

Simple Action Model: Enabling LLM to Sequential Function Calling Tool Chain

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Abstract—Today LLMs are everywhere, it is making human internet life a lot easier than ever. Everyday new sophisticated models are releasing. But these models are not good enough to become the personal assistant like the Jarvis from Sci-fi movie IronMan. This paper proposes a way to enable any LLM to execute complex requirements in real world applications. By leveraging state-of-the-art Large Language models, we can create a simple action model that can understand environment around them. Eventually these models can help or assist humans in real time applications. The Sequential Function Calling Tool Chain System aims to bridge the gap between human language understandings and computer programming.

Index Terms—Large language model, Action model, OpenAPI format and Function Calling Tools

I. INTRODUCTION

Now on a world without AI is impossible to imagine. New models will comes everyday, and new architecture will improve its performance. Multi Modality or Mixture of Models are not enough to become the personal assistant. Graph based models takes up lot of computation in the case of complex function calling. Simple Question, "what if the one good model with one request is enough to execute multiple functions sequentially?".

The integration of openAPI schema with LLM can make a decent action model that can understand the API specs of that specific applications. The large language model will take prompts and decides what to do. From programming side, we'll parse the information and execute. Simple action model is done.

By implementing a custom JSON parser alongside with an OpenAPI schema type system it is possible to utilize one model as main decision making inside an application. This technology works faster compared to other solutions, but requires much more intelligent language model.

This helps to provide stable and intelligent AI assistant in any applications uphold the integrity and standards API formats. This research paper also leads to the exploration of

Multiple and Sequential Function calling tool chain that utilizes State-of-the-Art Language model to enhance the security, time efficiency, flexibility for building AI applications.

Purpose of this paper is to explore and improve existing solutions of Function calling tools available in open source software community. This paper also aims to provide a new approach to prompting the LLMs without fine tuning.

II. LITERATURE SURVEY

These literature reviews provides knowledge about the existing researches done by various scholars and open source developers.

III. METHODOLOGY

The approach of Sequential Function calling tool is using the popular and newest OpenAPI schema 3.0. By fetching the schema json from the backend url is converted to type parser like Zod (npm) at build time. The prompt captured from the user is fed to LLM with proper type annotation of OpenAPI schema. Any popular open source model can be used to understand and extract object/json data from users prompts. The extracted data are then loaded into a custom JSON parser that supports extra keywords from standard JSON format. The parser moves the data to OpenAPI clients libraries like OpenAPI-Fetch (npm) which fetch result from the backend. The result is then passed to the next function in the chain. The process is repeated until the end of the chain. But LLM is used once just to write "what to do in this environment" according to users prompts and type definition.

A. Schema Preparation

The preparation of the schema at build time utilizes popular libraries like OpenAPI-TS (npm) and OpenAPI-Zod (npm). It'll generate types schema for using in few-shot learning of LLM and zod schema for parsing the input and return data to and from LLM. Feeding the LLM with raw OpenAPI schema

is waste of tokens and context window, that's why it is a crucial step to create simpler version of schema. This process involves collecting openAPI schema JSON (by fetching from application backend server), parsing and preprocessing, and then structuring it in a way that is useful for teaching the language model.

The recorded schema were obtained from backend frameworks that supports swagger-ui or other libraries that generates OpenAPI. Simplified parser schema and type are written to coding file (here typescript programming language is used) and saved into a folder. Later these obtained schema were resized to smaller chunks if schema is larger that models context window. Graph based structure is used to label and store nodes. This graph data structure will help to query through large schema faster in runtime.

