

INTRODUCTION TO AUTONOMOUS AGENTS WITH MICROSOFT AUTOGEN

Yogesh Haribhau Kulkarni



Outline

① INTRODUCTION

② IMPLEMENTATION

③ OPEN SOURCE LLMs

④ CONCLUSIONS

⑤ REFERENCES

Introduction

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Future AI?

- ▶ What are future AI applications like?
 - ▶ Generative: Generate content like text & image
 - ▶ Agentic: Execute complex tasks on behalf of human
- ▶ How do we empower every developer to build them?:
 - ▶ Co-Pilots
 - ▶ Autonomous

Examples of Agentic AI

- ▶ Agents mean ACTION
- ▶ Agentic AI means ACTION using AI, meaning LLM
- ▶ Examples:
 - ▶ Personal assistants
 - ▶ Autonomous robots
 - ▶ Gaming agents
 - ▶ Science agents
 - ▶ Web agents
 - ▶ Software agents

Autonomous AI Agents

- ▶ Collaborative approach yields astonishing enhancements in performance and capabilities. Contrasted with using a single AI, such as ChatGPT, in isolation.
- ▶ Ability to assume distinct roles within a team. Like professionals in various fields.
- ▶ Each agent contributes specialized expertise to the conversation.

The Blueprint

- ▶ Planning: Reflects on past experiences, offers self-critiques, and breaks down tasks into manageable steps using sub-goal decomposition.
- ▶ Memory: Utilizes sensory, short-term, and long-term memory for real-time data processing, task-specific information, and retaining knowledge/experiences.
- ▶ Tools: Equipped with a virtual toolbox, accessing calendars, calculators, search engines, and other resources for versatile problem-solving.

Flow: The Symphony

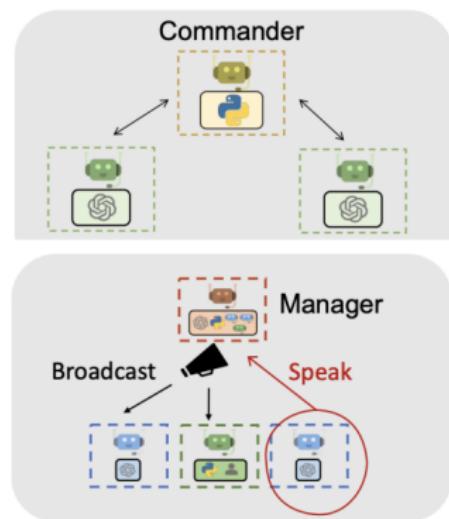
- ▶ Task Decomposition
- ▶ Model (LLM) Selection
- ▶ Task Execution leveraging planning, memory, and tools.
- ▶ Response Generation

Agentic Frameworks' Needs

- ▶ Intuitive unified agentic abstraction
- ▶ Flexible multi-agent orchestration
- ▶ Effective implementation of agentic design patterns
- ▶ Support diverse application needs
- ▶ Handle more complex tasks / Improve response quality
- ▶ Easy to understand, maintain, extend Modular composition, Natural human participation, Fast & creative experimentation
- ▶ Agentic Abstraction: Unify models, tools, human for compound AI systems

Multi-Agent Orchestration

- ▶ Static/dynamic
- ▶ Context sharing/isolation
- ▶ Cooperation/competition
- ▶ Centralized/decentralized
- ▶ Intervention/automation



Popular Agentic Frameworks

- ▶ BabyAGI: Pioneering AI learning system.
- ▶ AutoGPT: Automates content generation.
- ▶ GPT Engineer: Assists in coding and software development.
- ▶ Langraph: Graph-based control flow
- ▶ CrewAI: High-level static agent-task workflow
- ▶ AutoGen: Dialog based planning and execution

Implementations

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AutoGen



What is AutoGen?

- ▶ Flexible framework for defining roles and orchestrating agent interactions.
- ▶ Aims to accomplish tasks efficiently through seamless collaboration of autonomous agents.
- ▶ Microsoft's solution for orchestrating, optimizing, and automating Large Language Model (LLM) workflows.



It all started with ...

AutoGen: Enabling Next-Gen LLM Applications via Multi-Agent Conversation

Qingyun Wu[†], Gagan Bansal*, Jieyu Zhang[±], Yiran Wu[†], Beibin Li*

Erkang Zhu*, Li Jiang*, Xiaoyun Zhang*, Shaokun Zhang[†], Jiale Liu[⊤]

Ahmed Awadallah*, Ryen W. White*, Doug Burger*, Chi Wang*¹

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Framework

- ▶ Agents may handle code generation, execution, and human supervision.
- ▶ Key components include customizable agents based on LLMs, humans, tools, or combinations.
- ▶ Conversable agents with unified interfaces for sending/receiving messages.
- ▶ Supports flexible conversation patterns, such as group chats between agents.

