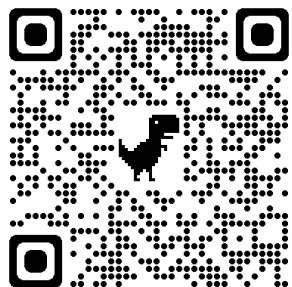




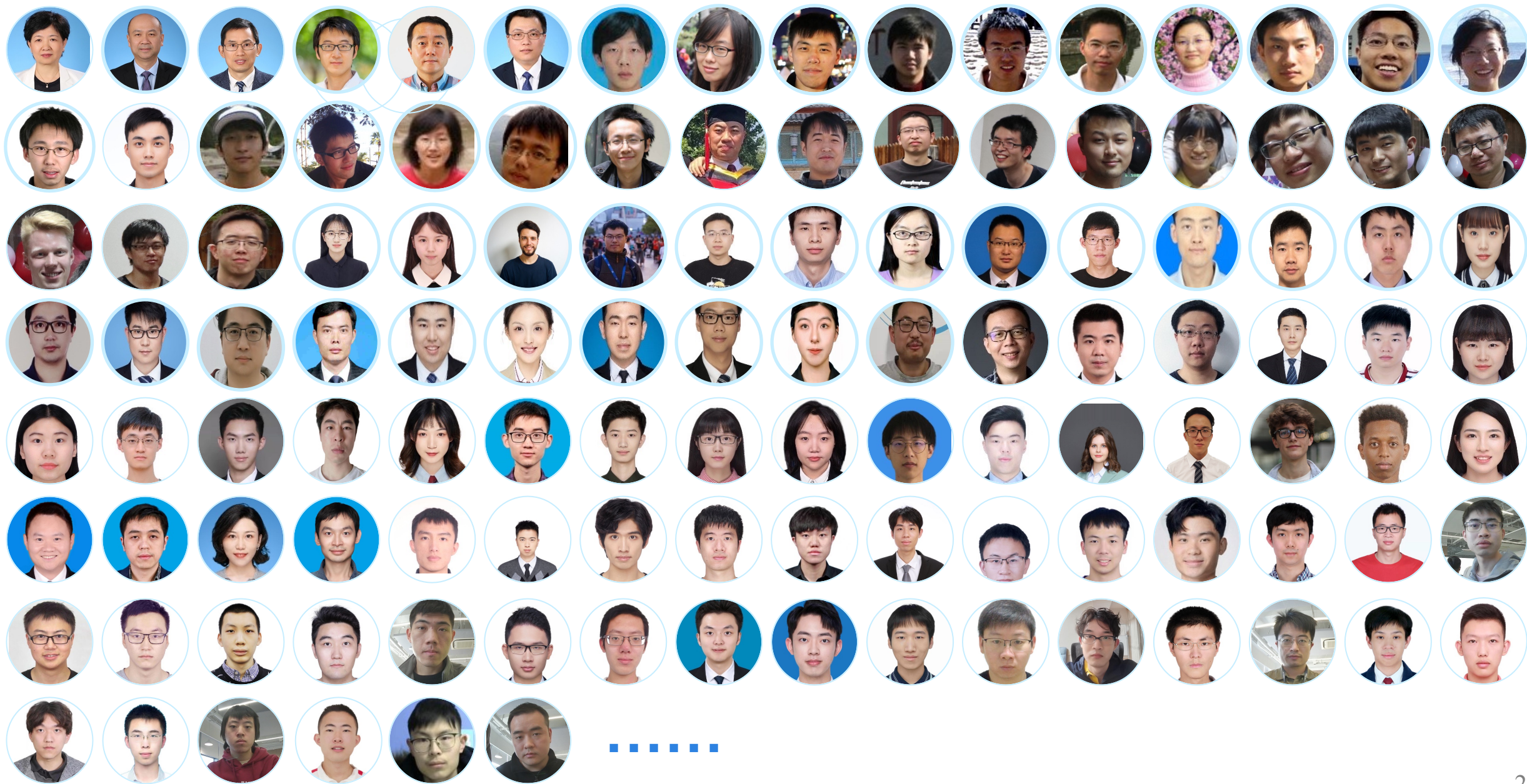
GLM: 从大模型看AGI的发展

唐杰

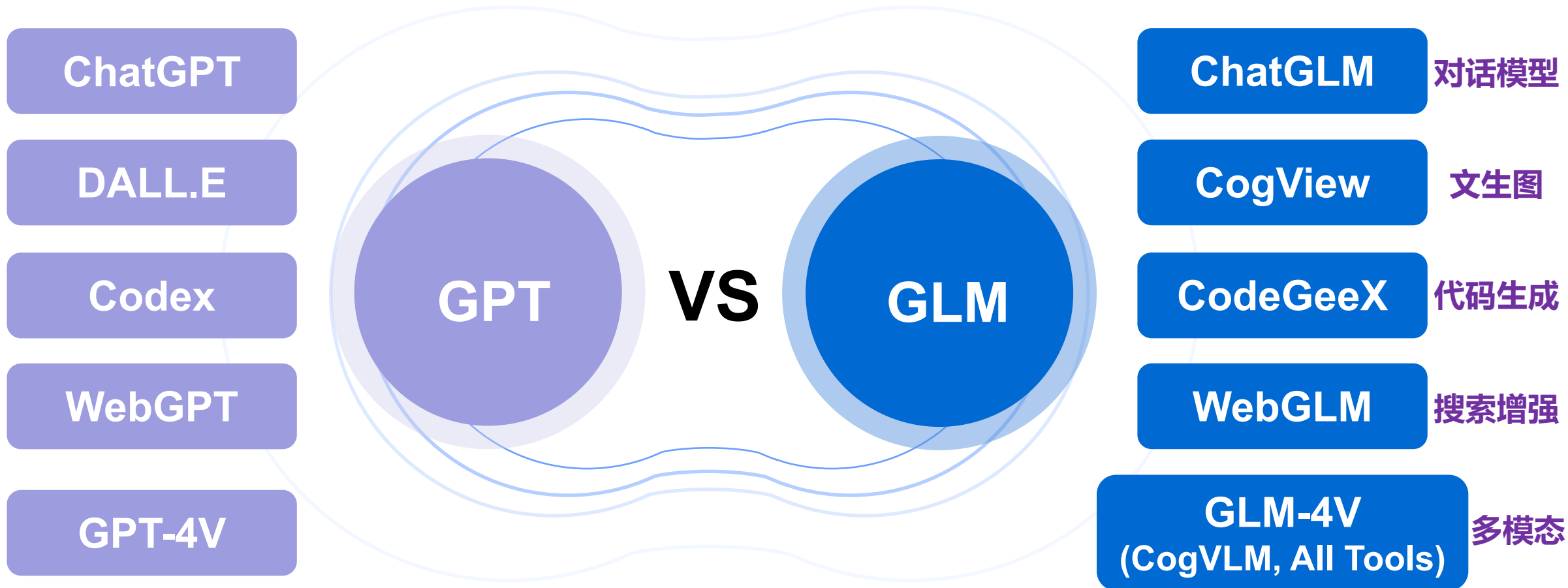
清华大学计算机系知识工程实验室 (KEG)
清华大学人工智能基础模型研究中心



一个很大的Team



GPT vs. GLM



自研大模型架构

GLM

Du et al. **GLM**: General Language Model Pretraining with Autoregressive Blank Infilling. arXiv:2103.10360. ACL'22

