-FluentUI-(Community)	21	1456
AWS-Amplify-UI-Kit-(Community)	28	713
AWS-Platform-(Community)	5	690
Ai-Design-Templates-(Community)	10	1071
Airbnb—Home, Search, and-Listing-Pages-(Community)	5	905
Airbnb-UI-Kit-(Community)	10	49
Amazon-UI-Design-(Community)	18	3522
Android-UI-Kit-(Community)	28	2364
App-Clips-(Community)	4	77
App-Store-Template—See-how-your-App-looks-like-in-App-Store-(Community)	3	756
Apple Design Resources - macOS (Community)	29	1164
Apple-Mail-(Community)	1	283
Apple-Mail-Design-(Community)-(Community)	3	72
Apple-Maps-iOS-(Community)	7	351
Apple-Messages-Templates-(Community)	8	567
Apple-Pay-(Community)	18	442
Apple-TV+-UI-Kit-(Community)	16	1290
Apple-Website-UI-2023-(apple.com)-(Community)	7	2618
Apple-Widgets-UI-Kit-(Community)	78	264
Apple-and-Google-Play-store-UI-(Community)	6	130
Apple-iCloud-Login-(Community)	2	2
Apps-Paywalls-and-Subscription-Screens-(Community)	5	48
Assets-Kit-UI-Mobile, Tablet-&-Desktop-(Community)	45	986
Audiobooks-by-Booksby-(Community)	3	76
Betting-Mobile-app-(Community)	6	162
Binance-Market-Trade-Dashboard-UI-Design-(Community)	1	584
Booking.com-Mobile-App-Redesign—UX/UI-Case-Study-(Community)	4	85
Budddy-Chatbot-Freebie-(Community)	8	241
CAPTCHA-UI-Kit-(Community)	16	124
CAR-RENTAL-WEBSITE-(RESOONSIVE-DESIGN)-(Community)	3	60
Calendar-Interactive-UI-Kit-(Community)	6	578
Call-Center-Desktop-App-(Community)	4	80
Car-Rent-Website-Design—Pickolab-Studio-(Community)	10	1232
Car-Rental-Mobile-App-(Community)	3	83
Casino-Web-Site-(Community)	12	3831
Chat-for-desktop/mobile-l-Free-to-use-(Community)	3	169
ChatGPT-UI-Kit, AI-Chat-(Community)	2	182
Cinema-4D-GUI-Redesign-(Community)	2	250
Clicon—eCommerce-Marketplace-Website-Figma-Template-(Community)	48	7178
Club-Website-Design-l-WEB-UI-(Community)	4	66
Code-block, Syntax-highlighting	2	20
Coding-Website—UI-Kit-(Community)	11	416
Coinbase-Clone—Website-Prices-Page-(Community)	1	448
Components-library—Light-&-Dark-mode-(Community)	13	256
Concept- -Mailbox-Design-(Community)	1	78

Continued on next page

Table 13 – countined from previous page

Design Templates	Images	Elements
Coursera-UI-KIT-(Community)	0	0
Crypto-App-Ui-Kit-(Community)	61	2430
Customer-onboarding-designs-&-components—by-Bento-(Community)	10	1315
Dark-UI-Elements, Dropdowns-&-Calendar-(Community)	4	254
Dashboard—Online-Learning-Profile-(Community)	3	201
Dashboard-UI-Kit—Dashboard, Free-Admin-Dashboard-(Community)	6	2224
Data-table-design-components.-Free-UI-Kit-(Community)	13	31059
Dating-Mobile-App-(Community)	42	722
Delivery-App-Ui-Kit-(Community)	54	2393
Desktop-Messaging-App-Concept-(Community)	1	26
Deupload—Decentralized-Cloud-Storage-Landing-Pages-(Community)	45	2188
Discord-(Community)	2	116
Discord-Redesign-(Community)	16	3236
Discord-UI-Mockup-(Community)	11	672
Disney+-App-Redesign-(Community)	2	6
DocketHub-(Community)	10	1121
Doordash-FREE-UI-Kit—By-Marvilo-(Community)	5	569
Dota-2-UI-Redesign-(Community)	12	2287
Duolingo-Pages-Collection-by-DesignDrops.io-(Community)	13	714
Duolingo-Workflows—Onboarding, Learning-a-language, Upgrading, &-Cancelling-(Community)	145	4974
E-Store—Mobile/web-(Community)	15	1502
E-Tutor—Learning-Management-System-(Community)	69	8475
E-commerce-UI—Figma-Ecommerce-UI-Kit-(Demo-Version)-(Community)	160	6522
E-commerce-Website-Template-(Freebie)-(Community)	9	858
Ebay-New-Design-Concept-(Community)	1	34
Ecommerce-Website-Design-(Community)	1	71
Element-UI-Kit-2.15.7-(Community)	42	2078
Elite—Food-Restaurant-&-Coffee-Free-Figma-Template-(Community)	16	769
Email-Message-Modal-(Community)	2	165
Embed-Media-Components-(Community)	6	38
Eonify—Mobile-App-Authentication-Page-(Community)	7	91
FREE-Gmail-Mockup-2024-template!-(Community)	4	98
FREEBIES-Landingpage-LaslesVPN-(Community)	1	28
Facebook-Page-Mockup-(2022)-(Community)	1	53
Facebook-ReDesign-2023-(Community)	7	449
Fantastical-Calendar-(Community)	1	655
FigmaSharp-Toolkit: macOS-Big-Sur-2.0.0-(Community)	5	573
Finance-Market-Trading-Terminal-(Community)	14	766
Fitness-App-UI-Kit-for-Gym-Workout-App-Fitness-Tracker-Mobile-App-Gym-Fitness-Mobile-App-UI-Kit-(Community)	87	1723
Fiverr-UI-Redesigned—Freelance-Marketplace-Website-Design-(Community)	3	681
Flight-Booking-App-UI-Kits-(Community)	20	249
Food-Catering-Service-App-With-Landing-Page—Figma-Freebies-l-Doradesign-(Community)	13	696
Food-Delivery-Website-&-App-Design-UI-Kit-(Community)	17	37
Food-delivery-app-Ui-kit-(Community)	18	117
FoodWagon-Food-Delivery-Landing-Template-by-ThemeWagon-(Community)	1	304
Forms-/—Desktop-&-Mobile-(Community)	12	341
Forum-Concept-for-Alem.school-(Community)	6	403
Free-Fitness-App-Ui-Kit-(Community)	48	841
Free-Instagram-UI-Mockups-2023-(Community)	12	364
Free-Modal-Upload-Files-Kit-for-Web-and-Mobile—Include-4-modes-(Community)	27	1150
Free-Trading-UI-Kit-(Community)	43	725
Free-YouTube-Shorts-Mockups-(Community)	18	634
Free-YouTube-Video-Player-Mockups-(Community)	6	506
Freebies—Apps-Tracking-Truck-Cargo-Courier-Delivery-(Community)	2	152
Freebies—Scooter-Renting-App-(Community)	4	77

Continued on next page

Table 13 – countined from previous page

Design Templates	Images	Elements
Full-Apple-Music-Classical-App-(Community)	160	18706
Full-E-Commerce-Website-UI-UX-Design-(Community)	15	2318
GitHub-UI-(Community)	2	1101
Github-UI—Free-UI-Kit-(Recreated)-(Community)	18	6568
Gmail-UI-Mobile-Design-Template-2024!-(Community)	4	38
Gmail-UI-Part-1: Inbox-(Community)	4	1940
Gmail-UI-Part-2: Reading-&-Composing-Emails-(Community)	9	2505
Google-Anlytics-Dashobard-(Community)	1	28
Google-Calendar—Web-version-revamp-(Community)	4	392
Google-Chrome-Browser-UI-Kit-2025-(Community)	14	695
Google-Chrome-UI-Kit-2022-(Community)	1	39
Google-Drive-Reverse-Engineer-(Community)	14	1620
Google-Gemini—Built-with-Material-3-Design-Kit-(Community)	4	646
Google-Maps—Bus-ticket-booking-(Community)	19	34
Google-Maps-Parking-Prototype-Testing-(Community)	5	68
Google-Meet-UI-(Community)	1	2
Google-Scholar-re-designed-(Community)	3	33
Google-Search-Result-Page-(SERP)-(Community)	2	167
Google-Sheet—Template-(Unofficial)-(Community)	23	3152
Google-Sign-in-GIS—Google-Identity-Services-(Community)	9	136
Google-Translate-Redesign-(Community)	9	140
Google-Weather-App-Redesign-(Community)	3	47
Google-search-(Community)	8	313
Health-Fitness-Workout-App-(FREEBIE—Prototype)-(Community)	8	332
HealthRise-Health-Tech-Dashboard-(Community)	4	4513
Hero-Giveaway—Redesigns-(Community)	7	1391
Hotel-booking-website-UI-(Community)	1	5
Hoteliq—Booking-Hotel-App-Design-(Community)	3	222
IKEA-/eCommerce-Concept-Design-(Community)	4	26
IMDb-Redesign-(Community)	15	2293
InTouch—Messaging-App-UI-Kit-(Community)	4	87
Instagram-UI-Screens-(Community)	36	441
IntelliJ-Platform-UI-Kit-(Community)	48	4598
Invoice/Payment-Components—Dipa-Inhouse-(Community)	17	828
Job-Finder-App-UI-Kit-(Community)	1	43
Job-Finder-Ui-App-Kit-(Community)	83	85
Jobpilot—Job-Portal-Figma-UI-Template-(Community)	3	913
LOGIFY—WEB-LOGIN-UI-KIT-(Community)	40	273
Leetcode-Homepage-(Community)	1	1
Lenskart-Redesigned—HiFi-Wireframes-(Community)	5	85
LinkedIn-Business-Page-Mockup-(2024)-(Community)	1	111
LinkedIn-Redesign-UI-Kit-(Community)	8	223
Linkedin-Page-Mockup-(2022)-(Community)	1	30
Linkedin-UI-Screens-(Community)	28	948
Liquipedia-Web-Redesign-(Community)	4	1606
Live-Score-UI-KIT-(FREEBIES)-(Community)	12	349
Login-&-Register-Web-UI-Kit-(Freebie)-(Community)	5	170
Loom-UI—Free-UI-Kit-(Recreated)-(Community)	28	5405
MEDDICAL—Hospital-website-template-(Community)	10	189
MacOS-file-upload-&-download-(Community)	3	363
Map-Navigation-Mobile-App-UI-Kit-Template-(Community)	2	15
Market-Stock-Exchange-(Community)	6	601
Medical-Clinic-Booking-(Doctor-Appointment)-App-UI-Concept-(Community)	3	20
Mercedes-Benz-App-(Community)	8	9
Messenger-Dashboard-design.-(Community)	9	582
Metroway—Train-Ticket-booking-website-(Community)	5	301
Microsoft-365-UI-Kit-(Community)	358	95741
Microsoft-Excel+-Word-2024-(Community)	4	1733
Mobile-Chat-Figma-UI-Kits-l-BRIX-Templates-(Community)	70	10979
Mobile-eCommerce-Clothing-Store-App-Design-(Community)	6	322