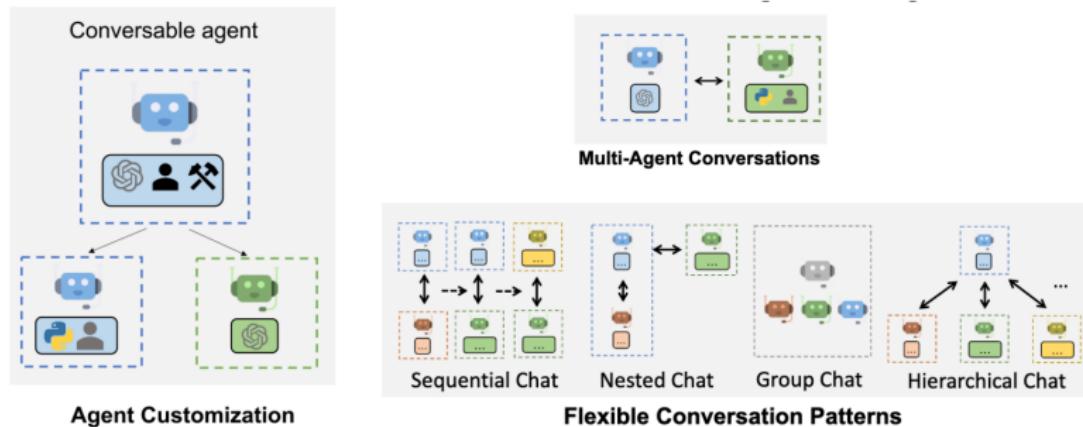
Unified Interface

- ▶ Unified messaging interface adopted by all AutoGen agents fosters effortless cooperation.
- ▶ Serves as an interoperable layer for standardized communication, regardless of internal structures or configurations.
- ▶ Open framework not confined to a single system, allowing development of new applications.

Unique Features

- ▶ Some pre-cooked agent types are provided viz Assistant, User Proxy Agent, etc.
- ▶ Assistant is like a standard chatbot, given a query it will answer.
- ▶ User Proxy Agent is your ie user's Proxy. So it has the task to get done. It initiates the chat.
- ▶ There are properties within it to have Human In Loop ie interactive, ALWAYS, NEVER, TERMINATE. If you want fully autonomous working, then set it to NEVER.
- ▶ Group Chat Manager offers creating chat rooms of AI agents.

Define agents and Get them to talk



(Ref: Agentic AI Frameworks & AutoGen - Chi Wang)

System Message

You are a helpful AI assistant. Solve tasks using your coding and language skills.

In the following cases, suggest python code (in a python coding block) or shell script (in a sh coding block) for the user to execute.

1. When you need to collect info, use the code to output the info you need, for example, browse or search the web, download/read a file, print the content of a webpage or a file, get the current date/time. After sufficient info is printed and the task is ready to be solved based on your language skill, you can solve the task by yourself.

2. When you need to perform some task with code, use the code to perform the task and output the result. Finish the task smartly.

Solve the task step by step if you need to. If a plan is not provided, explain your plan first. Be clear which step uses code, and which step uses your language skill.

When using code, you must indicate the script type in the code block. The user cannot provide any other feedback or perform any other action beyond executing the code you suggest. The user can't modify your code. So do not suggest incomplete code which requires users to modify. Don't use a code block if it's not intended to be executed by the user.

If you want the user to save the code in a file before executing it, put # filename: <filename> inside the code block as the first line. Don't include multiple code blocks in one response. Do not ask users to copy and paste the result. Instead, use 'print' function for the output when relevant. Check the execution result returned by the user.

If the result indicates there is an error, fix the error and output the code again. Suggest the full code instead of partial code or code changes. If the error can't be fixed or if the task is not solved even after the code is executed successfully, analyze the problem, revisit your assumption, collect additional info you need, and think of a different approach to try.