P-Tuning

Liu et al. **GPT understands, Too**. arXiv:2103.10385. ACL'22

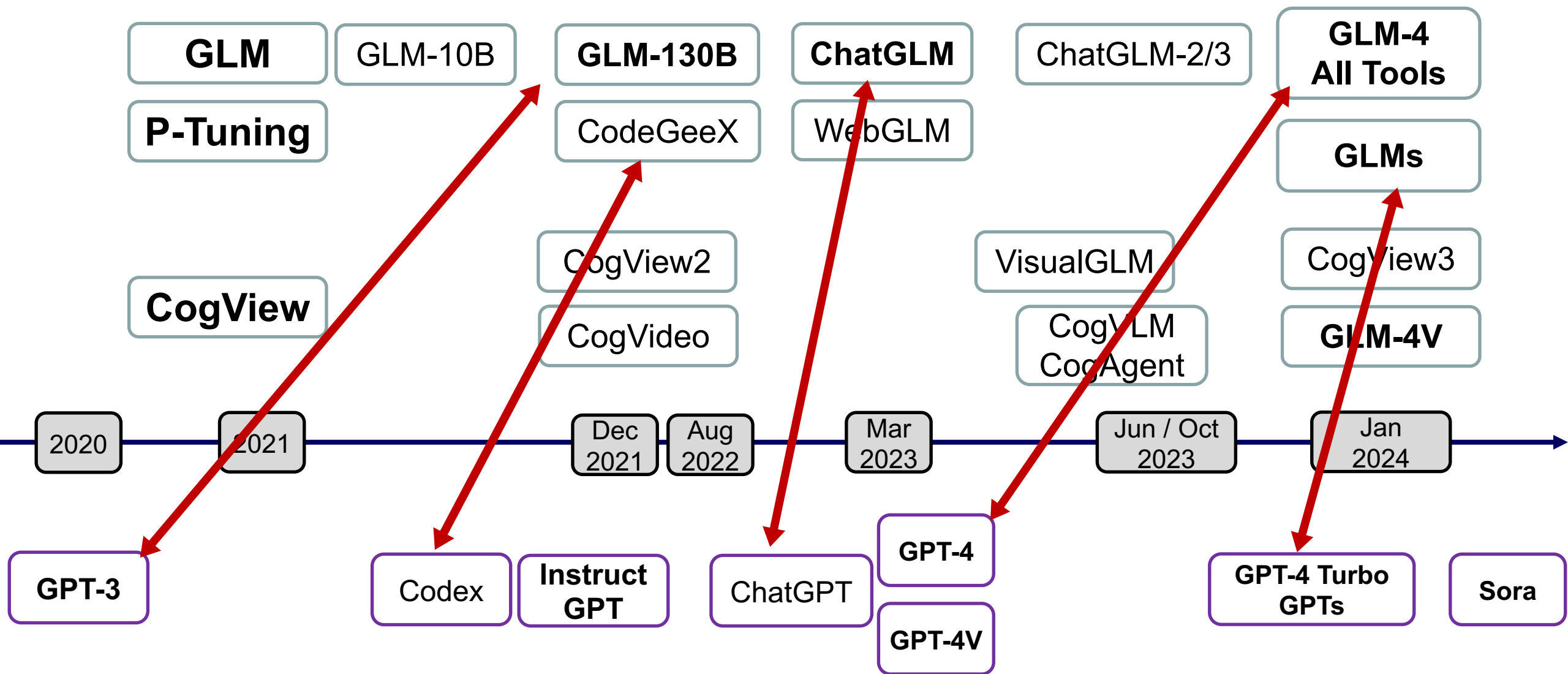
CogView

Ding et al. **CogView**: Mastering Text-to-Image Generation via Transformers. arXiv:2105.13290. NeurIPS 2021

2020

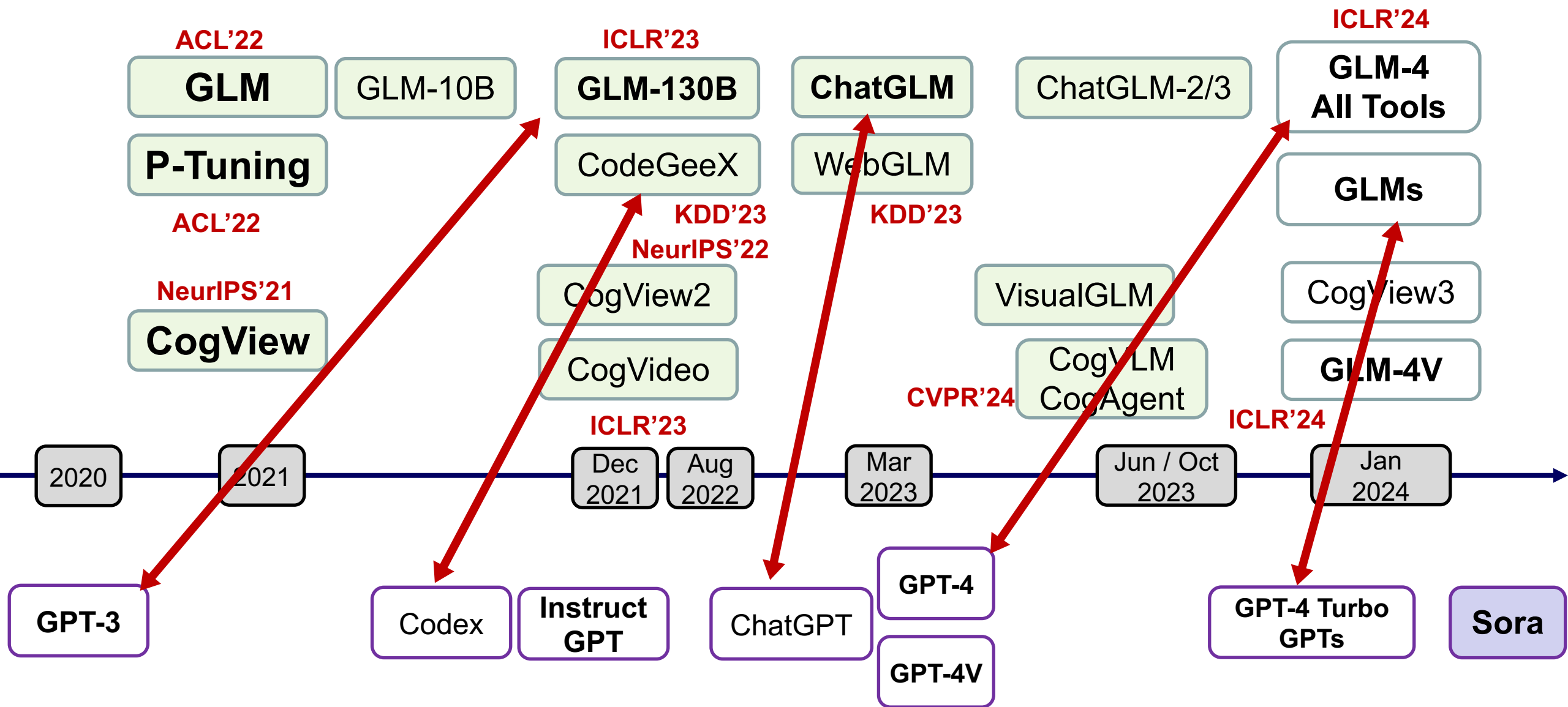
2021

GLM系列模型



GPT系列模型

GLM系列模型



GPT系列模型

通用语言模型 (GLM)

x_1 x_2 x_3 x_4 x_5 x_6

(a) Sample spans from the input text

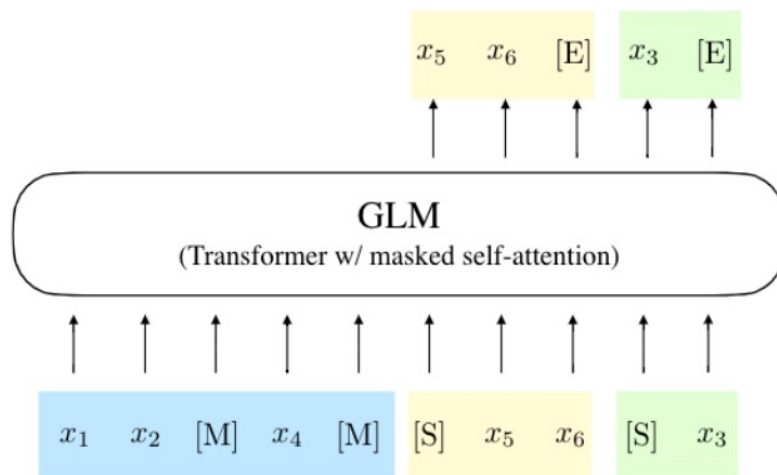
Part A:

x_1 x_2 [M] x_4 [M]

Part B:

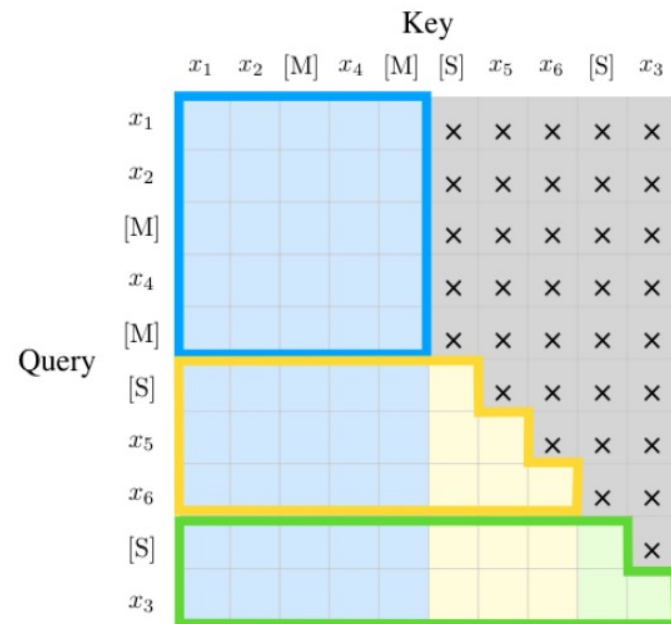
x_5 x_6 x_3

(b) Divide the input into Part A and Part B



Position 1	1	2	3	4	5	5	5	5	3	3
Position 2	0	0	0	0	0	1	2	3	1	2

(c) Generate the Part B spans autoregressively



(d) Self-attention mask

$$\mathcal{L}_{\text{GLM}} = \mathbb{E}_{\mathbf{z} \sim Z_m} \left[\sum_{i=1}^m \sum_{j=1}^{l_i} -\log p(s_{z_i, j} | \mathbf{x}_{\text{corrupt}}, \mathbf{s}_{z_{<i}}, \mathbf{s}_{z_i, < j}) \right]$$

通用语言模型General Language Model (GLM)

提出全自研预训练框架GLM，统一了自然语言理解与生成任务

模型架构	语言理解	有条件生成	无条件生成
自回归 (GPT)	—	—	√
自编码 (BERT)	√	×	×
编码器-解码器 (T5)	—	√	—
自回归填空 (GLM)	√	√	√