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Table 13 – continued from previous page

Design Templates	Images	Elements
Modern-Profile-UI-Kit—Freebies-UI-(Community)	4	6
Money-transfer-Ui-App-Kit-(Community)	55	236
Movie-App-Redesigned-HULU-(Community)	23	400
Movie-Ticket-Booking-Application—Coursera-UX-Specialization-(Community)	22	40
Movie-Ticket-Booking-Apps-(Community)	5	49
MyCourses.io—Course-Website-l-Course-Online-l-Course-details-l-Course-landing-page-l-Untitled-UI-(Community)	50	3731
Native-Web-Components—Browser-Default's-UI-Kit-(Community)	12	214
Navigation-App-Design-(Waze-App-Redesign)-(Community)	2	17
Neomorphism-music-player-for-desktop-(Community)	6	19
Netflix-Home-Page-desktop-&-TV-(Community)	1	8
Netflix-home-page—Mobile-&-TV/Desktop-(Community)	2	24
News-&-Blog-App-UI-Kit-By-Al-Ferdous-(Community)	6	46
News-Website-UI-and-Presentation-for-Opportunists-(Community)	2	2
Nike-UI—Free-UI-Kit-(Recreated)-(Community)	18	2769
Nowted—A-Note-taking-App-(Community)	6	362
Officevibe-UI—Free-UI-Kit-(Recreated)-(Community)	18	3577
On-Demand-Medicine-Delivery-App-(My-Orders-Flow)-(Community)	9	379
Onboarding-Appointment-booking-(Community)	1	183
Onest—Classified-Ads-Listing-Figma-Template-(Community)	44	6139
PDF-Viewer-(Community)	1	18
Papery—News-Magazine-Mobile-App-(Community)	21	1145
Parking-App-Design-UI-l-Figma-(Community)	30	270
Patterns & Layouts UI Kit (Community)	108	12275
Payment-Page-(Desktop)-(Community)	2	184
Picto—Personal-Portfolio-Free-Template-(Community)	1	202
Pinterest-Redesign-(Community)	5	363
Pinterest-UI—Free-UI-Kit-(Recreated)-(Community)	4	716
Plant-App-Freebies-(Community)	13	69
Print-dialog—Firefox-macOS-(Community)	2	72
Quiz-Game-(Community)	12	206
QuizGrad-webapp-(Community)	6	132
Quora-Redesign-(Community)	2	10
REIS—Real-State-Listing-Figma-Template-(Community)	3	572
Real-Estate-App-UI-Kit-(Community)	79	3255
Recreating-Google-Drive-Using-Lexicon-(Community)	2	1002
Reddit-Design-System-(Community)	16	762
Reddit-Material-Design-Redesign-(Community)	14	142
Redesign—ChatGPT-(Community)	1	53
Registration-Form-for-a-Medical-Laboratory-l-Medical-Analyzes-(Community)	5	502
Restaurant-Booking-Uikit-(Community)	20	122
Roommates-Apartments-Booking-(Community)	2	54
Sass Plat form Layouts - Wireframe Kit (Community)	11	1073
Scheddo—Bookings-&-Reservations-UI/UX—Freebie-(Community)	7	255
Shell-Template—Windows-11-(Community)	87	6881
Shopcart—Online-Ecommerce-website-(Community)	1	67
Shoperly—Organic-eCommerce-Shop-Website-Figma-Template-(Community)	37	6916
Simple-Chat-Widget-for-Desktop-(Community)	4	80
Siri-&-App-Shortcuts-(Community)	57	5077
Slack-Desktop-App-Clone-(Community)	5	238
Slack-UI—Desktop-(Community)	1	118
Snow-Dashboard-UI-Kit-(Community)	6	2608
Soccer-Score-App-(Community)	5	328
Social-Login-Auth-Modals-(Community)	5	49
Sportify—Sports-streaming-app-(Community)	34	1832
Spotify—Mobile-UI-Kit-(Community)	22	468
Spotify-Redesign-(Community)	32	6253
Spotify-UI—Free-UI-Kit-(Recreated)-(Community)	10	1329

Continued on next page

Table 13 – continued from previous page

Design Templates	Images	Elements
Spotify-UI-Design-(Search/Artist-Profile)-(Community)	2	580
Starbucks-Redesign-Mobil-App-(Community)	8	330
Steam-Redesign-(Community)	36	6855
Stock-Trading-App—UI-Concept-(Community)	6	302
Stripe-Apps-UI-toolkit-(Community)	35	2625
Stripe-Connect-Embedded-Components—UI-Toolkit-(Community)	63	6002
Subscription-Paywall-Modal-(Community)	1	56
Table-Booking-Restaurant-Application-(Web-+-Mobile-+-Admin-Panels)- (Community)	99	2524
Table-UI-3.0-l-Variants-Update-(Community)	1	223
Tap-to-Pay-on-iPhone-(Community)	2	20
Tasky—Task-and-Time-Management-Dashboard-(Community)	1	5
Taxi-Booking-App-(Community)	8	46
Technical-Support-Applications-Page-(Community)	4	266
Telegram-Design-System-(Community)	46	8535
Terminal-app-UI-(Community)	6	26
Tesla-Mobile-App-Redesign-(Community)	3	185
The-Unofficial-Spotify-Design-System-(Community)	5	854
Ticketing-App-Freebies-(Community)	8	549
TikTok-UI-Screens-(Community)	14	100
Tinder-Mobile-App-(Community)	23	192
TipKit-(Community)	8	67
To-do-list-dashboard-(Freebie)-(Community)	2	86
ToDoHQ—Activity-management-website-design-(Community)	18	329
Todoist-Free-UI-Kit—By-Marvilo-(Community)	8	868
Todoist-for-macOS-app-concept-(Community)	3	1196
Tour-Guide—travel-agency/travel-booking-website-(Community)	4	155
Travel-&-Hotel-Booking-Light-Mobile-App-(Community)	4	171
Trello-Concept-(Community)	2	2
Twitch-UI—Autolayout-Interface-(Community)	1	182
Twitch-UI—Free-UI-Kit-(Recreated)-(Community)	3	1670
Twitter-UI-Clone-Design-(Community)	9	992
Twitter-UI-Screens-(Community)	22	315
Twitter-desktop-pages-(feed, signup, login, profile)-(Community)	5	175
UF-File-Manager-(Community)	15	280
UI-DESIGN-FOR-MOCK-INTERVIEW-PLATFORM-(Company-side)- (Community)	50	528
Uber-App-UI—Free-UI-Kit-(Recreated)-(Community)	3	306
Uber-Redesign-(Community)	3	19
Ubuntu-Shiro-(Community)	10	606
VPN-App—UI-Kit-(Community)	9	200
Video-Player-For-Web-&-Mobile-(Community)	9	186
Video-Streaming-Website—Responsive-web-app-prototype-(Community)	3	50
Visual-Studio-Code-Toolkit-(Community)	45	8887
Wallet-(Community)	12	230
WeChat-(Community)	11	318
WeUI-kit(Wechat)-(Community)	33	391
Web-Browser-Mockups-(Community)	4	60
Web-Dashboard-UI—Task-&-Project-Management-(Community)	1	7
Website-FAQ-Accordions-Figma-Template-l-BRIX-Templates-(Community)	3	3
Website-Wireframes-UI-Kit-l-BRIX-Templates-(Community)	108	1800
WhatsApp-Pay-&-Split-(Community)	24	294
Wikipedia-(Community)	44	11773
Windows-11-Chat-UI-Kit-(Community)	15	857
Windows-File-Explorer—Ego's-Take-(Community)	18	3384
Windows-Install-Redesigned-(Concept)-(Community)	47	22947
Windows-Outlook-Template-(Community)	17	2269
WordPress-Design-System-(Community)	12	5289
YouTube-Music-App-Redesign: Elevating-the-Music-Experience- (Community)	3	50
YouTube-Redesign-(Community)	34	9176