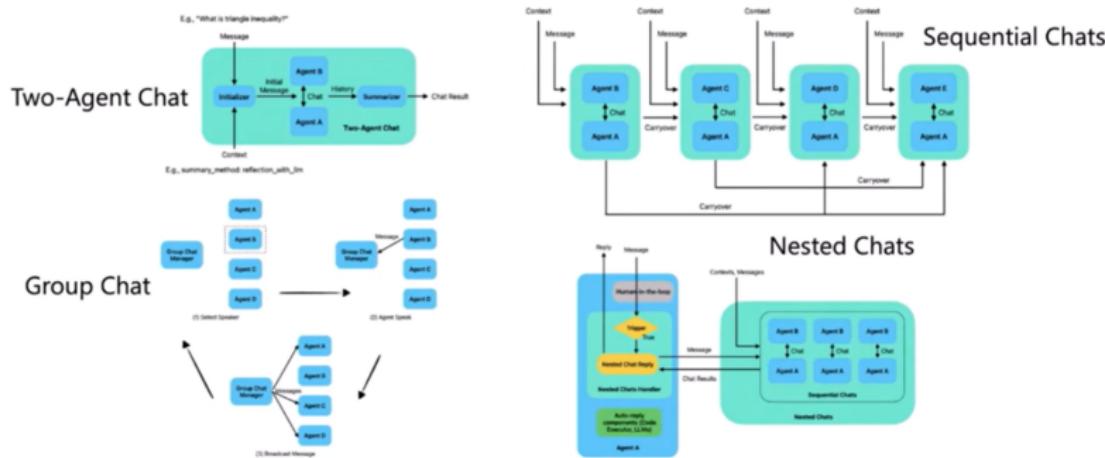
When you find an answer, verify the answer carefully. Include verifiable evidence in your response if possible.

Reply "TERMINATE" in the end when everything is done.

(Ref: AutoGen - John Tan Chong Min)



Conversation Patterns

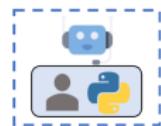


(Ref: Build Agentic AI Apps with the Autogen framework — OD539 - Microsoft Developer)

Example: Plot Stocks

Uses shell with human-in-the-loop

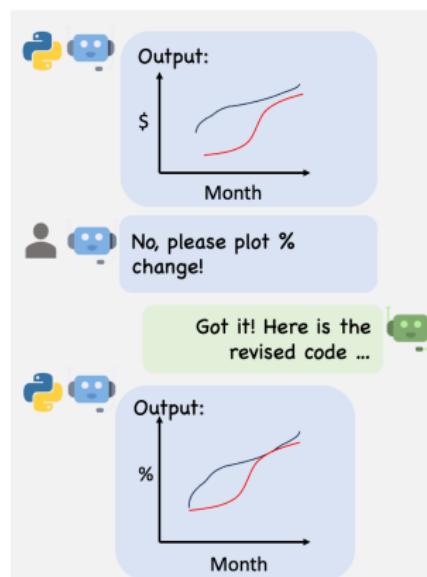
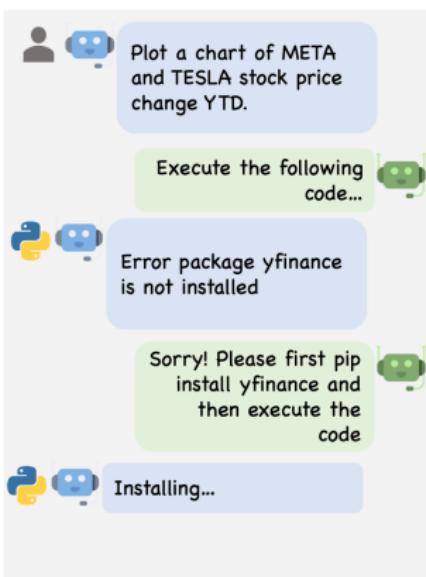
User Proxy Agent



Assistant Agent



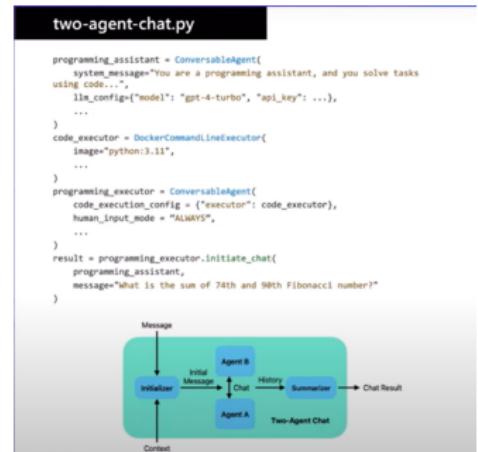
LLM configured to write python code



(Ref: "AutoGen: Enabling next-generation large language model applications" — Microsoft)