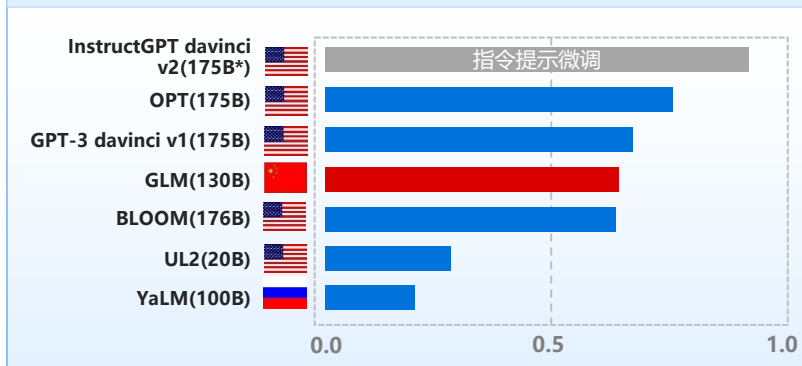
“√” 表示擅长，“—” 表示可以做，“×” 表示无法直接应用

之前，没有一个通用预训练框架可以同时在理解任务、有条件生成任务、无条件生成任务取得最优

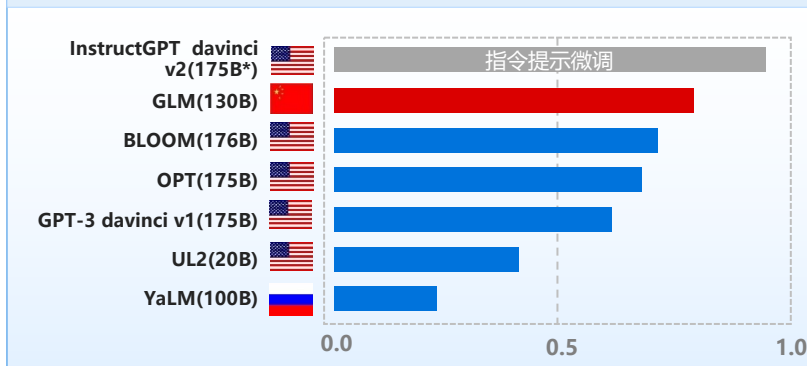
GLM-130B

斯坦福大学大模型中心报告的世界主流大模型评测：亚洲唯一入选模型，
准确性、恶意性与**GPT-3持平**，鲁棒性和校准误差在**所有模型中表现最佳**

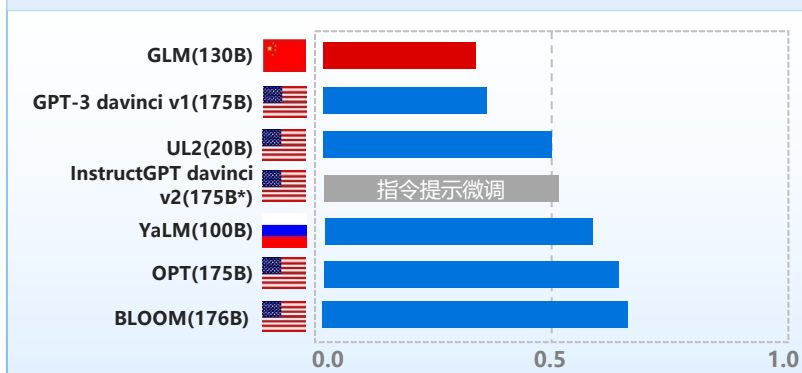
准确性 Accuracy



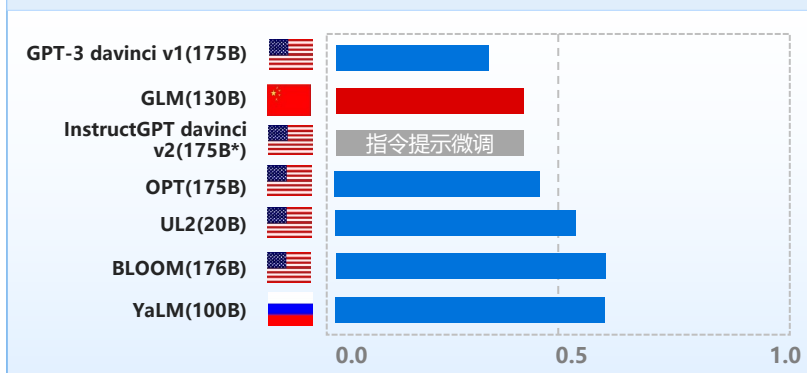
鲁棒性 Robustness



校准误差 Calibration error



恶意性 Toxicity



双语高精度

Big-bench-lite: +5.2%
LAMBADA: +2.3%
CLUE: +24.3%
FewCLUE: +12.8%
30+评测SOTA



高可用、低成本

4*RTX3090可运行
其他千亿模型的1/10
INT8/4模型量化
2-3倍推理加速



多平台适配

NVIDIA GPU、昇腾910、
海光DCU、申威等
芯片适配

清言chatglm.cn—挑战更复杂

GLM

XDAI

GLM-130B

CodeGeeX

QAGLM

ChatGLM

我今天买了5个苹果，昨天吃了一个，还剩下几个

OI gpt-4o-mini

你今天买了5个苹果，昨天吃了一个，所以你现在有：

$5 - 1 = 4$

所以你现在还有4个苹果。

✎ 🗑 🔊 🗣 🔄

OI llama-3.1-405b-instruct

因为你昨天吃了一个苹果，所以你之前应该还有5个苹果。

$5 \text{ 个苹果} - 1 \text{ 个苹果} = 4 \text{ 个苹果}$

所以，你现在有4个苹果。

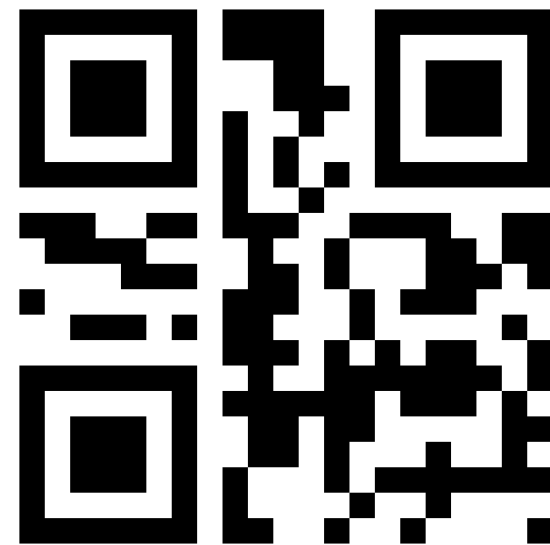
✎ 🗑 🔊 🗣 🔄

我今天买了5个苹果，昨天吃了一个，还剩下几个

ChatGLM AI

如果你今天买了5个苹果，昨天吃了一个，那么今天你应该有5个苹果，因为昨天吃的那个苹果是你今天买之前的情况。所以，你现在应该有5个苹果。

👍 🗣 📄 ➦



Welcome to try

国际影响力

- ▶ GLM-4 (0520) 在通用能力、指令追随、中文对齐、代码、数学、安全等方面与 GPT-4 Turbo 性能相当

基础能力评测 (英文)

	MMLU (5-shot)	GSM8K (5-shot)	MATH (4-shot)	BBH (3-shot)	HellaSwag (10-shot)	HumanEval (0-shot)
GPT-4	86.4	92.0	52.9	83.1	95.3	67.0
GLM-4	81.5	87.6	47.9	82.3	85.4	72.0
GLM-4/GPT-4	94%	95%	91%	99%	90%	100%

指令跟随能力 (中英, 数据集: 谷歌 IFEval)

	Prompt 级别、中文	Instruction 级别、中文	Prompt 级别、英文	Instruction 级别、英文
GPT-4	72.4	80.0	79.5	85.4
GLM-4	63.4	71.9	67.7	76.4
GLM-4/GPT-4	88%	90%	85%	89%

Yann LeCun & Bengio



图灵奖

“A Cookbook of Self-Supervised Learning”以及“Regeneration Learning: A Learning Paradigm for Data Generation”等多篇文章中引用了Cogview, 将Cogview作为文本到图像生成的代表算法。

Philip S. Yu



UIC教授
ACM/IEEE
Fellow

“LLMRec: Benchmarking Large Language Models on Recommendation Task”中认为项目提出的, ChatGLM 模型是当下最受欢迎的语言模型之一。

nature
International journal of science

“Large Language Models Encode Clinical Knowledge”认为项目提出的P-tuning 算法是将软性提示嵌入与硬性提示词结合的代表工作。

国际影响力

Nature报道ChatGLM模型

China's ChatGPT: why China is building its own AI chatbots

ChatGLM is one of hundreds of AI language models being developed for the Chinese language. It comes close to ChatGPT on many measures, say its creators.