Continued on next page

Table 13 – countined from previous page

Design Templates	Images	Elements
YouTube-UI-Clone-Design-(Community)	10	1801
Zoom-Apps-UI-Overview-(Community)	19	4507
aeroSpeed-Bus-Booking-Application-UI-Kit-[User+-Driver]-(Community)	14	330
chat-app-UI-kit-(Community)	5	7
eDex—Online-Course-E-Learning-Website-(Comunity)	2	447
iBank—Banking-&-E-Money-Management-App-l-FinPay-l-Digital-l-Finance-Mobile-Banking-App-Ui-Kit-(Community)	89	2027
iMessage-Apps-and-Stickers-(Community)	22	1761
iOS-17-Apple-music-Now-Playing-interface-(Community)	4	4
iOS-18-and-iPadOS-18-(Community)	91	7171
lark-(Community)	28	45169
macOS-Big-Sur-UI-Kit-(Community)	20	3214
macOS-Browser-UI-Kit-(Big-Sur-Update)-(Community)	6	51
telegram-app-(Community)	15	297
ui—Design-System-(Community)	17	343
Total	5273	563721

A.2.5 Cost Analysis

We utilized GPT-4o throughout our data generation pipeline, with all cost calculations based on GPT-4o’s token pricing. The comprehensive cost breakdown for the three components of the JEDI dataset is detailed below:

- **Icon Data (0.4M samples):** We employed input prompts and images to generate visual and functionality descriptions for icons. Each sample incurred approximately \$0.01 in processing costs, resulting in a total expenditure of ~\$4,000.
- **Component Data (1M samples):** This category comprised two distinct subsets:
 - *Template-based fine-grained operations* (~40K samples): Generated using predefined template rules for slides and sheets data, incurring no additional costs.
 - *Code-rendered data* (~1M samples): Costs were distributed across component rendering, action generation, and filtering processes, averaging ~\$0.025 per sample, totaling ~\$25,000.
- **Layout Data (2.3M samples from 0.8M captions):** We leveraged GPT-4o to generate comprehensive screenshot captions. Each caption required processing of approximately 3 images (~2,100 tokens) plus prompts (~550 tokens), with an average output of ~250 tokens. This resulted in a cost of ~\$0.0091 per caption, totaling ~\$7,000 for the complete set of 0.8M captions.

The aggregate cost for utilizing GPT-4o across all data generation tasks amounted to approximately **\$36,000**.

A.3 JEDI Dataset Construction: A Detailed Pipeline for Component

A.3.1 Component Collection and Style Augmentation

We begin by collecting example components from four mainstream UI libraries hosted on GitHub: `Material UI`, `Ant Design`, `Mantine UI`, and `Chakra UI`. From each repository, we extract example code snippets (in `typescript`) that showcase usage of individual components.

To diversify these examples, we apply style augmentation using two LLMs: `GPT-4o` and `Claude-3.5-Sonnet`. For each original code snippet, we first ask the model to envision a unique UI usage scenario. Based on the original code and the imagined context, it then generates a stylistically augmented variant code.

This process is repeated multiple times per example, each time with a different context to promote diversity. Previously generated variants are included in the prompt to prevent redundancy across augmented examples.

A.3.2 Rendering and Interaction Preparation

Each augmented component is rendered on a React application. Components are wrapped in a container with a randomized position to mitigate positional overfitting. Using `Playwright`, we programmatically open and interact with the rendered pages.

We extract **screenshots** of the rendered component and **element tree information** (positioning, hierarchy, etc.) using `Playwright`'s `evaluate` method and custom JavaScript.

These outputs are used to generate component-grounded actions via two distinct pipelines.

Pipeline 1: Component-level Action Generation

Step 1: Generate Action Intents

We prompt `GPT-4o` with component name, component code and screenshot. `GPT-4o` returns a list of action intents, each representing a high-level user interaction. We use few-shot examples to guide this process.

Step 2: Generate Action Details

For each intent, we generate detailed interaction metadata using component name, component code, screenshot, element position tree and action intent.

Each action detail includes:

1. **Thought Process:** The thinking process of generating an action detail
2. **Action Space Type:**
 - **None:** No action space exists,
 - **Unique:** Only one possible action exists (e.g., clicking a button),
 - **Discrete:** Limited/unlimited set of distinct possible actions (e.g., selecting from a list of options),
 - **Continuous:** Infinite possible actions within a range (e.g., dragging a slider to any position)
3. **Action Description:** Describe what the action does, which serves as the instantiation/implementation of the action intent.
4. **Action Parameters:** List of all parameter names for the action function (in action code)
5. **Discrete Values:** List of all possible parameter values for discrete action spaces (if applicable)
6. **Continuous Intervals:** List of interval for all possible parameter values for continuous action spaces (if applicable)
7. **Action Code:** A function using `PyAutoGUI` to represent one action or a kind of actions

Example

```
1 {  
2   "thought_process": "The target element is a slider, which  
   provides a continuous range of values from 0 to 100. The  
   action involves setting a specific value within this range by  
   determining the corresponding position on the slider bar and  
   simulating a click at that position. The slider's endpoints  
   are identified, and linear interpolation will be used to  
   calculate the appropriate position based on the desired  
   value.",
```

```

3     "action_space_type": "continuous",
4     "action_desc": "Set saturation to <saturation>",
5     "action_params": [
6         "saturation"
7     ],
8     "action_discrete_values": null,
9     "action_continuous_interval": {
10         "saturation": [
11             [
12                 0.0,
13                 100.0
14             ]
15         ]
16     },
17     "action_code": "def action(saturation):\n    x_0, y_0 = 600.5,\n    830 # Left endpoint\n    x_1, y_1 = 1064.5, 830 # Right\n    endpoint\n    x = x_0 + (x_1 - x_0) * (saturation / 100)\n    pyautogui.click(x, y_0)"
18 }

```

We then convert the action code (e.g., `def action(parameter): ...`, often involving `pyautogui`) into one or more pieces of *grounding data*—such as `pyautogui.click(x, y)`—by sampling from the corresponding action space. If the action space is `None`, no sampling is needed. This conversion is guided using few-shot examples. An example of this process can be seen below.

Example

Instruction: *Set saturation to <saturation>*

Action code:

```

def action(saturation):
    x_0, y_0 = 600.5, 830 # Left endpoint of the saturation slider
    x_1, y_1 = 1064.5, 830 # Right endpoint of the saturation slider
    x = x_0 + (x_1 - x_0) * (saturation / 100)
    pyautogui.click(x, y_0)

```

Sampled grounding data:

```

# Set saturation to 24%
pyautogui.click(711.86, 830)

# Set saturation to 60%
pyautogui.click(878.90, 830)
...

```

Pipeline 2: Element-Level Action Generation

Step 1: Element Extraction and Filtering We render each augmented component in a browser and traverse the DOM tree to collect element nodes. Two filtering rules are applied:

- **Duplicate boxes:** Only one node is retained if multiple share the same bounding box.
- **Abnormal sizes:** Nodes with very small or very large bounding boxes are discarded.

For each valid node, we collect position, text, visibility, interactivity, parent-child relationships, and metadata.

Step 2: Multimodal Context Encoding To help GPT-4o understand each element, we provide element box, parent box, cropped screenshot(cropped screenshot with only the element region), context screenshot(cropped screenshot with element region and nearby surroundings, with the element highlighted in red bounding box) and full-page screenshot(full screenshot with the element highlighted in red bounding box) as input. And the model outputs include visual description(a detailed account of the element’s appearance), position textual information(spatial relationship relative to the viewport and its parent), element functionality, UI type (e.g., button, slider) and possible actions at element center.

To ensure quality, we also include visibility check and atomicity check, to check whether this element is a single visible UI unit.

Step 3: Action Detail Generation For each possible action, we prompt GPT-4o with the action and relevant element information—including visual description, position, text content, functionality, and UI type. The model is asked to generate detailed action information, including the thought process, action description, action parameters, and action code. This is similar to the action detail in Pipeline 1, but limited to the **unique action space**.

Step 4: Continuous Action Detection To identify elements like sliders that support continuous interactions, the model determines whether the element has a continuous action space and generates the corresponding thought process, action description, action parameters, value range(action_continuous_interval), and action code. This step parallels the action detail in Pipeline 1, but focuses solely on the **continuous action space**.