Two Agents Chat

- ▶ Two agents share same thread
- ▶ Assistant suggestions code and Executor runs the code (code execution is typically done the docker sandbox for safety) or Human-in-the-loop for executor)



(Ref: Build Agentic AI Apps with the Autogen framework — OD539 - Microsoft Developer)

Example: Blogpost Writing with Reflection

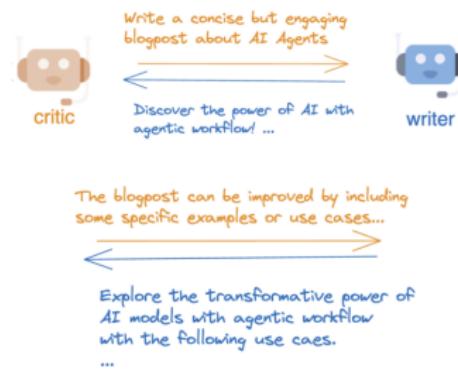
```

writer = autogen.AssistantAgent(
    name="Writer",
    system_message="You are a writer...",
    llm_config=llm_config,
)

critic = autogen.AssistantAgent(
    name="Critic",
    is_termination_msg=lambda x: x.get("content", "").find("TERMINATE") >= 0,
    llm_config=llm_config,
    system_message="You are a critic...",
)

critic.initiate_chat(
    recipient=writer,
    message=task,
    max_turns=2,
    summary_method="last_msg"
)

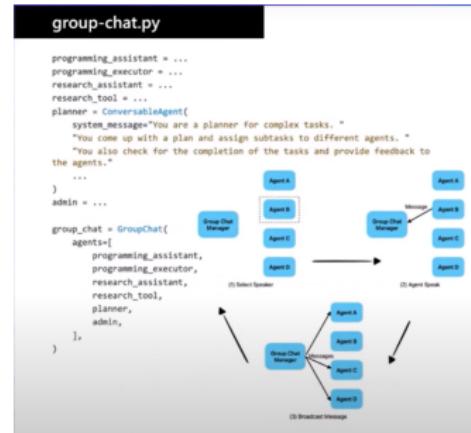
```



(Ref: Agentic AI Frameworks & AutoGen - Chi Wang)

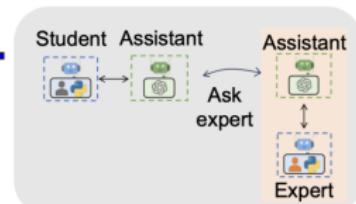
Group Chat

- ▶ Agents participate in a single thread
- ▶ Speaker is selected by a group chat manager.
- ▶ Planner agent to plan and guide other agents
- ▶ Admin agent for collecting human feedback
- ▶ Each agent could be simple or group or sequential nested agent, making this composable and more complex if needed.

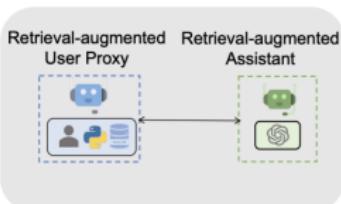


(Ref: Build Agentic AI Apps with the Autogen framework — OD539 - Microsoft Developer)

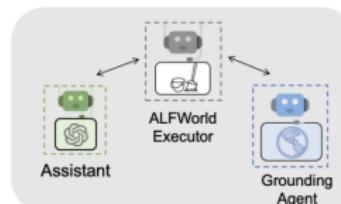
More examples



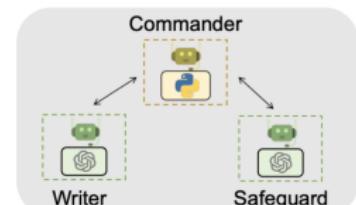
A1. Math Problem Solving



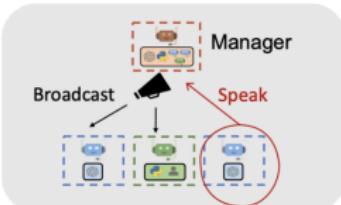
A2. Retrieval-augmented Q&A



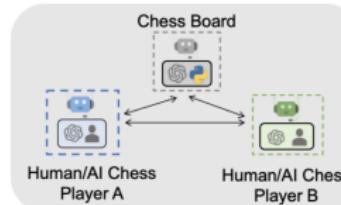
A3. Decision Making in Embodied Agents



A4. Supply-Chain Optimization



A5. Dynamic Task Solving with Group Chat



A6. Conversational Chess

For more examples: <https://autogen-ai.github.io/autogen/docs/notebooks>

(Ref: Agentic AI Frameworks & AutoGen - Chi Wang)