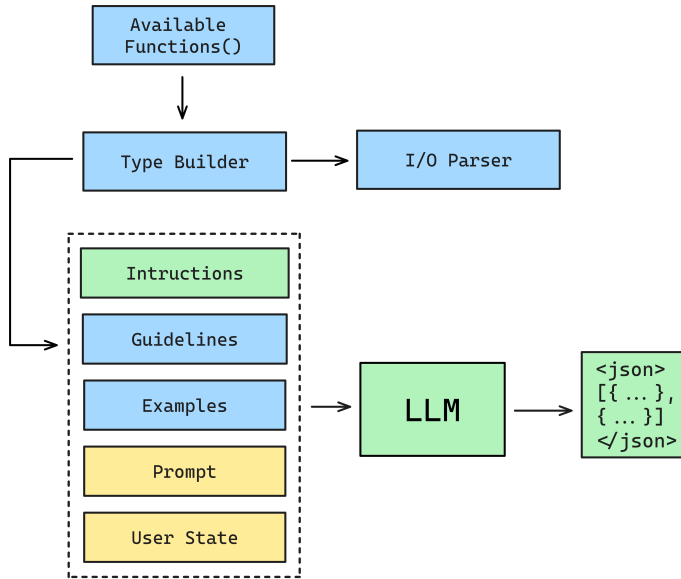


Fig. 1. Block Diagram for Normal In-context Learning

B. Prompt Preparation

Always the LLM is instructed to return response in `JSON` tags, making the data easier to extract from string. Also available functions list (or schema from OpenAPI) is converted to easy type definitions, which makes easier to understand by the LLMs.

But normally open source LLMs are stupid without examples. They are trained on general knowledge, that why its important for few shot in-context learning to make it understand the environment.

Also fine tuning approach is also great if type definition and instructions is larger than context window of the LLM using. Teach the Model with entire OpenAPI schema and examples before deploying to production give better result in response and saves lot of tokens while prompting each time.

C. Server Architecture

Initially developer specifies the backend URL and OpenAPI schema URL in the configuration file. The CLI fetches the

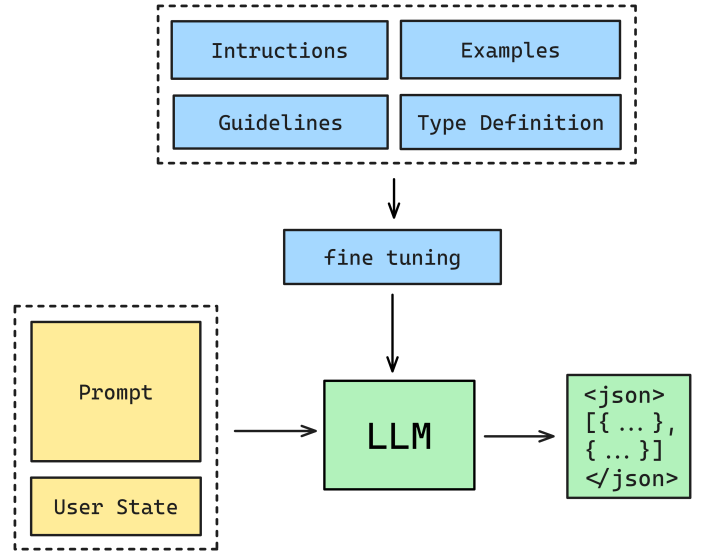


Fig. 2. Block Diagram for Fine tuned learning

schema from the backend applications and preparation the schema at build time. The server is an standalone backend that listens to end users prompts. Server takes user prompt, type definition of OpenAPI schema and sends to LLM. The developer also need to mentions the provider and model in configuration file. Then the LLM return with some JSON data wrapped with `JSON` tag. The data shows "what to run", "where to fetch" and "what are the parameter and request body". The server then parses the JSON data and sends to the Action engine. The engine take care of function calling and chaining. Finally the result is sent back to user in JSON format (or stream the UI if server is built with meta-frameworks like Next.js or Nuxt.js).

D. Action Engine Architecture

The Action engine architecture follow the same pattern as the build time CLI (CLI that converts the OpenAPI schema to type definitions). Action engine is not an AI system. Currently it is a simple JSON parser that can understand the JSON data from LLM. It turns normal Large Language Model to an Simple Action Model, that enables function calling and chaining.

Let consider a simple application mathematical calculations, the user asked "what is $10 + 2 / 4$ " and Action engine had access to all type of mathematical functions. So the LLM return instructions in JSON tag and the Action engine will execute the function in the order of the instructions. The result is then sent back to the user.