Step 5: Grounding Actions We convert each action code into one or more grounding samples, similar to that in Pipeline 1.

A.3.3 Comparison of Pipelines

- **Pipeline 1** is simpler. However, it may suffer from inaccurate bounding box targeting, limited action diversity and action vagueness.
- **Pipeline 2** generates data with better localization and diversity. **In practice, most of our dataset is generated using Pipeline 2.**

A.3.4 Post-Processing and Filtering

To ensure data quality, we apply multiple filtering stages.

1. Visual Filter (via GPT-4o)

Given:

- Cropped screenshot
- Marked screenshot (click position highlighted with a green dot and circle)
- Full screenshot (element highlighted)

GPT-4o filters out data that:

1. Shows visible errors (e.g., "Compiled with problems" or red overlays)
2. Targets an incorrect GUI element
3. Has incorrect click localization (e.g., not centered on button/text)

2. Instruction Filter (LLM-Based)

Using GPT-4o-mini, we filter out ambiguous or low-quality instructions from Pipeline 1:

1. Unclear or vague semantics
2. Multiple interactive targets
3. References to non-visual identifiers like "index 1"
4. Multi-step or compound interactions

3. Instruction Filter (Rule-Based)

We filter instructions with high error likelihood based on pattern rules:

1. Contains explicit coordinates (e.g., (x, y)): Instructions referencing raw screen coordinates are filtered out, as such positional references are not meaningful in a vision-only context.
2. Mentions structural terms such as `child`, `parent`, `path`, or `container`: These terms imply hierarchical relationships derived from accessibility trees, which are not observable in visual input.
3. Mentions a `card` component without spatial qualifiers such as `in`, `within`, or `at`: Such instructions typically refer to an entire composite element (e.g., a card) rather than a specific atomic component within it, resulting in ambiguous interaction targets.
4. Includes directional terms in combination with `screen`: Phrases like "top-left of the screen" are frequently found to be incorrect or misaligned with actual component layouts, likely due to LLM misinterpretation.

5. **Refers to highlights or visual annotations** (e.g., red dot, circle, highlight): These often result from the model misidentifying annotation markers (used to denote interaction points) as intrinsic parts of the interface.
6. Mentions textual UI elements (e.g., text, label, heading) in combination with interaction verbs (e.g., read, hover, click, interact): If the associated bounding box is visually simple—based on low color variance and edge density—it often indicates that the relevant text is located on the periphery of the box, while its center is visually empty, leading to inaccurate click localization.
7. Refers to sliders without specifying interaction values: Instructions such as “interact with the slider” without numerical targets are prone to ambiguity and do not provide sufficient grounding for generating actionable behavior.

A.3.5 Real-world augmentation pipeline

Office software, including document editors, presentation tools, and spreadsheets, is integral to daily work for many. Automating workflows in these applications can significantly boost productivity. However, a gap exists between synthetic use cases and real-world scenarios, as synthetic datasets often lack sufficient office software-related cases. To bridge this, we propose a targeted approach to designing and generating relevant data.

Our methodology centers on creating two pools: **a resource pool** and **an action pool**. The resource pool includes a diverse set of office files, such as Excel spreadsheets, Word documents, and PowerPoint slides, sourced from the web, including online tutorials. The action pool enumerates common tasks performed in these applications, such as scrolling through a document, clicking specific cells in a spreadsheet, or auto-filling data in Excel. For each action, we manually analyze the associated structural components and develop code to extract relevant coordinate arrangements. For example, consider the action of “scrolling a document” in Microsoft Word Online. The associated component is the scrollbar. We analyze the webpage structure to identify features that precisely locate the scrollbar, then use code to extract its coordinates, synthesizing a data instance. Similarly, in Excel, for the action “click the center of cell B3,” we leverage the accessibility tree and HTML DOM structure to extract cell positions, generating precise instructions like “click the center of cell B3,” “auto-fill from the bottom-right corner of cell A1,” or “select column D.” These rule-based extraction methods ensure accurate component-level interactions across productivity applications.

Additional actions and their components, including spreadsheet-specific tasks, are detailed in Table 14.

Table 14: Actions and Associated Components in Office Software

Office Software	Action Type	Associated Component
Doc	Scroll	Scrollbar
Doc	Select	NormalTextRun
Doc	Click	NormalTextRun
Slide	Drag	Text Box
Slide	Click	Text Box
Slide	Click	Slide Thumbnail
Sheet	Click	Cell
Sheet	Click	Edge
Sheet	Click	Cell Corner
Sheet	Click	Column Header
Sheet	Click	Row Header

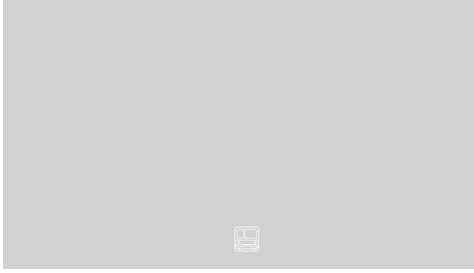
A.4 Additional Data Examples

A.4.1 Icon data

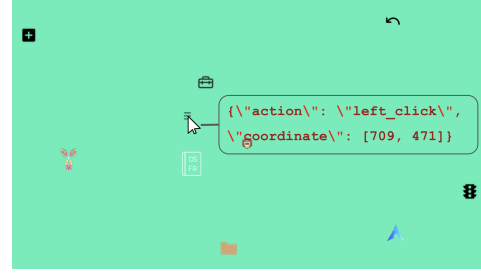
Icon description data

In the icon description data, each data item includes an image of a single icon as input and produces a description that includes both its visual appearance and functionality as output.

An example in JSON format is shown below. The corresponding image (Figure 9a) features an icon labeled `krl_access`, which likely represents access to a commuter rail or train service—such as the KRL (Kereta Rel Listrik) system.



(a) Example of icon description data



(b) Example of icon grounding data

Figure 9: Examples of icon data

```

1 {
2   "conversations": [
3     {
4       "from": "system",
5       "value": {
6         "text": "You are a GUI assistant that helps users
7           understand and interact with interface elements.
8           \nWhen describing elements, focus on their visual
9           appearance and functionality in clear, natural
10          language.\nFor each element, describe the visual
11          appearance and functionality:\n1. What it looks
12          like - including shape, color, symbols, and any
13          text\n2. What it does when used - its purpose and
14          effect\n3. When users might want to use it -
15          common use cases and scenarios"
16        }
17      },
18      {
19        "from": "user",
20        "value": [
21          {
22            "image":
23              "images_pure_color_background/categorized_icons/Arcticons-Team/Arco
24            "width": 1920,
25            "height": 1080,
26            "resized_height": 1092,
27            "resized_width": 1932,
28            "seq_len": 2693
29          },
30          {
31            "text": "Please describe what this interface
32              element looks like and what it does."
33          }
34        ]
35      },
36      {
37        "from": "assistant",
38        "value": [
39          {
40            "text": "Visual Appearance:\nThe icon is a
41              simple, white outline of a train or subway
42              car on a black background. It features a
43              rectangular shape with rounded corners, two
44              windows at the top, and a front bumper at the
45              bottom. The design is minimalistic and uses
46              clean lines to represent the front view of a
47              train.\n\nFunctionality: The icon labeled
48              'krl_access' likely represents access to a
49              commuter rail or train service, such as a KRL

```

```

30         (Kereta Rel Listrik) system. It might be used
31         in applications or websites to indicate train
32         schedules, ticket purchasing, or station
33         information. Clicking this icon could lead to
34         more details about train services or access
35         to a train-related feature."
    }
  ],
  "image_id": "d4e5596b-c166-4345-a7d0-947014505f0a"
}

```

Icon grounding data

In the icon grounding data, each data item includes an image containing multiple icons and a description of the target icon as input, and produces a grounding action (e.g., a click) in the Qwen2.5-VL tool-use format as output.