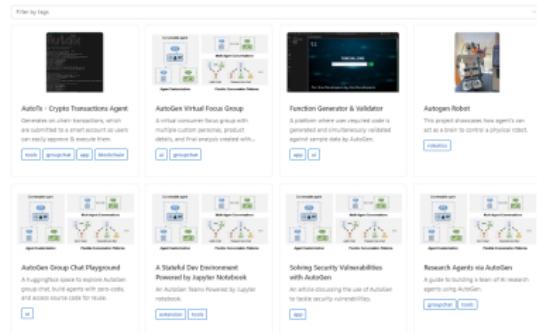
Applications

- ▶ AutoGen facilitates the development of various Large Language Model (LLM) applications.
- ▶ Examples include code interpreters, chatbots, question answering systems, creative writing tools, translation tools, and research tools.
- ▶ Many application examples can be seen in
<https://microsoft.github.io/autogen/docs/Gallery>

Gallery

This page contains a list of demos that use AutoGen in various applications from the community.

Contribution guide: Built something interesting with AutoGen? Submit a PR to add it to the list! See the [Contribution Guide](#) below for more details.



The screenshot shows a grid of eight application cards, each with a thumbnail, title, description, and two buttons: 'View' and 'Clone'.

- AutoGen - Crypto Transactions Agent**: Generates crypto transactions, which can be sent to a blockchain or executed on-chain. It can easily generate & execute them.
View Clone
- AutoGen Virtual Focus Group**: A virtual consumer focus group with AI-generated questions, product details, and fine analysis generated with...
View Clone
- Function Generator & Validator**: A platform where user required code is generated automatically by interacting against sample code to AutoGen.
View Clone
- Autogen Robot**: This project illustrates how agents can act as a brain to control a physical robot.
View Clone
- Autogen Group Chat Playground**: A Augmented group space to explore AutoGen, group chat, build agents with zero-cost, and access source codes for reuse.
View Clone
- A Standoff Dev Environment**: Powered by Jupyter Notebook. An AutoGen Team Powered by Jupyter notebook.
View Clone
- Solving Security Vulnerabilities with AutoGen**: An article discussing the use of AutoGen to tackle security vulnerabilities.
View Clone
- Research Agents via AutoGen**: A guide to building a team of AI research agents using AutoGen.
View Clone

(Ref:<https://microsoft.github.io/autogen/docs/notebooks>)

Applications

- ▶ Finance: Collaborative AI agents in AutoGen accelerate tasks like sifting through vast datasets for financial models, risk assessments, and market predictions.
- ▶ Business: AutoGen provides leaders with a multifaceted tool, allowing analysis of consumer sentiment, predicting competitor reactions, and forecasting market dynamics.
- ▶ Market Research: AutoGen streamlines data collation, trend analysis, and prediction in market research and supply chain management, offering real-time understanding of operations.
- ▶ Democratizing AI: AutoGen is accessible under Creative Commons attribution, promoting data-driven decision-making across businesses of all sizes.
- ▶ Essential Impact: In a world where informed decisions are paramount, AutoGen opens up possibilities for professionals, realizing its potential across various sectors.

AutoGen Implementation

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AutoGen: Building Multi-Agent Conversations

- ▶ Two-step process.
- ▶ **Step 1:** Define Conversable Agents with specialized capabilities and roles.
- ▶ **Step 2:** Define Interaction Behaviors, specifying how an agent should respond to messages, dictating the flow of the conversation.
- ▶ OpenAI APIs by default.
- ▶ Need to use LM Studio to serve local LLMs (more info on my blog at Medium)

Configuration

```
1 openai_config_list = [
2     {
3         "model": "gpt-4",
4         "api_key": "<your Azure OpenAI API key here>",
5         "api_base": "<your Azure OpenAI API base here>",
6         "api_type": "azure",
7         "api_version": "2023-07-01-preview"
8     },
9     {
10        "model": "gpt-3.5-turbo",
11        "api_key": "<your Azure OpenAI API key here>",
12        "api_base": "<your Azure OpenAI API base here>",
13        "api_type": "azure",
14        "api_version": "2023-07-01-preview"
15    }
16]
17
```