The new unknown variable is generated and used at runtime. Type structure of return JSON can be customized. Here this JSON is enough to represent environment. JSON is parsed and validated by engine and array to moved to execution stack and each function is called sequentially, where result of previous execution is stored in heap at runtime.

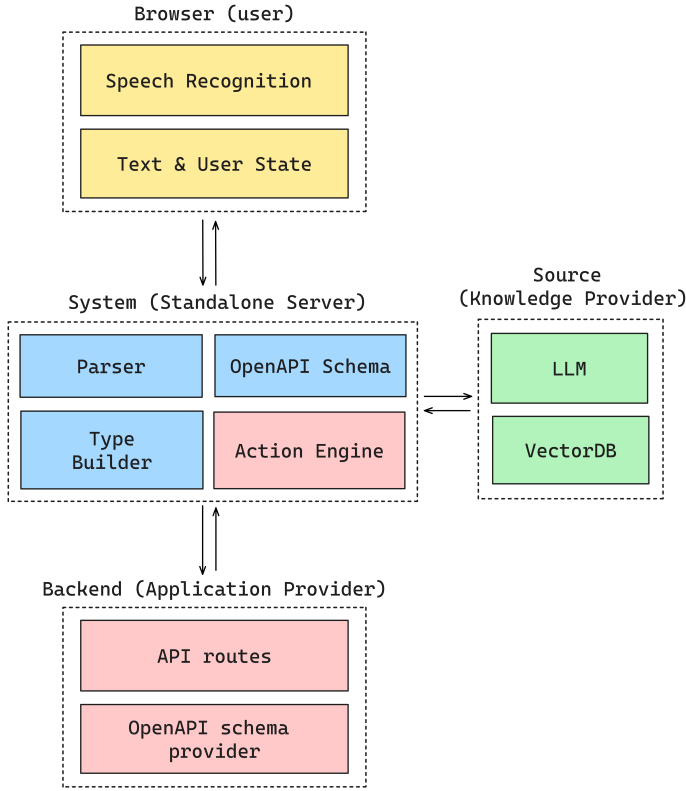


Fig. 3. Simplified Maths problem done with Function Calling.

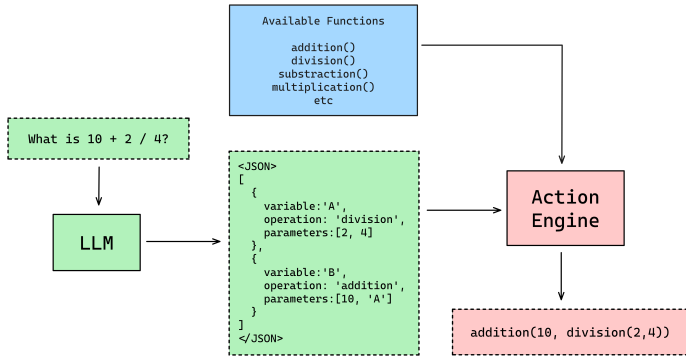


Fig. 4. Simplified Maths problem done with Function Calling.

Two type of instructions can be evaluated. Single: parse the json, execute the function, done. But for multiple sequential instructions require careful validations and parsing. First execution of function requires complete set of parameters. Always store the executed data and function parameters in heap. If other instructions requires data from previous execution, search in input params list in stack or search heap. If data is not found, return error (and let the server handle that part).

To ensure consistency and compatibility, the input data params and output result from each execution is also validated before passing down to next instructions. This standardization allows for seamless processing and execution of function calling, enabling the system to effectively detect any instances