An example in JSON format is provided below. The image (Figure 9b) contains several icons, and the description corresponds to one commonly used icon which represents “density” or “line spacing” in user interfaces.

```

1 {
2   "conversations": [
3     {
4       "from": "system",
5       "value": {
6         "text": "You are a helpful assistant.\n\n#
          Tools\n\nYou may call one or more functions to
          assist with the user query.\n\nYou are provided
          with function signatures within <tools></tools>
          XML tags:\n<tools>\n{\n  \"type\": \"function\",
          \"function\": {\n    \"name\": \"computer_use\",
          \"description\": \"Use a mouse and keyboard to
          interact with a computer, and take
          screenshots.\n\n* This is an interface to a
          desktop GUI. You do not have access to a terminal
          or applications menu. You must click on desktop
          icons to start applications.\n\n* Some
          applications may take time to start or process
          actions, so you may need to wait and take
          successive screenshots to see the results of your
          actions. E.g. if you click on Firefox and a
          window doesn't open, try wait and taking another
          screenshot.\n\n* The screen's resolution is 1092
          x1932.\n\n* Whenever you intend to move the cursor
          to click on an element like an icon, you should
          consult a screenshot to determine the coordinates
          of the element before moving the cursor.\n\n* If
          you tried clicking on a program or link but it
          failed to load, even after waiting, try adjusting
          your cursor position so that the tip of the
          cursor visually falls on the element that you
          want to click.\n\n* ..."
        }
      },
9     {
10      "from": "user",
11      "value": [
12        {
13          "image": "images_grounded/categorized_icons -
14          /tabler/tabler-icons/baseline-density-medium.png",
15          "width": 1920,
16          "height": 1080,
17          "resized_height": 1092,
18          "resized_width": 1932,

```

```

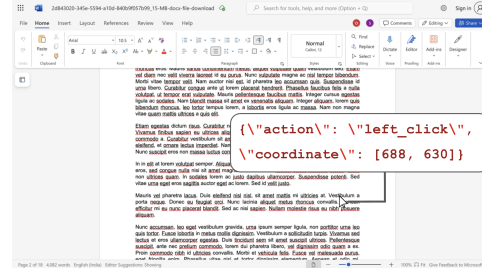
19         "seq_len": 2693
20     },
21     {
22         "text": "Click on the icon with functionality:
                This icon is typically used to represent a
                'density' or 'line spacing' setting in user
                interfaces. It suggests adjusting the spacing
                between lines or items to a medium level.
                Clicking this icon might change the display
                settings to a medium density, balancing
                between compact and spacious layouts."
23     }
24 ]
25 },
26 {
27     "from": "assistant",
28     "value": [
29         {
30             "text": "<tool_call>\n{\"name\":
                    \"computer_use\", \"arguments\": {\"action\":
                    \"left_click\", \"coordinate\": [709, 471
                    ]}}\n</tool_call>"
31         }
32     ]
33 }
34 ],
35 "image_id": "cb1cb4ba-61ab-4caf-8c8d-a57ba3a6c310"
36 }

```

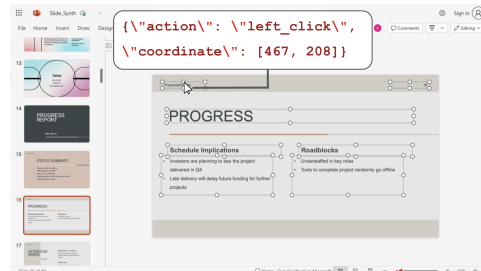
A.4.2 Component data



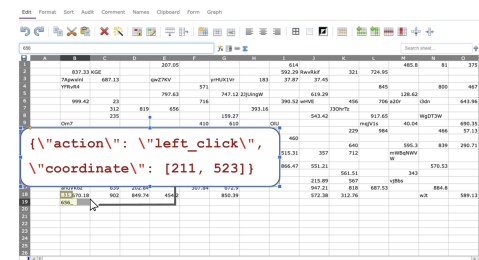
(a) Example of rendered component grounding data



(b) Example of doc grounding data



(c) Example of slide grounding data



(d) Example of sheet grounding data

Figure 10: Examples of component data

Component data from Code-and-rendering pipeline

In the component data from the Code-and-Rendering pipeline, each data item includes an image containing a rendered UI component and a corresponding user instruction as input, and produces a grounding action (e.g., a click) in the Qwen2.5-VL tool-use format as output.

An example in JSON format is shown below. The associated image (Figure 10a) displays a slider component, and the instruction reads "...Read the text label displaying 'UI/UX Design Basics' located in the lower third of the catalog interface, which is part of a book listing..."

```

1 {
2   "conversations": [
3     {
4       "from": "system",
5       "value": {
6         "text": "You are a helpful assistant.\n\n#
          Tools\n\nYou may call one or more functions to
          assist with the user query.\n\nYou are provided
          with function signatures within <tools></tools>
          XML tags:\n<tools>\n{\n  \"type\": \"function\",
          \"function\": {\n    \"name\": \"computer_use\",
          \"description\": \"Use a mouse and keyboard to
          interact with a computer, and take
          screenshots.\n\n* This is an interface to a
          desktop GUI. You do not have access to a terminal
          or applications menu. You must click on desktop
          icons to start applications.\n\n* Some
          applications may take time to start or process
          actions, so you may need to wait and take
          successive screenshots to see the results of your
          actions. E.g. if you click on Firefox and a
          window doesn't open, try wait and taking another
          screenshot.\n\n* The screen's resolution is 1092
          x1932.\n\n* Whenever you intend to move the cursor
          to click on an element like an icon, you should
          consult a screenshot to determine the coordinates
          of the element before moving the cursor.\n\n* If
          you tried clicking on a program or link but it
          failed to load, even after waiting, try adjusting
          your cursor position so that the tip of the
          cursor visually falls on the element that you
          want to click..."
7       }
8     },
9     {
10      "from": "user",
11      "value": [
12        {
13          "image": "data/chakra/slider/other_screenshot/-
14            original/SkillLevelAdjuster_1742005837.475969.png",
15          "width": 1920,
16          "height": 1080,
17          "resized_height": 1092,
18          "resized_width": 1932,
19          "seq_len": 2693
20        },
21        {
22          "text": "Please generate the next move according
              to the UI screenshot and
              instruction.\n\nInstruction: Set the skill
              level to 4% on the slider."
23        }
24      ]
25    },
26    {
27      "from": "assistant",
28      "value": [

```

```

29         {
30             "text": "<tool_call>\n{\"name\":\n\n                \"computer_use\", \"arguments\": {\"action\":\n                \"left_click\", \"coordinate\": [681, 260\n                ]}}\n</tool_call>\"
31         }
32     ]
33 }
34 ],
35     \"image_id\": \"568b8930-ec6a-4574-9b75-a18ed2c87cc0\"
36 }

```

Component data for real-world augmentation

In the component data for real-world augmentation, each data item includes an image containing a real-world screenshots from an existing website or application and a corresponding user instruction as input, and produces a grounding action (e.g., a click) in the Qwen2.5-VL tool-use format as output.

We provide one example for each of the three data sources: *doc*, *slide*, and *sheet*. The user instructions for these examples are as follows:

- **Doc:** *Given the following text: ". Vestibulum a", find this text in the document and click the space between the consecutive characters "t" and "i".*
- **Slide:** *Please generate the next move according to the UI screenshot and instruction. Instruction: Select the handle located at the top of the text box that contains the text "Presentation title."*
- **Sheet:** *Navigate to the top-left corner of cell C19.*

Corresponding examples in JSON format are shown below. The associated UI screenshots are provided in Figures 10b, 10c, and 10d, respectively.

Example of doc grounding data:

```

1 {
2     "conversations": [
3         {
4             "from": "system",
5             "value": {
6                 "text": "You are a helpful assistant.\n\n#
                        Tools\n\nYou may call one or more functions to
                        assist with the user query.\n\nYou are provided
                        with function signatures within <tools></tools>
                        XML tags:\n\n<tools>\n{\"type\": \"function\",
                        \"function\": {\"name\": \"computer_use\",
                        \"description\": \"Use a mouse and keyboard to
                        interact with a computer, and take
                        screenshots.\n\n* This is an interface to a
                        desktop GUI. You do not have access to a terminal
                        or applications menu. You must click on desktop
                        icons to start applications.\n\n* Some
                        applications may take time to start or process
                        actions, so you may need to wait and take
                        successive screenshots to see the results of your
                        actions. E.g. if you click on Firefox and a
                        window doesn't open, try wait and taking another
                        screenshot.\n\n* The screen's resolution is 728
                        x1288.\n\n* Whenever you intend to move the cursor
                        to click on an element like an icon, you should
                        consult a screenshot to determine the coordinates
                        of the element before moving the cursor.\n\n* If
                        you tried clicking on a program or link but it
                        failed to load, even after waiting, try adjusting
                        your cursor position so that the tip of the
                        cursor visually falls on the element that you
                        want to click..."
7                 }
8             }
9         ]
10    }

```

```

8      },
9      {
10         "from": "user",
11         "value": [
12             {
13                 "image":
14                     "AmHHgw-Nep9dv1S3X9n5gaoKsDxY_1280x720_SPACE_563_5.png",
15                 "width": 1280,
16                 "height": 720,
17                 "resized_height": 728,
18                 "resized_width": 1288,
19                 "seq_len": 1198
20             },
21             {
22                 "text": "Given the following text:\n\n".
23                     Vestibulum a "\n", find the text in the
24                     document and click the space between the
25                     continuous character "\t" and "\i" in the
26                     text."
27             }
28         ]
29     },
30     {
31         "from": "assistant",
32         "value": [
33             {
34                 "text": "<tool_call>\n{\n\"name\":
35                     \"computer_use\", \"arguments\": {\n\"action\":
36                     \"left_click\", \"coordinate\": [688, 630
37                     ]}}\n</tool_call>"
38             }
39         ]
40     },
41     {
42         "image_id": "3d35b0b2-d541-45ea-be23-b668263b5b69"
43     }
44 ]
45 }