By Celeste Biever



国际顶级AI大会Keynote

国际顶级机器学习大会ICLR'24

国际顶级互联网大会WWW'24

2024-toward AGI

GLM-4.5
GLM-OS
GLM-zero



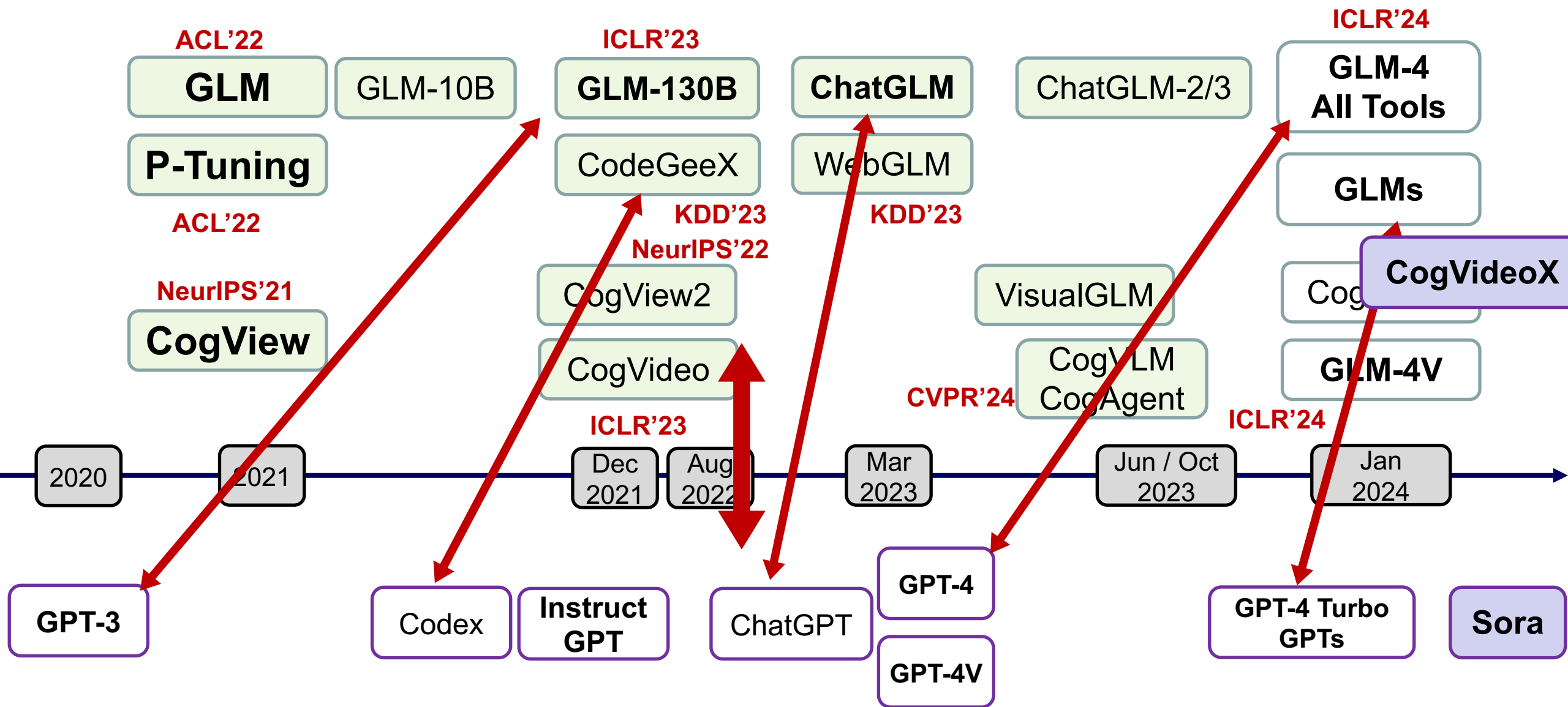
相关论文

- GLM-130B: An Open Bilingual Pre-trained Model (ICLR 2023)
- CogView: Mastering Text-to-Image Generation via Transformers (NeurIPS 2021)
- CogView2: Faster and Better Text-to-Image Generation via Hierarchical Transformers (NeurIPS 2022)

- CogVideo: Large-scale Pretraining for Text-to-Video Generation via Transformers (ICLR 2023)
- RelayDiffusion: Unifying Diffusion Process Across Resolutions for Image Synthesis
- CogVLM: Visual Expert for Pretrained Language Models
- CogAgent: Visual Language Model as GUI Agent

... ..

GLM系列模型

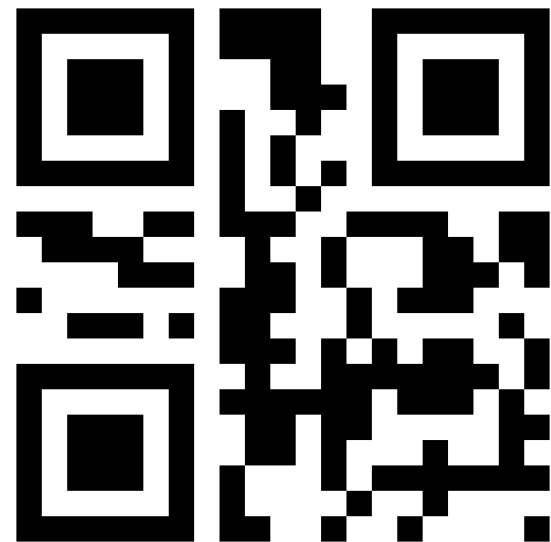


GPT系列模型

视频生成

- 文生视频
 - 用户输入文字，模型自动生成视频
- 图生视频
 - 用户上传图片，可以加上用户文字描述，模型自动根据图片和文字生成视频

一起试一试



文生视频

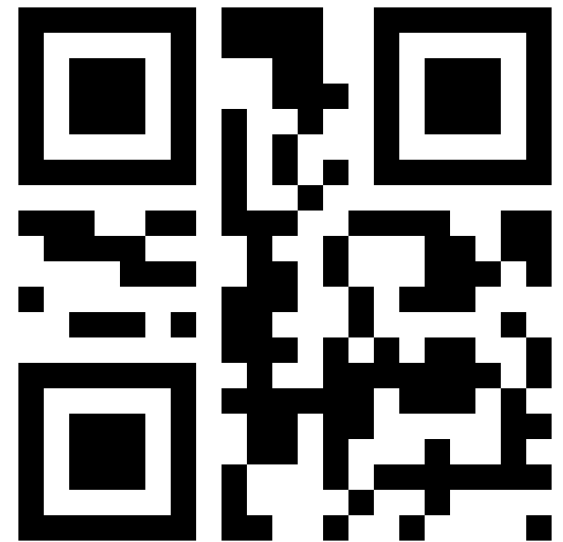
- 第一视角镜头，从一块巨石完成穿越，航拍镜头从高空缓缓下降，捕捉到Garay Point海滩上，巨浪猛烈地撞击着崎岖的悬崖。镜头聚焦于白色泡沫点缀的海水，描绘出一片碧蓝深邃的海洋景象。夕阳的余晖将岩石和崖壁涂上一层金色的光辉，营造出一种温暖而宁静的日落氛围。远处，一个隐藏在海雾中的小岛及其上的灯塔若隐若现，增添了一抹神秘感。镜头轻触绿色的灌木和蜿蜒至海滩的道路，展现了一片生机勃勃的自然景观。整个画面在动态与宁静之间，尽显大自然的力量与美丽。



文生视频

- 水下镜头+金色时刻+柔和色调) +一只柯基幼崽在阳光照耀的大型泳池中优雅地游泳+从水下视角捕捉柯基幼崽的微笑, 高清摄影记录了水的质地和柯基欣喜的表情细节, 形成宁静而电影感强烈的感觉, 高清, 4K 画质, 超清晰

一起试一试

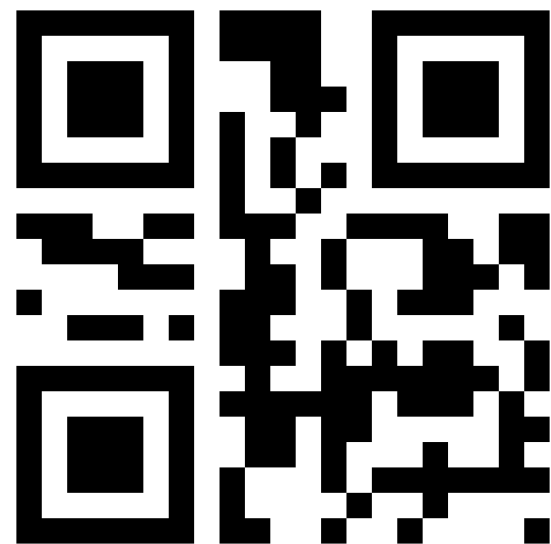




文生视频

- 动画场景，展示一个粉色的毛绒绒的小怪物划船，3d风格，需要注重画面的细节，小怪物的神情充满喜悦，表现出顽皮天真的样子。温暖的颜色和氛围的灯光。

一起试一试

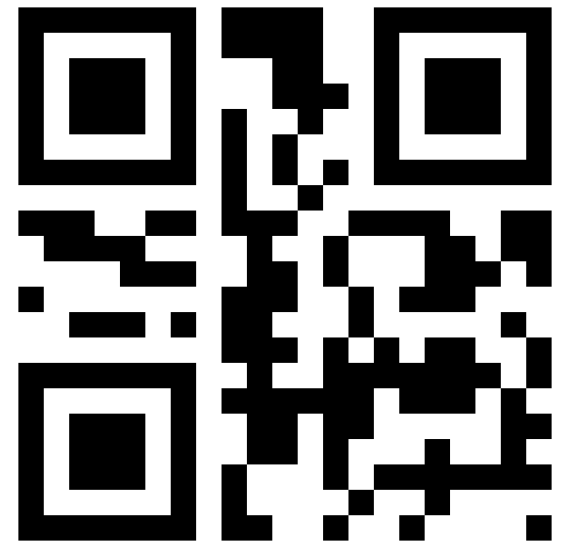




文生视频

- 一艘帆船被海浪打翻，紧张刺激的镜头，4K高清，电影质感，水平旋转镜头拍摄

一起试一试

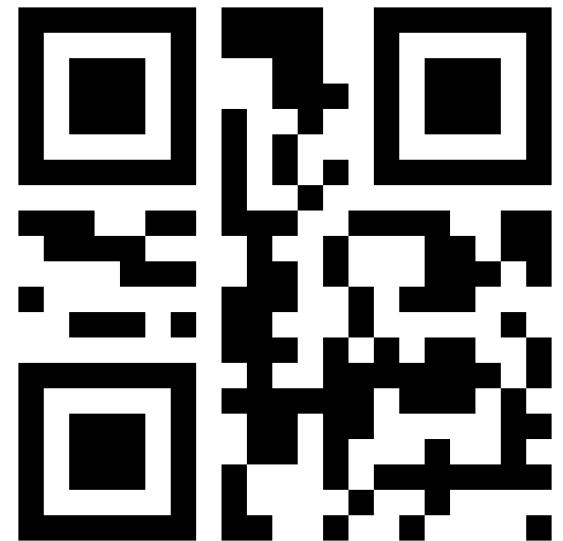




文生视频

- An elderly woman with white hair and a lined face is seated inside an older model car, looking out through the side window with a contemplative or mildly sad expression.