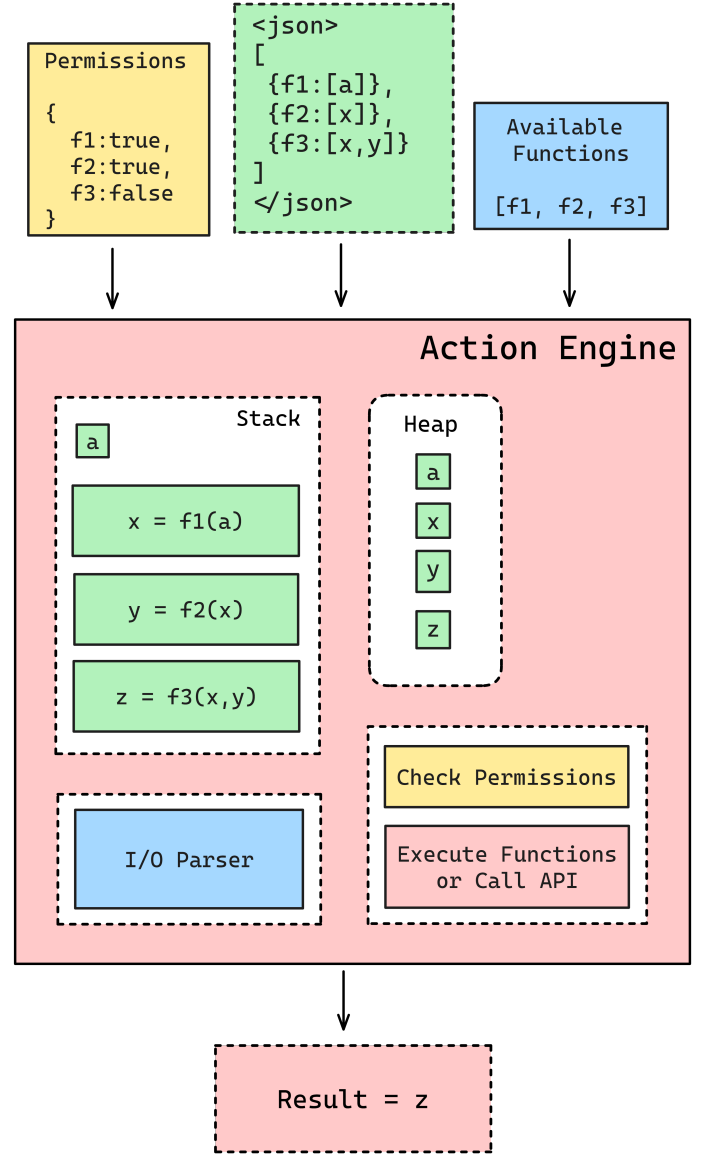


Fig. 5. Block Diagram of Action Engine Architecture

of error made by language model.

The permission is the list of functions that are allowed to run without users concerns. If a function is true, then execute it without asking for permission. If not then return the current result stack of execution back to user and wait until user permits. This feature is crucial while building high secure and user data depended applications. Users don't want any LLM to take decisions and execute some functionalities by its own without their permissions.

E. Model Training

The design of the offline exam proctoring system utilizing artificial intelligence has been structured to ensure efficient monitoring and supervision during examinations. This model architecture incorporates advanced AI technology to detect and

prevent any form of cheating or misconduct during offline exams.

YOLOv8 pre-trained on COCO dataset, enabling it to learn and generalize patterns by exposing it to real-time environment. The Convolutional Neural Network (CNN) backbone serves as a feature extractor, learning essential patterns from input images.

A VGG16 Image classifier trained on a custom dataset to identify the "cheating" and "non-cheating" behaviour. The transfer learning technique is used in the classifiers training to reduce the time and effort to train the classifier.

TABLE I
VGG16 CLASSIFIER

VGG16 parameters	parameter values
Batch size	32
Epochs	50
Optimizer	adam
Class mode	Categorical
loss	categorical_crossentropy

F. Object Detection

The video feed of the exam environment is segmented into a grid of cells, and employing a YOLOv8-like methodology, the object detection model detects students within each cell. This grid-based methodology enables the system to perform simultaneous monitoring of the entire exam setting, facilitating comprehensive detection coverage throughout the entirety of the video feed.

G. Classification

The classification of offline exam proctoring systems has undergone a significant transformation with the integration of artificial intelligence (AI). By leveraging a dataset that has been meticulously annotated in roboflow, the system can effectively discern between the various behaviors displayed by students during exams using VGG16 classifier, specifically focusing on distinguishing between cheating and non-cheating actions.