```

Example of slide grounding data:

```

1  {
2      "conversations": [
3          {
4              "from": "system",
5              "value": {
6                  "text": "You are a helpful assistant.\n\n#
                          Tools\n\nYou may call one or more functions to
                          assist with the user query.\n\nYou are provided
                          with function signatures within <tools></tools>
                          XML tags:\n<tools>\n{\n\"type\": \"function\",
                          \"function\": {\n\"name\": \"computer_use\",
                          \"description\": \"Use a mouse and keyboard to
                          interact with a computer, and take
                          screenshots.\n\n* This is an interface to a
                          desktop GUI. You do not have access to a terminal
                          or applications menu. You must click on desktop
                          icons to start applications.\n\n* Some
                          applications may take time to start or process
                          actions, so you may need to wait and take
                          successive screenshots to see the results of your
                          actions. E.g. if you click on Firefox and a
                          window doesn't open, try wait and taking another
                          screenshot.\n\n* The screen's resolution is 728
                          x1288.\n\n* Whenever you intend to move the cursor
                          to click on an element like an icon, you should
                          consult a screenshot to determine the coordinates

```



```

of the element before moving the cursor.\\n* If
you tried clicking on a program or link but it
failed to load, even after waiting, try adjusting
your cursor position so that the tip of the
cursor visually falls on the element that you
want to click..."
7     }
8   },
9   {
10    "from": "user",
11    "value": [
12      {
13        "image": "slides_1280*720/slide_15/original.png",
14        "width": 1280,
15        "height": 720,
16        "resized_height": 728,
17        "resized_width": 1288,
18        "seq_len": 1198
19      },
20      {
21        "text": "Please generate the next move according
                to the UI screenshot and
                instruction.\\n\\nInstruction: Select the
                handle located at the top of the text box
                that contains the text \"Presentation
                title.\\n\"
22      }
23    ]
24  },
25  {
26    "from": "assistant",
27    "value": [
28      {
29        "text": "<tool_call>\\n{\\\"name\\\":
                  \\\"computer_use\\\", \\\"arguments\\\": {\\\"action\\\":
                  \\\"left_click\\\", \\\"coordinate\\\": [467, 208
30        ]}\\n</tool_call>\"
31      }
32    ]
33  },
34  "image_id": "3f2ebbae-dee3-4fea-bbc0-ab93136bedab"
35 }

```

Example of sheet grounding data:

```

1 {
2   "conversations": [
3     {
4       "from": "system",
5       "value": {
6         "text": "You are a helpful assistant.\\n\\n#
                  Tools\\n\\nYou may call one or more functions to
                  assist with the user query.\\n\\nYou are provided
                  with function signatures within <tools></tools>
                  XML tags:\\n<tools>\\n{\\\"type\\\": \\\"function\\\",
                  \\\"function\\\": {\\\"name\\\": \\\"computer_use\\\",
                  \\\"description\\\": \\\"Use a mouse and keyboard to
                  interact with a computer, and take
                  screenshots.\\n\\n* This is an interface to a
                  desktop GUI. You do not have access to a terminal
                  or applications menu. You must click on desktop
                  icons to start applications.\\n\\n* Some
                  applications may take time to start or process
                  actions, so you may need to wait and take

```

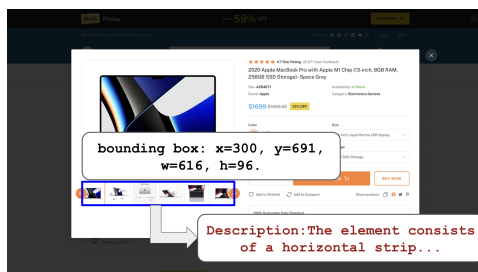
```

7      }
8      },
9      {
10         "from": "user",
11         "value": [
12             {
13                 "image":
14                     "cell_left_top_corner/images/1280x720_cell_C19.png",
15                 "width": 1280,
16                 "height": 720,
17                 "resized_height": 728,
18                 "resized_width": 1288,
19                 "seq_len": 1198
20             },
21             {
22                 "text": "Navigate to top left corner of C19"
23             }
24         ],
25         {
26             "from": "assistant",
27             "value": [
28                 {
29                     "text": "<tool_call>\n{\"name\":
30                         \"computer_use\", \"arguments\": {\"action\":
31                             \"mouse_move\", \"coordinate\": [211, 523
32                             ]}}\n</tool_call>"
33                 }
34             ]
35         }
36     ],
37     "image_id": "15987cec-74d4-4624-b539-43a114caac8f"
38 }

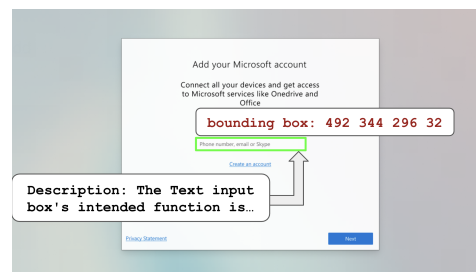
```

successive screenshots to see the results of your actions. E.g. if you click on Firefox and a window doesn't open, try wait and taking another screenshot.\\n* The screen's resolution is 728x1288.\\n* Whenever you intend to move the cursor to click on an element like an icon, you should consult a screenshot to determine the coordinates of the element before moving the cursor.\\n* If you tried clicking on a program or link but it failed to load, even after waiting, try adjusting your cursor position so that the tip of the cursor visually falls on the element that you want to click..."

A.4.3 Layout data



(a) Example of icon description data



(b) Example of icon grounding data

Figure 11: Examples of component grounding data

Layout description data

In the layout description data, each item includes a screenshot and the bounding box coordinates of a target element as input, and generates a description covering the element's visual composition, spatial context, user interaction, and type.

An example in JSON format is provided below. The associated image (Figure 11a) shows a product interface from a shopping website, where the target element is an image carousel featuring thumbnail views of a laptop.

```
1 {
2   "conversations": [
3     {
4       "from": "system",
5       "value": {
6         "text": "Working as a UI navigation guide, you will
          analyze a screenshot and bounding box
          coordinates. Your objective is to provide a
          detailed, user-friendly description of the UI
          element within the specified region, helping
          users identify it without relying on coordinates.
          Address these key points:\n\n1. Visual
          Composition: Detail the element's visual aspects,
          including its geometry, color scheme, and
          styling\n2. Spatial Context: Describe the
          element's position in relation to surrounding
          interface components\n3. User Interaction:
          Explain the element's functionality and how users
          should interact with it\n4. Element Type: Specify
          the category of UI component (such as progress
          bar, tooltip)\n\nMaintain precision and clarity
          in your descriptions, avoiding vague references.
          Emphasize distinctive characteristics and
          contextual relationships that make the element
          easily identifiable."
7       }
8     },
9     {
10      "from": "user",
11      "value": [
12        {
13          "image": "ce0ff960..."(Truncated due to layout
            constraints),
14          "width": 1920,
15          "height": 1080,
16          "resized_height": 1092,
17          "resized_width": 1932,
18          "seq_len": 2693
19        },
20        {
21          "text": "bounding box: x=300, y=691, w=616, h=96.
            Generate pls."
22        }
23      ]
24    },
25    {
26      "from": "assistant",
27      "value": [
28        {
29          "text": "## Visual Composition: The element
            consists of a horizontal strip of thumbnail
            images, each depicting different views of a
            laptop. The thumbnails are bordered by a thin
            line and are evenly spaced. On either side of
            the strip, there are orange circular buttons
            with white arrows, indicating navigation
            options to scroll through more images. The
```

```

30         thumbnails include images of the laptop from
31         various angles and a box content view.\n\n##
32         Spatial Context: The element is located
33         centrally below the main product image within
34         a pop-up product detail view. It is
35         positioned above the product description and
        purchase options, acting as a secondary image
        gallery for the product.\n\n## User
        Interaction: The primary function of this
        element is to allow users to preview
        different images of the product. Users can
        click on the thumbnails to view a larger
        version of the image in the main display area
        above. The navigation arrows enable scrolling
        through additional images.\n\n## Element
        Type: Image carousel with navigation buttons."
    }
  ],
  "image_id": "e54778c0-4d45-4997-a382-33244ced2513"
}

```

Layout grounding data

In the layout grounding data, each data item includes a screenshot and a corresponding user description of an element as input, and produces a bounding box of corresponding element as output.

An example in JSON format is shown below. The associated image (Figure 11b) displays the layout of adding a Microsoft account, and the description refers to the text input box that allows users to input their phone number, email, or Skype ID.

```

1  {
2    "conversations": [
3      {
4        "from": "system",
5        "value": {
6          "text": "Operating as a GUI element localization
              agent, your primary function is to process
              screenshots and element descriptions to identify
              the exact position of interface components. You
              work with coordinates (x, y, width, height)."

```

```

23     ]
24     },
25     {
26         "from": "assistant",
27         "value": [
28             {
29                 "text": "492 344 296 32"
30             }
31         ]
32     }
33 ],
34 "image_id": "db53ba9b-7416-4a01-bb19-e2a66d3a666d"
35 }

```

For demonstration purposes, we only show one round of dialogue in each "conversations" entry. In practice, to speed up training and save storage space, multiple rounds of dialogue related to a single screenshot are consolidated into a single JSON object's "conversations" list.

A.5 Additional Case Studies

In this section, we explain more logic behind the models' actions and analyze the factors that contribute to their improvements or failures.