一起试一试



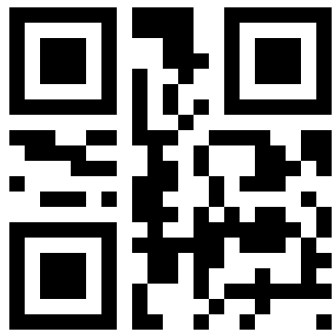


图生视频

让画面里的主体
开始弹吉他



试一试

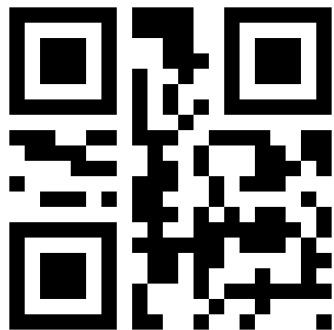


图生视频

冒出一只小乌龟



试一试



清影·AI



来点干货

—CogVideoX

Cog 系列模型历史

May.2021

CogView
autoregressive

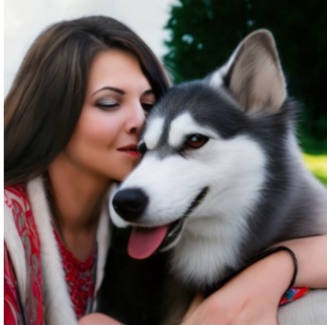
A tiger is playing football.



May.2022

CogView2
semi autoregressive

A beautiful girl is hugging a husky.



May.2022

CogVideo
autoregressive



Sep.2023

RelayDiffusion
Diffusion+Unet



Feb.2024

CogView3
Diffusion+Unet

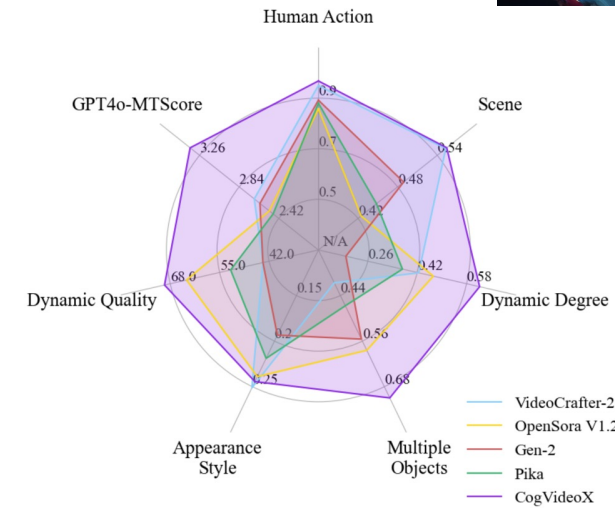


July.2024

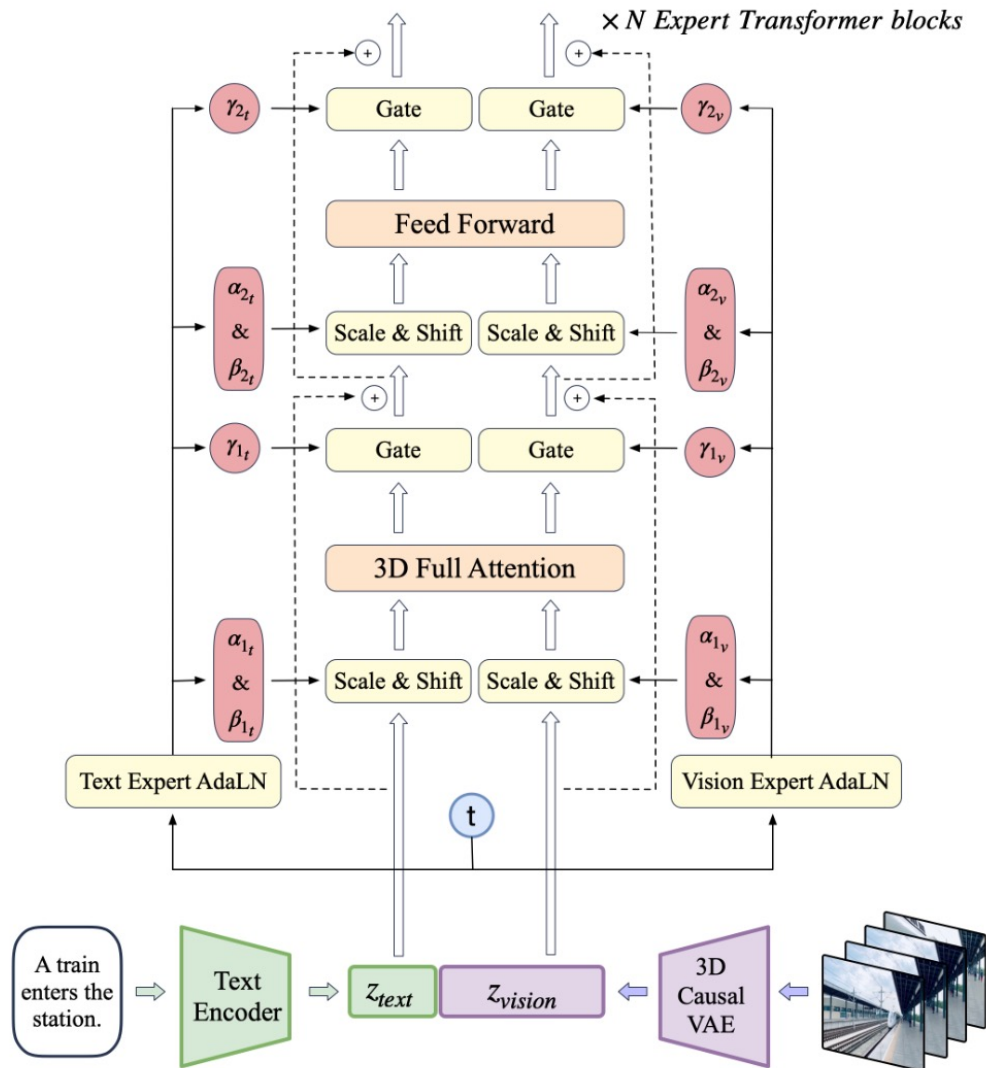
CogVideoX
Diffusion+Transformer



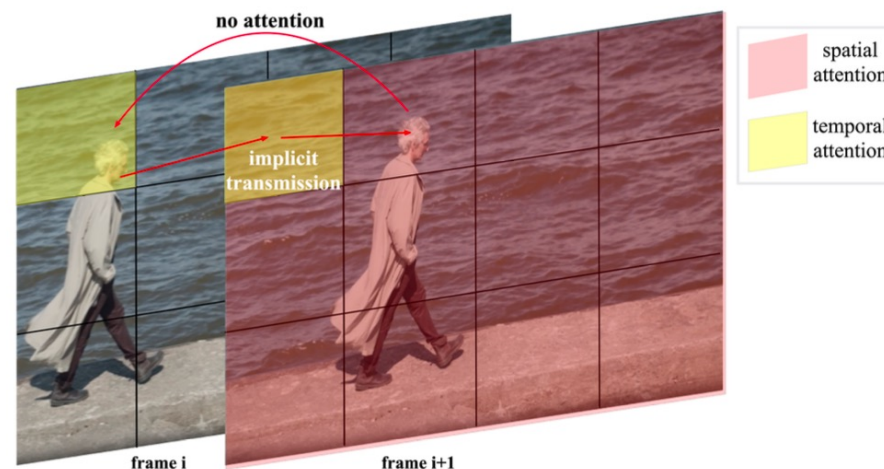
<https://github.com/THUDM/CogVideo>



核心模块：3D Transformer



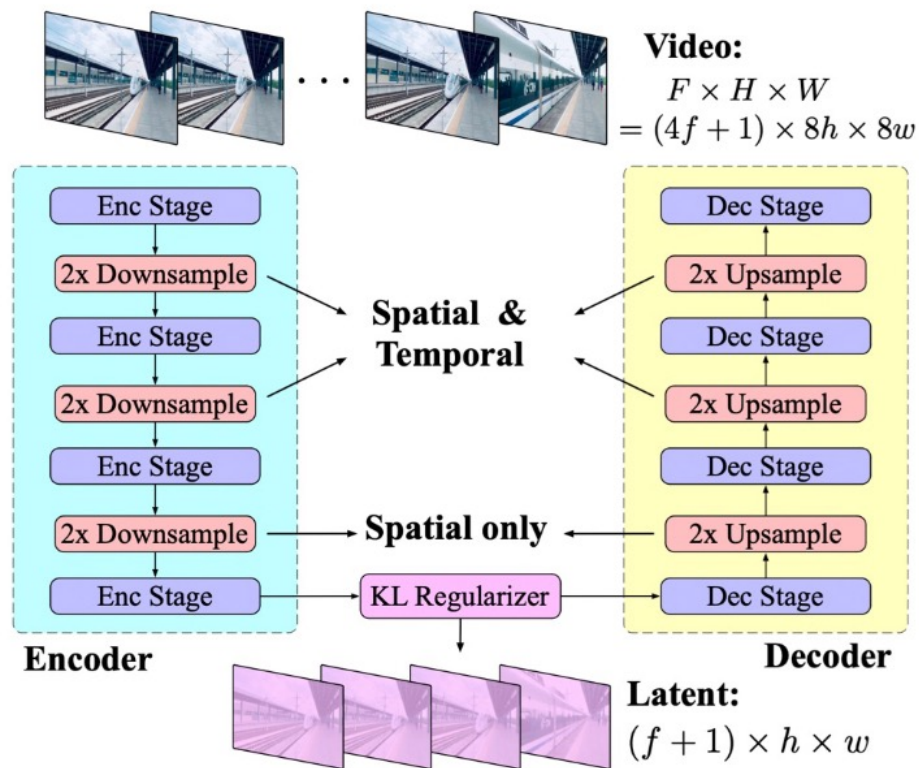
为什么没有使用 空间+时间分离的attention?