H. Output and Utilization

The utilization of offline exam proctoring system powered by AI not only promotes academic integrity but also improves the overall efficiency of the examination process. With AI technology, institutions can automate the monitoring and evaluation of exams, saving time for both educators and students. This streamlined approach enhances the productivity of exam administration while maintaining the quality and accuracy of assessments.

Along with real-time detection, images of student who attempted to commit malpractices during the exam are also saved to a folder for later cross references with their confidence score.



Fig. 6. Predicted Output From the Model

IV. IMPLEMENTATION AND RESULT

A. Implementation

The study used an advanced object identification model called YOLOv8 (You Only Look Once version 8) to achieve real-time and accurate detection of students in the class. YOLOv8 is widely recognized for its remarkable precision and effectiveness in object recognition, rendering it a perfect match for the specific object detection task. The VGG16 classifies the images into required classes.

A centralized system with a good graphical processor act as the central hub of the entire system which houses an object detection model(YOLOv8)and an image classification model(VGG16)

B. Performance Evaluation

The result in Table II demonstrates that in the study of YOLOv8 for the detecting the students in exam hall, the model showed outstanding performance across key metrics. YOLOv8 continuously maintained high precision, as seen by its high Mean Average Precision (mAP) , guaranteeing the accuracy of 95% in detecting students. It minimized false positives with an exceptional precision score of 0.94. With closely no misses, the model's recall of 0.96 demonstrated its ability to accurately identify all the students . All of these findings demonstrate how reliable and accurate YOLOv8 is an appropriate model to detect students in the classroom, which makes it an important tool for offline exam proctoring.YOLOv8 is the most trending and accurate model which has accuracy close

to perfect predictions. combining the state-of-the-art YOLOv8 and VGG16 provided the project with a level of perfection that is unmatched with humans. Humans have blind spots and other limitations but the EX-GUARD does not have such limitations.

The VGG16 classifier which was trained in house using our custom data set showed some of the best results. The trained model could adapt to the varying demands and situations of the examination hall. The VGG16 provided an accuracy of 92% in its evaluation phase.

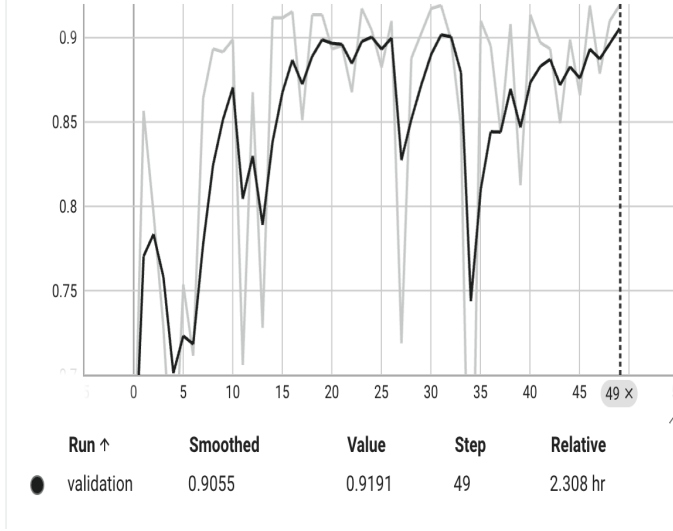


Fig. 7. Accuracy of Vgg16

While comparing with other models like AlexNet, the VGG16 provided better output regarding the ability to classify the student's behaviors. Combining the YOLOv8 and VGG16 the system performed better than the humans.

TABLE II
PERFORMANCE EVALUATION: YOLOv8

Metric	YOLOv8
Accuracy	95%
Precision	0.94
Recall	0.96
F1-score	0.95

C. Findings

From Fig. 6, which illustrates the usefulness of the YOLOv8 model for detecting students and VGG16 for classification, the study derives a number of noteworthy findings. The following are the main findings:

- 1) High detection Accuracy: The high Mean Average Precision (mAP) score indicates that the YOLOv8 model typically attained a high level of accuracy. This high accuracy ensures correct detection of exam takers.
- 2) High classification accuracy: The high accuracy of VGG16 classifier (92%) plays a major role in correctly classifying between cheating and non cheating.