A.5.1 Cases of improvement

Case 12a Leveraging training on icon, component, and layout data, JEDI places greater emphasis on keywords like `button` and `on the left`. In contrast, Qwen concentrates more on literal text matching, resulting in clicking on `Sheet1`.

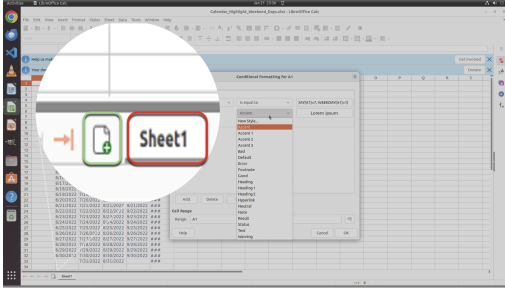
Case 12b JEDI effectively identifies the correct icon with the specified function from numerous elements on the screen, showcasing its deep understanding of common icon functionalities. In contrast, traditional models often struggle to learn the association between icons and their functions when trained with coarse-grained data.

Case 12c To execute this example correctly, models must thoroughly understand both the specific component (what constitutes a `horizontal scroll bar`) and the overall layout (where the scroll bar is located). The Qwen model, however, interacted with an unrelated element.

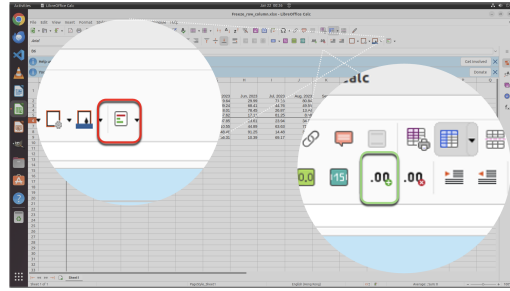
Case 12d We found that the base model, which has not been trained on components and layouts, may not accurately manage subpages such as pop-ups and message bars. In contrast, JEDI successfully identifies clickable text links.

Case 12e This task involves having the model click on a specific mathematical symbol. Although the Qwen model demonstrates strong mathematical skills, these abilities do not improve its GUI grounding capability without fine-tuning on decomposed GUI data.

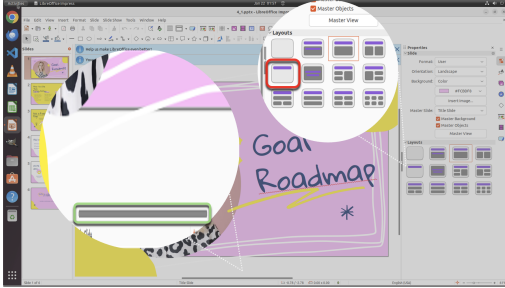
Case 12f The GUI for this task includes a variety of elements and complex functions. However, JEDI successfully identified the area relevant to mode switching through precise text matching.



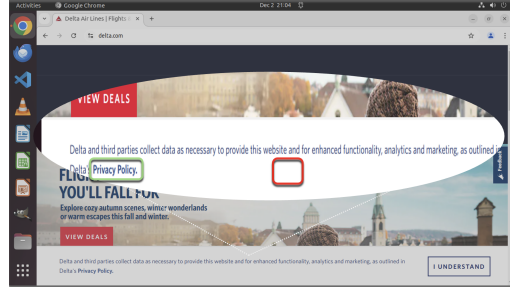
(a) Instruction: Add a sheet by clicking the button on the left of "Sheet1".



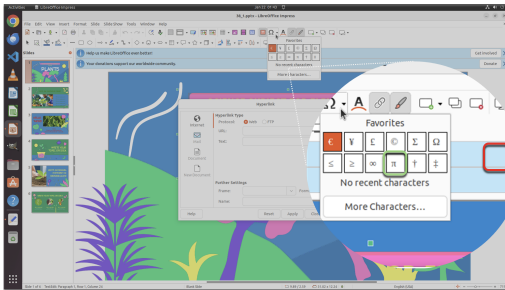
(b) Instruction: Add Decimal Place for the current cell.



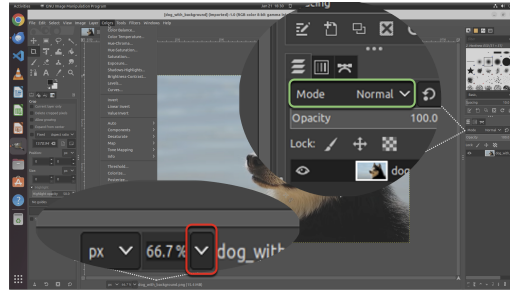
(c) Instruction: Drag the horizontal scroll bar to center the image in the viewing area.



(d) Instruction: Check the privacy policy of delta.com.



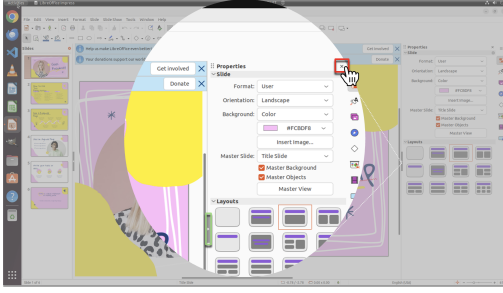
(e) Instruction: Click on the character of PI.



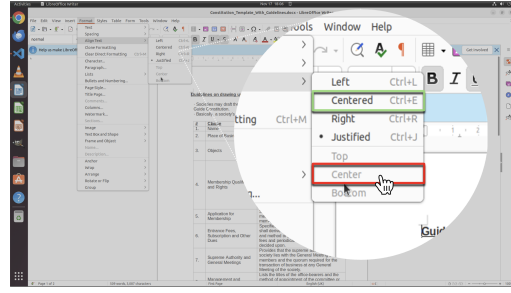
(f) Instruction: Change the mode of this image.

Figure 12: Additional cases demonstrate JEDI's improvement compared to Qwen2.5-VL-7B-Instruct. The green square represents the click position of JEDI, while the red square indicates the click position of Qwen.

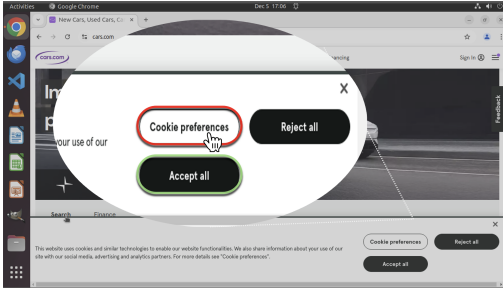
A.5.2 Cases of failure



(a) Instruction: Collapse the Properties panel by clicking on the right arrow.



(b) Instruction: Align the text to the center.



(c) Instruction: Accept the cookie preferences.



(d) Instruction: Click on the letter "o" of the word "for" in the slide.

Figure 13: Four OSWORLD-G failure cases for JEDI.

JEDI still faces challenges in certain situations. We present a selection of representative examples, with solutions to these challenges reserved for future work.

Case 13a The task required the model to click the right-pointing arrow to close the right panel. Instead, JEDI clicked the ‘x’ button. Although this action was functionally correct, it did not strictly follow the requirement to **click the right arrow**. Therefore, we classify this as a failure case.

Case 13b The interface for this task shows the word **center** twice. One is displayed in white, indicating it is active, while the other is in gray, indicating it is inactive. JEDI misunderstood the color difference and mistakenly clicked the lower, inactive **center** option.

Case 13c In this task, JEDI was instructed to accept the cookie options. However, it mistakenly focused on the **cookie preferences** option. We believe the wording in the instruction misled the model.

Case 13d This task required clicking on a letter in an artistic font, highlighting the model’s current limitations in handling grounding tasks involving artistic or stylized designs. This shortcoming may arise from the lack of art and design data in the current training corpus.