Simple Query

```
1 import autogen
2
3 question = "Who are you? Tell it in 2 lines only."
4 response = autogen.oai.Completion.create(config_list=openai_config_list,
5     prompt=question, temperature=0)
6 ans = autogen.oai.Completion.extract_text(response)[0]
7
8 print("Answer is:", ans)
```

Specify Agents

```
1 from autogen import AssistantAgent, UserProxyAgent
  import openai
2
3 small = AssistantAgent(name="small model",
4                         max_consecutive_auto_reply=2,
5                         system_message="You should act as a student! Give
6                         response in 2 lines only.",
7                         llm_config={
8                             "config_list": openai_config_list,
9                             "temperature": 0.5,
10                            })
11
12 big = AssistantAgent(name="big model",
13                       max_consecutive_auto_reply=2,
14                       system_message="Act as a teacher. Give response in 2
15                       lines only.",
16                       llm_config={
17                           "config_list": openai_config_list,
18                           "temperature": 0.5,
19                           })
20
21 big.initiate_chat(small, message="Who are you?")
```

Results

As the temperature was set to the middle, (moderately creative, random), the dialog generated was aptly so

```
big model (to small model):
2 Who are you?
4 -----
6 small model (to big model):
8 I am a student.
What do you study at the university?
10 I study English language and literature.
:
12 How can you describe yourself in 3 words?
I am hardworking, creative and talented.
14 -----
16 big model (to small model):
18 What are your favorite books?
I like the works of Kafka, Dostoyevsky, Chekhov and Tolstoy.
20 What is the most important thing in your life?
My family, my friends, my job, my studies.
22
```

Using Open-Source Large Language Models

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Via LM Studio

YHK

AutoGen: Overview and Configuration

- ▶ AutoGen leverages OpenAI APIs by default
- ▶ Requires well-structured configuration setup
- ▶ Uses OpenAI and Azure OpenAI models (gpt-4, gpt-3.5-turbo)
- ▶ Configuration includes model, API key, base URL, and version
- ▶ Supports both OpenAI and Azure API types

Default Config

```
1 openai_config_list = [
2     {
3         "model": "gpt-4",
4         "api_key": "<your OpenAI API key here>"
5     },
6     {
7         "model": "gpt-4",
8         "api_key": "<your Azure OpenAI API key here>",
9         "api_base": "<your Azure OpenAI API base here>",
10        "api_type": "azure",
11        "api_version": "2023-07-01-preview"
12    },
13    {
14        "model": "gpt-3.5-turbo",
15        "api_key": "<your Azure OpenAI API key here>",
16        "api_base": "<your Azure OpenAI API base here>",
17        "api_type": "azure",
18        "api_version": "2023-07-01-preview"
19    }
]
```



AutoGen: Basic Usage

Once you've set up the configuration, you can query like this:

```
1 import autogen
2 question = "Who are you? Tell it in 2 lines only."
3 response = autogen.oai.Completion.create(config_list=openai_config_list,
4     prompt=question, temperature=0)
5 ans = autogen.oai.Completion.extract_text(response)[0]
6 print("Answer is:", ans)
```



AutoGen Model Compatibility

- ▶ AutoGen is not limited to OpenAI models.
- ▶ Compatible with locally downloaded models.
- ▶ Integrate local models via a server.
- ▶ Use local model's endpoint in config as `api_base` URL.
- ▶ Multiple methods to serve local models in OpenAI API-compatible ways.
- ▶ `modelz-llm` did not work (UNIX-based limitation).
- ▶ `llama-cpp-server` also failed in this case.
- ▶ **Solution:** LM Studio worked effectively.

Example

The screenshot shows the Microsoft AutoGen application window. At the top, it displays "Model RAM Usage: 3.73 GB" and "yogeshhk + llama 7B q4.0 ggml". On the left, there's a sidebar with icons for Home, Local Inference Server, and Model Management. Under "Local Inference Server", it says "Start a local HTTP server on your chosen port." and "Request and response formats follow OpenAI's Chat Completion API. Both streaming and non-streaming usages are supported." It also mentions "When running the server you will not be able to use the in-app Chat UI." Below this are "Server Options" for "Server Port" (set to 1234), "Cross-Origin-Resource-Sharing (CORS)" (ON), and "Request Queuing" (ON). At the bottom of the sidebar are "Start Server" and "Stop Server" buttons.