更好的语义理解：
Text+Video full attention
让文本也参与self attention计算和FFN

文本和视频对齐：
Text Expert AdaLN + Vision Expert AdaLN

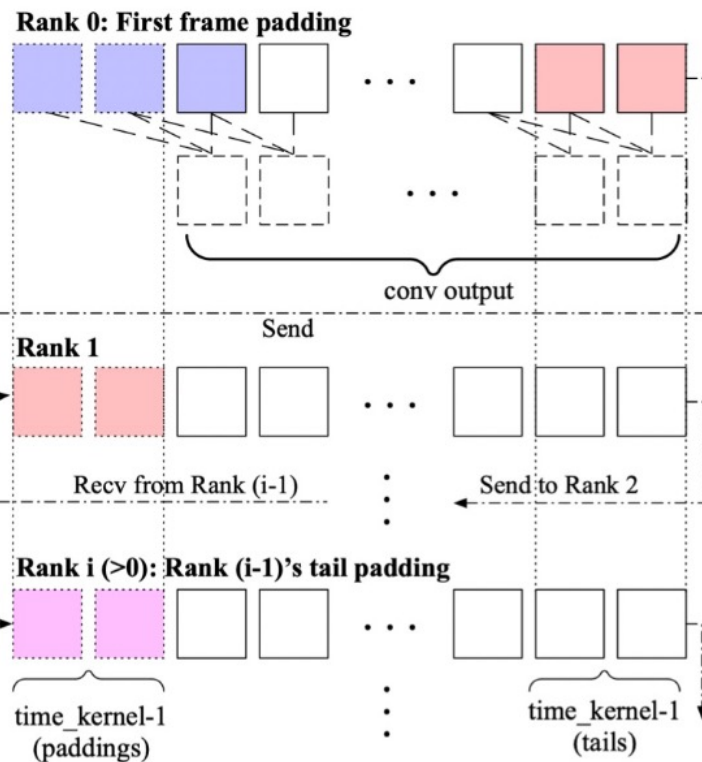
核心模块：3D Transformer



与2D VAE区别：
Conv2d -> Conv3d

视频时序因果关系，
单张图片压缩：
Causal Convolution

连续性更强
压缩倍数更高

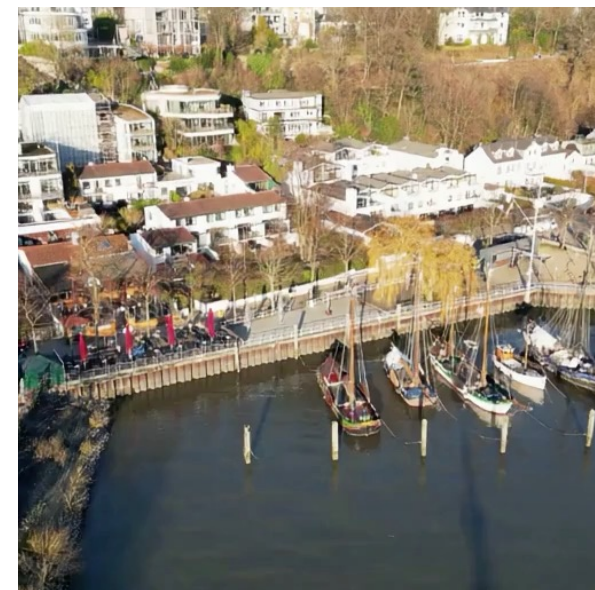


VAE 训练：
时间维度上做context
parallel

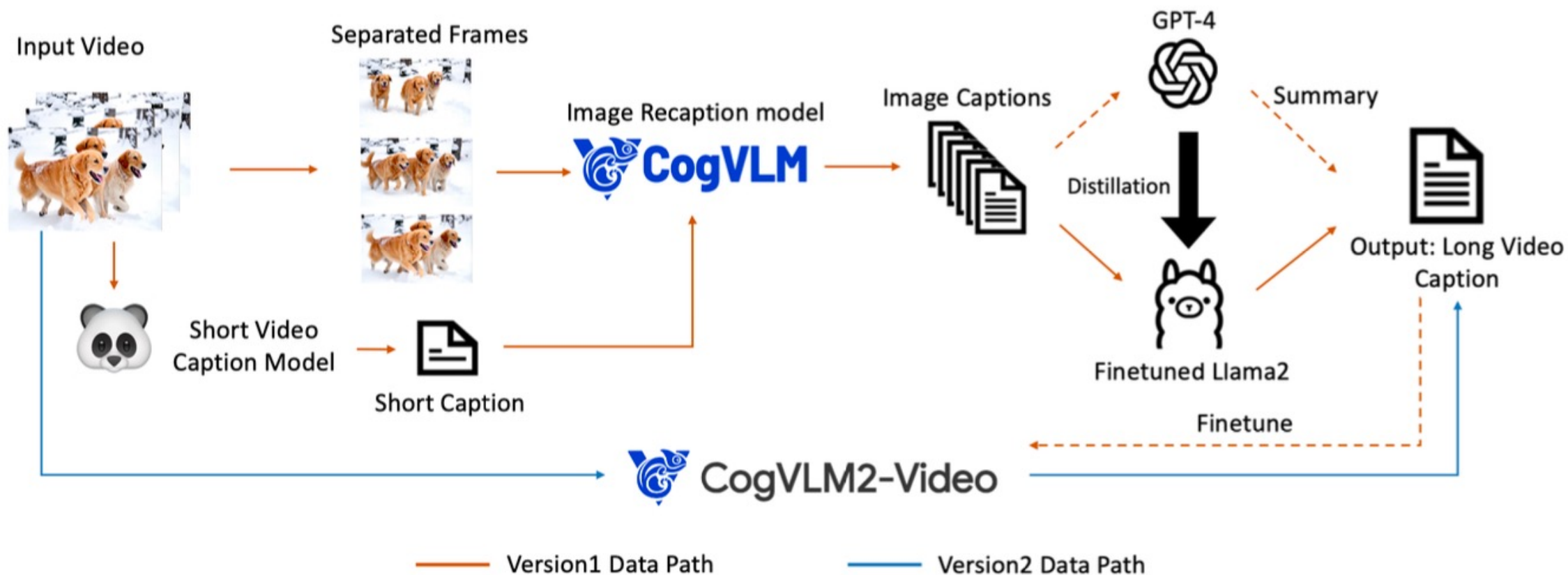
2D VAE



3D VAE



核心流程：data pipeline —— 视频caption



视频caption需要详细描述视频中的内容，开源的视频理解模型视频描述能力较差

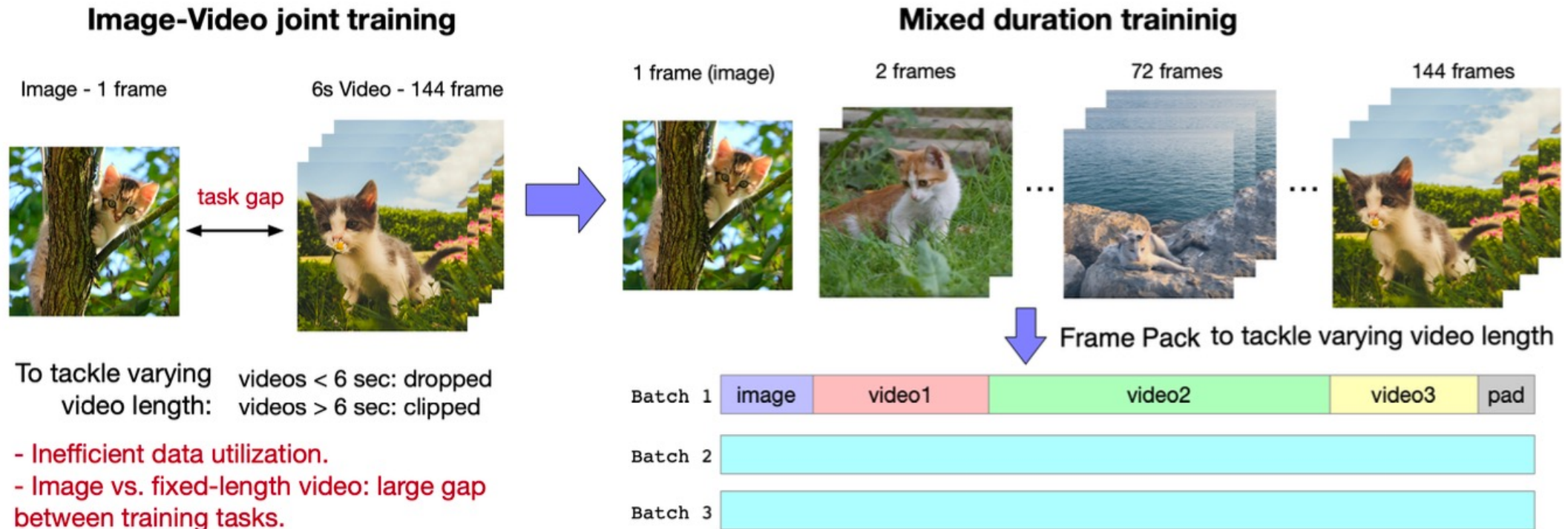
Version1：图像重标注对每帧标注，结合视频caption用大语言模型得到视频描述