A.6 Agentic Benchmark Results of JEDI

Model	Configuration	Overall	OS	Calc	Impress	Writer	VLC	TB	Chrome	VSC	GIMP	Workflow	OS	Office	Daily	Pro	Workflow
JEDI-3B	15 Steps																
	Run 1	21.95	39.13	6.38	8.57	26.08	29.41	20.00	26.09	56.52	50.00	11.83	39.13	11.13	25.64	53.06	11.83
	Run 2	22.76	39.13	6.38	12.83	17.38	29.41	33.33	28.06	60.87	53.85	9.68	39.13	11.13	29.37	57.14	9.68
	Run 3	22.37	43.48	6.38	12.77	17.38	17.65	33.33	25.94	56.52	53.85	11.39	43.48	11.11	25.55	55.10	11.39
	Run 4	22.36	39.13	8.51	10.70	34.77	32.72	26.67	21.54	60.87	50.00	8.60	39.13	14.55	24.96	55.10	8.60
	Pass@4	32.50	60.87	12.77	14.89	43.48	47.06	33.33	34.78	78.26	73.08	15.05	60.87	19.66	37.18	75.51	15.05
	Avg	22.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	50 Steps																
	Run 1	23.83	47.83	6.38	10.70	26.08	29.41	33.33	32.61	52.17	53.85	10.48	47.83	11.99	32.05	53.06	10.48
	Run 2	24.73	43.48	8.70	12.77	39.12	23.53	40.00	30.43	47.83	64.00	9.78	43.48	16.54	30.77	56.25	9.78
	Run 3	23.61	45.45	6.38	10.64	43.47	29.41	33.33	26.09	47.83	53.85	10.75	45.45	15.38	28.21	51.02	10.75
	Run 4	22.36	39.13	8.51	12.77	21.73	23.53	33.33	23.91	56.52	53.85	9.68	39.13	13.46	25.64	55.10	9.68
	Pass@4	33.33	52.17	10.64	12.77	56.52	47.06	46.67	36.96	78.26	76.92	15.05	52.17	20.51	41.03	77.55	15.05
	Avg	23.63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	100 Steps																
	Run 1	24.43	38.10	8.51	13.11	26.08	23.53	46.67	32.40	43.48	68.00	9.68	38.10	13.82	33.21	56.25	9.68
	Run 2	25.19	40.91	8.51	14.95	39.12	29.41	40.00	34.58	39.13	56.00	12.62	40.91	17.12	34.49	47.92	12.62
	Run 3	23.66	45.45	10.64	17.47	30.42	23.53	20.00	25.88	56.52	53.85	9.78	45.45	17.27	24.24	55.10	9.78
	Run 4	22.74	39.13	6.38	13.11	21.73	31.32	20.00	32.40	56.52	46.15	11.55	39.13	12.09	29.78	51.02	11.55
	Pass@4	34.44	56.52	14.89	21.28	43.48	41.18	46.67	39.13	69.57	73.08	18.28	56.52	23.08	41.03	71.43	18.28
	Avg	24.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JEDI-7B	15 Steps																
	Run 1	22.20	43.48	8.51	10.70	30.42	35.29	26.67	23.71	56.52	56.00	5.38	43.48	13.70	24.00	56.25	5.38
	Run 2	23.04	43.48	10.64	10.70	30.42	17.65	33.33	28.05	65.22	50.00	7.53	43.48	14.55	23.68	57.14	7.53
	Run 3	22.42	34.78	10.64	10.70	21.73	29.41	33.33	25.88	65.22	42.31	10.75	34.78	12.84	26.20	53.06	10.75
	Run 4	23.31	34.78	17.02	8.51	43.47	23.53	20.00	28.05	60.87	50.00	7.61	34.78	18.80	19.74	55.10	7.61
	Pass@4	31.86	52.17	21.28	10.70	43.48	41.18	40.00	39.13	82.61	65.38	11.83	52.17	21.37	31.58	73.47	11.83
	Avg	22.74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	50 Steps																
	Run 1	26.06	30.43	17.02	8.59	30.42	40.40	46.67	34.58	60.87	61.54	8.60	30.43	16.27	38.17	61.22	8.60
	Run 2	26.27	47.83	19.15	10.71	43.47	38.96	40.00	25.88	56.52	46.15	10.75	47.83	20.54	31.45	51.02	10.75
	Run 3	23.87	39.13	14.89	14.95	43.47	17.65	33.33	32.40	56.52	46.15	5.38	39.13	20.54	29.36	51.02	5.38
	Run 4	23.87	34.78	12.77	10.70	34.77	23.53	33.33	25.88	69.57	53.85	8.60	34.78	16.26	26.8	61.22	8.60
	Pass@4	35.56	52.17	25.53	14.89	56.52	47.06	53.33	39.13	86.96	65.38	13.98	52.17	27.35	43.59	75.51	13.98
	Avg	25.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	100 Steps																
	Run 1	25.94	39.13	14.89	16.30	34.77	29.41	26.67	32.40	60.87	46.15	12.90	39.13	19.39	30.65	53.06	12.90
	Run 2	29.40	52.17	12.77	14.95	43.47	29.41	46.67	36.75	73.91	57.69	11.83	52.17	19.68	37.06	65.31	11.83
	Run 3	25.64	43.48	6.38	14.95	36.35	20.72	53.33	28.05	73.91	46.15	11.68	43.48	15.54	31.32	59.18	11.68
	Run 4	26.86	34.78	10.64	10.71	39.12	29.41	46.67	32.40	78.26	53.85	11.56	34.78	16.27	34.49	65.31	11.56
	Pass@4	38.89	65.22	21.28	21.28	60.87	41.18	53.33	45.65	95.65	65.38	17.2	65.22	29.06	46.15	79.59	17.2
	Avg	27.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 16: Detailed performance of JEDI on WindowsAgentArena with four runs for each configuration

Model	Configuration	Overall	Chrome	File Explorer	Notepad	Edge	OS Settings	VLC	VS Code	Calculator	Libre Calc	Libre Writer	Paint
JEDI-3B	15 Steps												
	Run 1	28.86	0.00	47.37	50.00	30.77	60.00	38.10	45.83	0.00	4.17	26.30	33.33
	Run 2	28.72	5.88	36.84	50.00	23.08	80.00	52.75	45.83	0.00	8.33	10.53	33.33
	Run 3	29.92	5.88	47.37	50.00	30.77	40.00	42.32	50.00	0.00	4.17	26.30	33.33
	Run 4	28.72	5.88	42.11	50.00	38.46	60.00	43.23	37.50	0.00	8.33	21.04	33.33
	Pass@4	41.33	5.88	57.89	50.00	38.46	80.00	57.14	70.83	0.00	8.33	42.11	33.33
	Avg	29.06	-	-	-	-	-	-	-	-	-	-	-
	50 Steps												
	Run 1	32.05	5.88	47.37	50.00	30.77	60.00	43.23	45.83	0.00	8.33	31.57	66.67
	Run 2	32.48	5.88	44.44	50.00	38.46	40.00	47.99	52.17	0.00	4.17	36.83	33.33
	Run 3	32.05	0.00	57.89	0.00	23.08	60.00	52.75	50.00	0.00	8.33	26.30	33.33
	Run 4	28.72	5.88	42.11	50.00	38.46	60.00	42.23	37.50	0.00	8.33	21.04	33.33
	Pass@4	44.00	5.88	63.16	50.00	53.85	60.00	52.38	75.00	0.00	8.33	47.37	66.67
	Avg	31.33	-	-	-	-	-	-	-	-	-	-	-
	100 Steps												
	Run 1	34.57	5.88	52.63	50.00	38.46	80.00	46.91	45.83	0.00	12.50	31.57	33.33
	Run 2	30.72	5.88	57.89	50.00	30.77	80.00	33.70	33.33	0.00	8.33	36.83	33.33
	Run 3	33.23	5.88	63.16	50.00	7.69	60.00	42.15	58.33	0.00	8.33	31.58	33.33
	Run 4	33.61	6.25	47.37	50.00	30.77	80.00	43.23	58.33	0.00	8.33	21.04	66.67
	Pass@4	46.67	11.76	63.16	50.00	53.85	80.00	57.14	70.83	0.00	12.50	52.63	66.67
	Avg	33.03	-	-	-	-	-	-	-	-	-	-	-
JEDI-7B	15 Steps												
	Run 1	30.00	5.88	31.58	50.00	23.08	40.00	52.38	41.67	0.00	8.33	36.83	66.67
	Run 2	29.38	0.00	31.58	50.00	23.08	60.00	43.23	50.00	0.00	8.33	31.57	66.67
	Run 3	31.90	0.00	42.11	50.00	38.46	60.00	42.15	50.00	0.00	4.17	36.83	66.67
	Run 4	29.38	0.00	42.11	50.00	30.77	60.00	42.23	41.67	0.00	8.33	26.30	66.67
	Pass@4	42.67	5.88	52.63	50.00	46.15	60.00	57.14	70.83	0.00	8.33	52.63	66.67
	Avg	30.17	-	-	-	-	-	-	-	-	-	-	-
	50 Steps												
	Run 1	32.57	0.00	52.63	50.00	30.77	80.00	46.91	50.00	0.00	4.17	26.30	66.67
	Run 2	32.57	11.76	47.37	50.00	46.15	60.00	51.67	41.67	0.00	4.17	26.30	33.33
	Run 3	34.05	0.00	47.37	50.00	46.15	80.00	43.23	50.00	33.33	4.17	31.57	66.67
	Run 4	32.00	0.00	42.11	50.00	46.15	60.00	52.38	45.83	0.00	8.33	26.30	33.33
	Pass@4	46.00	11.76	52.63	50.00	61.54	80.00	61.90	70.83	33.33	8.33	47.37	66.67
	Avg	32.80	-	-	-	-	-	-	-	-	-	-	-
	100 Steps												
	Run 1	33.90	0.00	52.63	50.00	30.77	80.00	46.91	54.17	0.00	8.33	31.57	33.33
	Run 2	34.67	5.88	47.37	50.00	38.46	60.00	52.38	45.83	0.00	8.33	36.83	66.67
	Run 3	33.46	0.00	47.37	50.00	38.46	80.00	43.76	45.83	0.00	8.33	42.09	33.33
	Run 4	32.67	5.88	52.63	50.00	38.46	40.00	42.86	45.83	33.33	8.33	31.57	33.33
	Pass@4	47.33	5.88	63.16	50.00	53.85	80.00	61.90	75.00	33.33	8.33	52.63	66.67
	Avg	33.68	-	-	-	-	-	-	-	-	-	-	-