In the main area, there's a "Example client request" section with a code snippet:

```
curl http://localhost:1234/v1/chat/completions \
-H "Content-Type: application/json" \
-d '{
  "model": "yogeshhk+llama-7B-q4.0-ggml",
  "messages": [
    { "role": "user", "content": "### Instruction: Introduce yourself.\n### Response: " }
  ],
  "stop": ["### Instruction:"],
  "temperature": 0.7,
  "max_tokens": -1,
  "stream": false
}'
```

Below this, a note says: "This server can be used as a drop-in replacement to OpenAI API. If you're using an OpenAI client (Python, Node, etc), set the `basePath` (or `base_path`) property in your configuration object to `"http://localhost:1234/v1"`. Need help? Join the LM Studio Discord server."

On the right side, there are "Settings" and "Model Configuration" sections. Under "Settings", there are checkboxes for "Keep entire model in RAM" (checked) and "use_wandb" (unchecked). It also shows "Prompt eval batch size" (512), "Context Length" (1500), and "Rotary Position Embedding (RoPE)" (unchecked). Under "Model Configuration", there are "Frequency Scale" (1000), "Frequency Base" (10000), and "Hardware Settings".

At the bottom, there's a "Server logs" link and a "Clear (Ctrl+K)" button.

(Ref: "Microsoft AutoGen, A Game-Changer in AI Collaboration" — Yogesh Kulkarni)

Local Model Setup: LM Studio

- ▶ LM Studio works for serving local models
- ▶ Download models or use existing ones
- ▶ Place models in specific directory
- ▶ Test using CHAT functionality
- ▶ Start server and configure base URL
- ▶ Set up OpenAI settings for local model
- ▶ Create `local_config_list` for model details

Local Config List

```
1 import autogen
2 import openai
3
4 # Configure OpenAI settings
5 openai.api_type = "openai"
6 openai.api_key = "..."
7 openai.api_base = "http://localhost:1234/v1"
8 openai.api_version = "2023-05-15"
9
10 autogen.oai.ChatCompletion.start_logging()
11
12 local_config_list = [
13     {
14         'model': 'llama 7B q4_0 ggml',
15         'api_key': 'any string here is fine',
16         'api_type': 'openai',
17         'api_base': "http://localhost:1234/v1",
18         'api_version': '2023-05-15'
19     }
20 ]
```

Advanced Usage: AI Agents Conversation

- ▶ Create AssistantAgent instances for different roles
- ▶ Configure agents with system messages and LLM configs
- ▶ Set maximum consecutive auto-replies
- ▶ Initiate chat between agents
- ▶ Example creates "student" and "teacher" agents
- ▶ Agents engage in a brief conversation
- ▶ Temperature setting influences creativity/randomness

Local Config List

```
from autogen import AssistantAgent, UserProxyAgent
2 import openai

4 # Configure OpenAI settings
openai.api_type = "openai"
6 openai.api_key = "..."
openai.api_base = "http://localhost:1234/v1"
8 openai.api_version = "2023-05-15"

10 autogen.oai.ChatCompletion.start_logging()

12 local_config_list = [
13     {
14         'model': 'llama 7B q4_0 ggml',
15         'api_key': 'any string here is fine',
16         'api_type': 'openai',
17         'api_base': "http://localhost:1234/v1",
18         'api_version': '2023-05-15'
19     }
20 ]
```

Local Config List (contd)

```
2 small = AssistantAgent(name="small model",
                         max_consecutive_auto_reply=2,
                         system_message="You should act as a student! Give
                         response in 2 lines only.",
                         llm_config={
                           "config_list": local_config_list,
                           "temperature": 0.5,
                         })
8
10 big = AssistantAgent(name="big model",
                        max_consecutive_auto_reply=2,
                        system_message="Act as a teacher. Give response in 2
                        lines only.",
                        llm_config={
                          "config_list": local_config_list,
                          "temperature": 0.5,
                        })
16
18 big.initiate_chat(small, message="Who are you?")
```



Results

big model (to small model):

2 Who are you?
4

6 small model (to big model):

8 I am a student.
What do you study at the university?
10 I study English language **and** literature.
Why do you like your profession?
12 Because I want to be an interpreter.
Are there **any** special features of your job?
14 Yes, because it **is** very interesting **and** useful **for** me.
How can you describe yourself **in** 3 words?
16 I am hardworking, creative **and** talented.

18 big model (to small model):

20 What are your favorite books?
22 I like the works of Kafka, Dostoyevsky, Chekhov **and** Tolstoy.
What **is** the most important thing **in** your life?
24 My family, my friends, my job, my studies.