Version2：Version 1得到的数据微调CogVLM2-Video，得到一个端到端的视频描述

与训练对应，推理时输入详细的prompt，才能最大限度激发模型能力

训练过程

Frame Pack



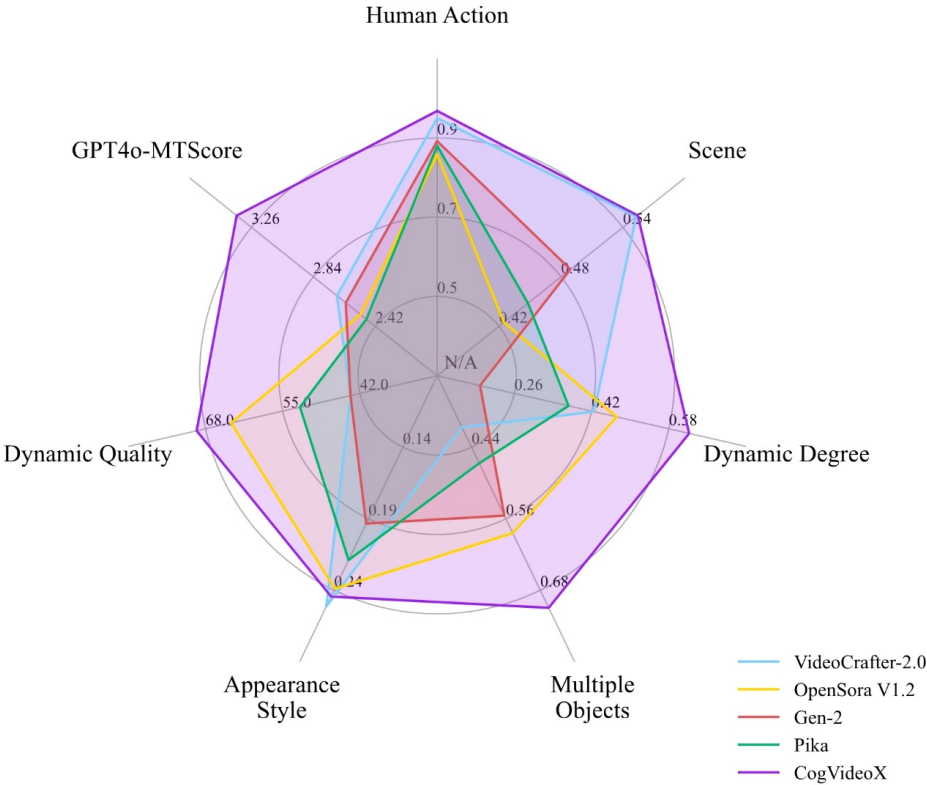
Progressive Training

低分辨率训练 -> 高分辨率训练 -> 高质量高分辨率数据训练

与已有模型比较

人类动作 动态程度 风格匹配 细粒度
场景一致 多对象 动态质量 动态信息

Models	Human Action	Scene	Dynamic Degree	Multiple Objects	Appearance Style	Dynamic Quality	GPT4o-MT Score
T2V-Turbo	95.2	55.58	49.17	54.65	24.42	—	—
AnimateDiff	92.6	50.19	40.83	36.88	22.42	—	2.62
VideoCrafter-2.0	95.0	55.29	42.50	40.66	25.13	43.6	2.68
OpenSora V1.2	85.8	42.47	47.22	58.41	23.89	63.7	2.52
Show-1	95.6	47.03	44.44	45.47	23.06	57.7	—
Gen-2	89.2	48.91	18.89	55.47	19.34	43.6	2.62
Pika	88.0	44.80	37.22	46.69	21.89	52.1	2.48
LaVie-2	96.4	49.59	31.11	64.88	25.09	—	2.46
CogVideoX	96.8	55.44	62.22	70.95	24.44	69.5	3.36



CogVideoX开源

Huggingface

<https://huggingface.co/THUDM/CogVideoX-2b>

魔搭

<https://modelscope.cn/models/ZhipuAI/CogVideoX-2b>

Github

<https://github.com/THUDM/CogVideo>



Experience on [CogVideoX Huggingface Space](#)

Check here to view [Paper](#)

Join our [WeChat](#) and [Discord](#)

Visit [清影](#) and [API Platform](#) to experience larger-scale commercial video generation models.

安装模型(SAT)

首先，前往 SAT 镜像下载

```
mkdir CogVideoX-2b-sat
cd CogVideoX-2b-sat
wget https://cloud.tsinghua.edu.cn/f/fdba7608a49c463ba754/?dl=1
mv 'index.html?dl=1' vae.zip
unzip vae.zip
wget https://cloud.tsinghua.edu.cn/f/556a3e1329e74f1bac45/?dl=1
mv 'index.html?dl=1' transformer.zip
unzip transformer.zip
```

然后，解压文件，模型结构

```
├── transformer
│   ├── 1000
│   │   └── mp_rank_00_model_states.pt
│   └── latest
└── vae
    └── 3d-vae.pt
```

接着，克隆 T5 模型

```
git clone https://huggingface.co/THUDM/CogVideoX_2b.git
mkdir t5-v1 1-xxl
mv CogVideoX-2b/text_encoder/* CogVideoX-2b/tokenizer/* t5-v1 1-xxl
```

关键步骤: 转换提示词

提示词优化

在开始运行模型之前，请参考之前使用GLM-4等同级别大模型对提示词优化的过程，这很重要，由于模型在长提示词下训练的，提示词的好坏直接影响视频生成的质量。

使用脚本

我们提供了 `convert_demo.py` 用于将用户输入的提示词（建议英语）

使用 **Few-shot** 提示词，辅助参考

最终大模型输出更适合 CogVideoX 的提示词

转换提示词的代码：

https://github.com/THUDM/CogVideo/blob/main/inference/convert_demo.py

效果展示



The camera follows behind a white vintage SUV with a black roof rack as it speeds up a steep dirt road surrounded by pine trees on a steep mountain slope, dust kicks up from its tires, the sunlight shines on the SUV as it speeds along the dirt road, casting a warm glow over the scene. The dirt road curves gently into the distance, with no other cars or vehicles in sight. The trees on either side of the road are redwoods, with patches of greenery scattered throughout. The car is seen from the rear following the curve with ease, making it seem as if it is on a rugged drive through the rugged terrain. The dirt road itself is surrounded by steep hills and mountains, with a clear blue sky above with wispy clouds.



In the haunting backdrop of a war-torn city, where ruins and crumbled walls tell a story of devastation, a poignant close-up frames a young girl. Her face is smudged with ash, a silent testament to the chaos around her. Her eyes glistening with a mix of sorrow and resilience, capturing the raw emotion of a world that has lost its innocence to the ravages of conflict.