- 3) Precision and Recall: The model's 0.94 precision and 0.96 recall scores highlights its ability to reduce false positives, a crucial aspect of detecting only students from each frame.
- 4) Balanced F1-Score: At 0.95, the F1-Score, a measure of accuracy that is balanced, was observed. This measure shows that the YOLOv8 model successfully reduces false positives and false negatives while maintaining good detection accuracy.
- 5) Practical Deployment: We have developed a practical and easily understandable automated proctoring system by integrating pre-trained YOLOv8 model with our custom-trained VGG16 classifier.

By providing a user-friendly interface for monitoring road conditions, this system makes real-time analysis and reporting easier.

These indicate the resilience and effectiveness of the YOLOv8 model in detecting students and VGG16 model in classifying the students into "cheating" and "non cheating". The foundation for improved road maintenance and safety is laid by this research, which may find use in damage prevention and real-time monitoring.

D. Comparison with State-of-the-Art methods

In the realm of offline exam proctoring systems, leveraging deep learning models for real-time detection and analysis has become increasingly prevalent. This script integrates several state-of-the-art components, notably utilizing YOLO (You Only Look Once) for object detection, particularly focusing on identifying individuals, typically students, within an exam setting. YOLO offers real-time object detection with impressive accuracy, efficiently bounding boxes around detected objects. YOLOv8 is the best-performing object detection algorithm [17] in the field with the highest accuracy and performance measures.

The system also uses VGG16 classifiers for classifying images, we trained the AlexNet with the same dataset as that of the VGG16. Referring to Table II, the following outcomes of the comparative study between VGG16 (the proposed model) and AlexNet on the same dataset are shown:

TABLE III
COMPARISON OF THE PERFORMANCE METRICS FOR VGG16 AND ALEXNET

Metric	VGG16	AlexNet
Accuracy	92%	64%
Loss	68	76

V. CONCLUSION

The offline exam proctoring system using AI is an utilization of a combination of YOLO object detection for detecting people in a video stream and a pre-trained VGG16 model for determining whether detected individuals are engaged in cheating behavior during an exam.

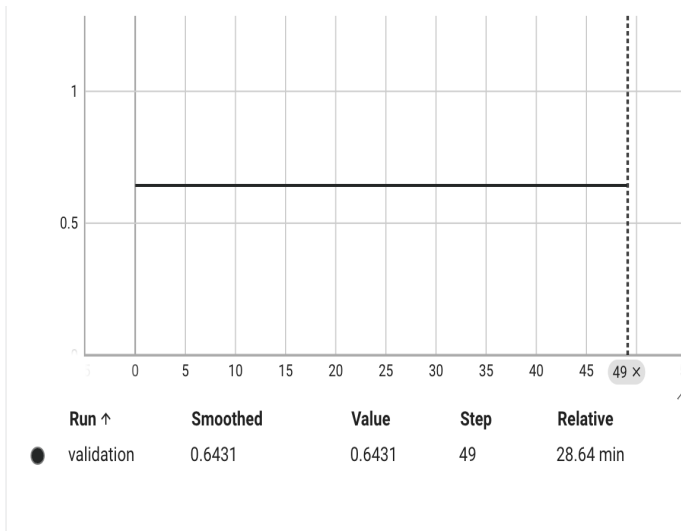


Fig. 8. Accuracy of AlexNet

In essence, the system processes each frame of the video stream, identifying people using YOLO, and then analyzing each detected person's behavior using the VGG16 model. If the VGG16 model predicts that the person is potentially cheating based on certain features extracted from their behavior or surroundings, such as looking at unauthorized materials, it saves an image of the person for further review. Conversely, if the model determines that the person is not engaged in cheating behavior, it continues processing the video stream. This process is repeated for each frame of the video, allowing the system to continuously monitor and flag potential instances of cheating during an exam.

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