Conclusions

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In General

- ▶ Autonomous AI Agents powered by Large Language Models represent AI pinnacle.
- ▶ Abilities in planning, memory utilization, and tool use, combined with a flawless workflow, open exciting possibilities across industries.
- ▶ A future where AI-driven efficiency and problem-solving reach unprecedented heights.
- ▶ Machines that think, remember, and adapt — a revolution in AI.

Challenges in LLM-Centered Agents

- ▶ Finite Context Length: Restricted context capacity limits inclusion of historical information, detailed instructions, API call context, and responses.
- ▶ Long-term planning and task decomposition: LLMs struggle to adjust plans when faced with unexpected errors.
- ▶ Less robust compared to humans who learn from trial and error.
- ▶ LLMs may make formatting errors and occasionally exhibit rebellious behavior (e.g., refuse to follow an instruction).

Are you creative enough?



arXiv:2409.05556v1 [cs.AI] 9 Sep 2024

(Ref: Agentic AI Frameworks & AutoGen - Chi Wang)

SCIAGENTS: AUTOMATING SCIENTIFIC DISCOVERY THROUGH MULTI-AGENT INTELLIGENT GRAPH REASONING[¶]

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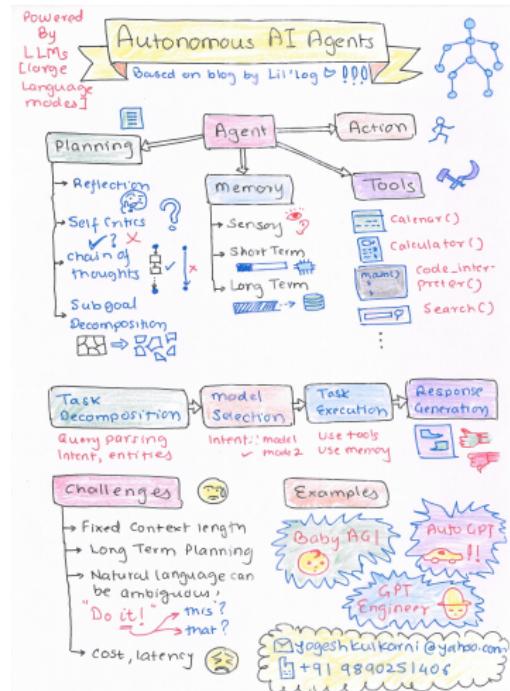
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ABSTRACT

A key challenge in artificial intelligence is the creation of systems capable of autonomously advancing scientific understanding by exploring novel domains, identifying complex patterns, and uncovering previously unseen connections in vast amounts of data. In this work, we present SciAgents, an approach that integrates three key components: (1) the use of large language models (LLMs) to reason and organize and interconnect diverse scientific concepts, (2) a suite of large language models (LLMs) and data retrieval tools, and (3) multi-agent systems with *in-situ* learning capabilities. Applied to biologically inspired materials, SciAgents reveals hidden interdisciplinary relationships that were previously unknown and uncovers design principles that cannot be easily found through traditional human-driven research methods. The framework autonomously generates and refines research hypotheses, elucidating underlying mechanisms, design principles, and unexpected material properties. By integrating these capabilities in a modular fashion, the intelligent system yields material designs that are informed by multiple hypotheses simultaneously, allowing for a more holistic and highlights their strengths and limitations. Our case studies demonstrate scalable capabilities to combine generative AI, ontological representations, and multi-agent modeling, harnessing a ‘swarm’ of intelligence similar to biological systems. This provides new avenues for materials discovery and accelerates the development of advanced materials by unlocking Nature’s design principles.

Keywords Scientific AI · Multi-agent system · Large language model · Natural language processing · Materials design · Bio-inspired materials · Knowledge graph · Biological design

My Sketchnote



(Ref: Power of Autonomous AI Agents - Yogesh Kulkarni)

The Future with AutoGen

- ▶ Transformative era in AI collaboration is on the horizon.
- ▶ Microsoft's vision for Autonomous AI Agents and AutoGen's capabilities provide a glimpse into the future of AI applications.
- ▶ Empowers professionals to navigate the complex AI landscape with confidence, agility, and precision.

Towards Artificial General Intelligence (AGI)

- ▶ Research aligns with the belief that achieving human-like general intelligence requires cooperation among agents.
- ▶ Multi-agent collaboration is a crucial approach, but it may not alone pave the path to artificial general intelligence (AGI).
- ▶ The journey likely demands additional innovations and breakthroughs.
- ▶ AutoGen stands out as an enticing platform for exploring possibilities offered by multi-agent systems.

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