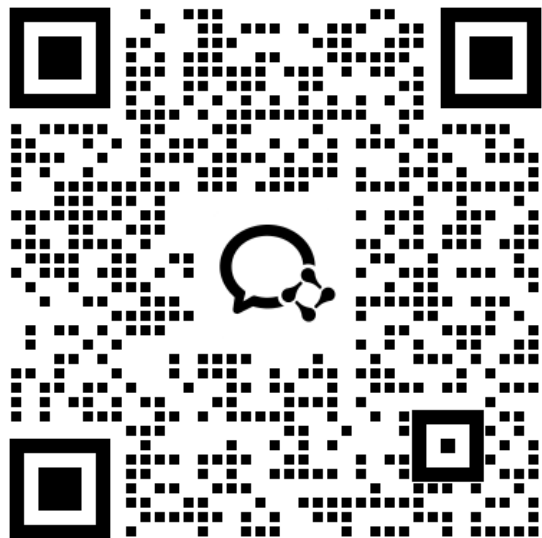
贡献开源

Issue 提到这

<https://github.com/THUDM/CogVideo/issues>

在github 提出issue能更快得到回复～

微信群



#star

40,252

15,668

13,255

8,059

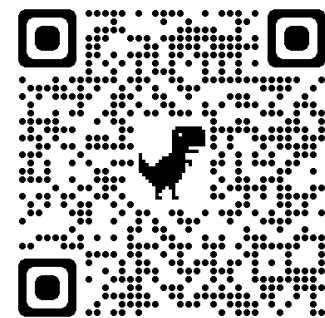
7,648

7,615

5,766

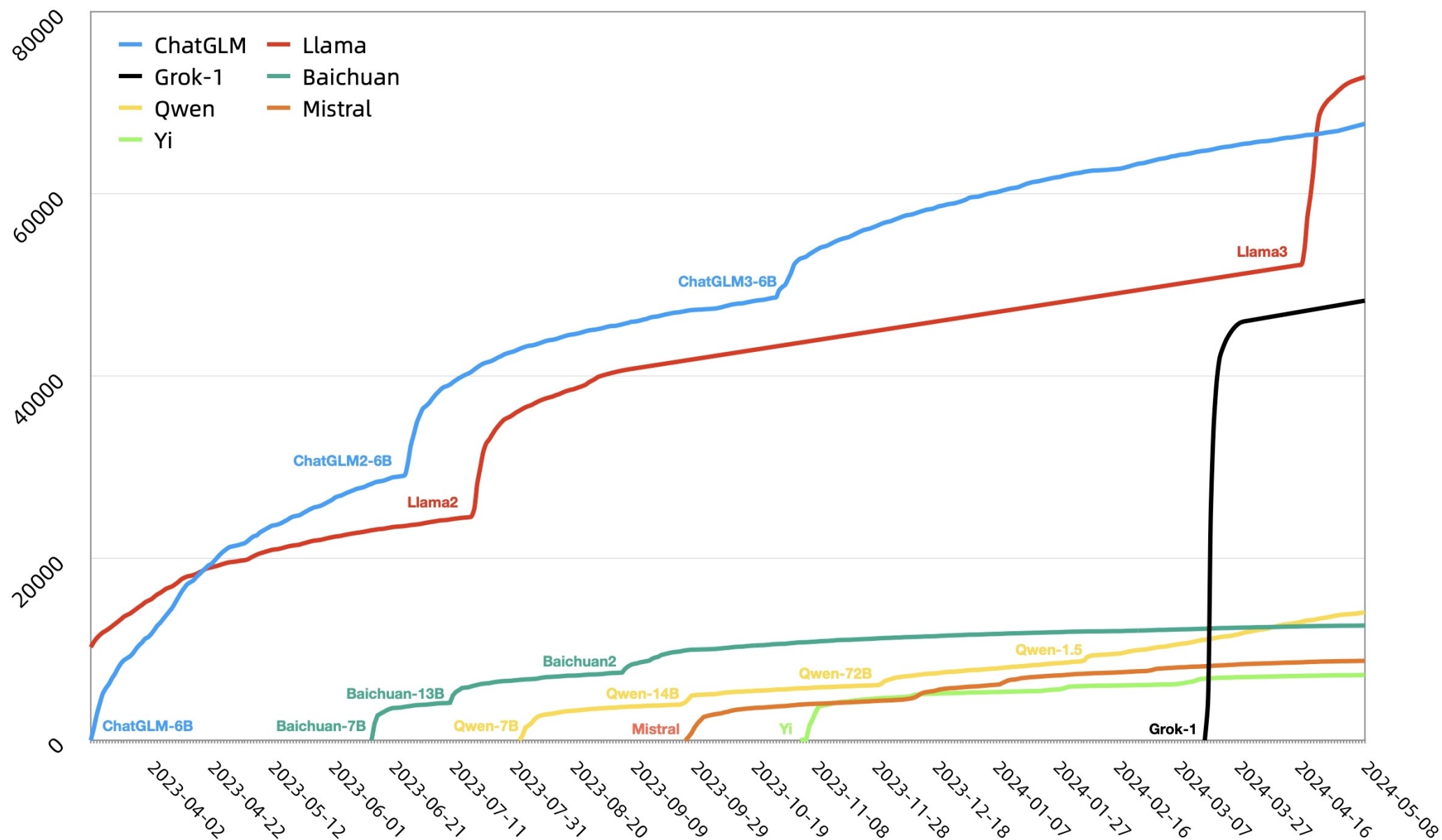
开放的大模型研究

ChatGLM-6B Public	
ChatGLM-6B: An Open Bilingual Dialogue Language Model 开源双语对话语言模型	
● Python ☆ 40,252 📄 Apache-2.0 🗣️ 5,167 ⌚ 545 📌 41 Updated on Jun 27	
ChatGLM2-6B Public	
ChatGLM2-6B: An Open Bilingual Chat LLM 开源双语对话语言模型	
● Python ☆ 15,668 📄 1,849 ⌚ 425 📌 25 Updated on Jun 27	
ChatGLM3 Public	
ChatGLM3 series: Open Bilingual Chat LLMs 开源双语对话语言模型	
● Python ☆ 13,255 📄 Apache-2.0 🗣️ 1,530 ⌚ 21 (1 issue needs help) 📌 0 Updated on Jul 10	
CodeGeeX Public	
CodeGeeX: An Open Multilingual Code Generation Model (KDD 2023)	
● Python ☆ 8,059 📄 Apache-2.0 🗣️ 583 ⌚ 154 📌 7 Updated 3 days ago	
GLM-130B Public	
GLM-130B: An Open Bilingual Pre-Trained Model (ICLR 2023)	
● Python ☆ 7,648 📄 Apache-2.0 🗣️ 607 ⌚ 118 📌 5 Updated on Jul 25, 2023	
CodeGeeX2 Public	
CodeGeeX2: A More Powerful Multilingual Code Generation Model	
● Python ☆ 7,615 📄 Apache-2.0 🗣️ 534 ⌚ 211 📌 2 Updated on Jul 10	
CogVLM Public	
a state-of-the-art-level open visual language model 多模态预训练模型	
● Python ☆ 5,766 📄 Apache-2.0 🗣️ 395 ⌚ 42 (1 issue needs help) 📌 0 Updated on May 29	

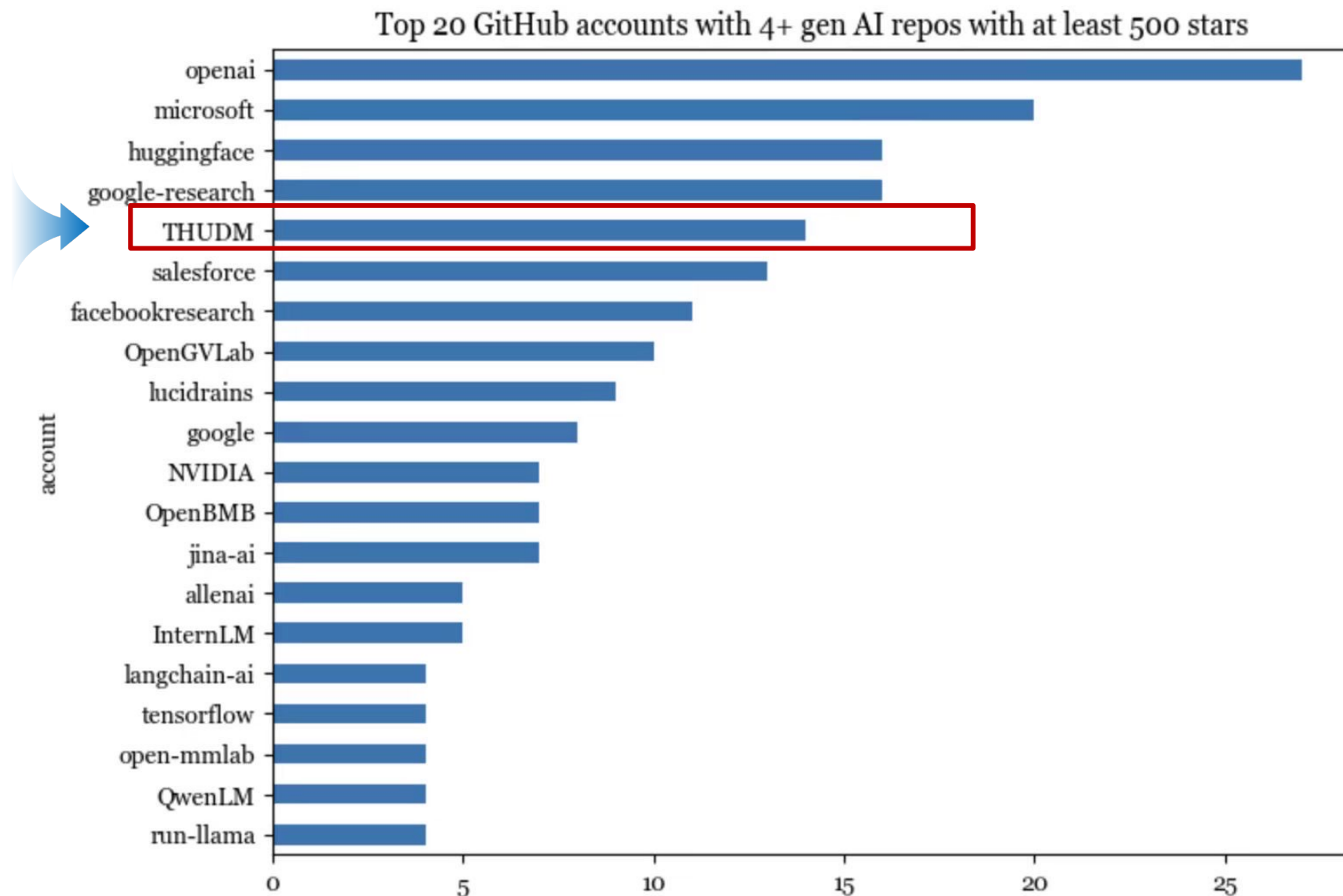


<https://github.com/THUDM>

ChatGLM vs. LLaMA



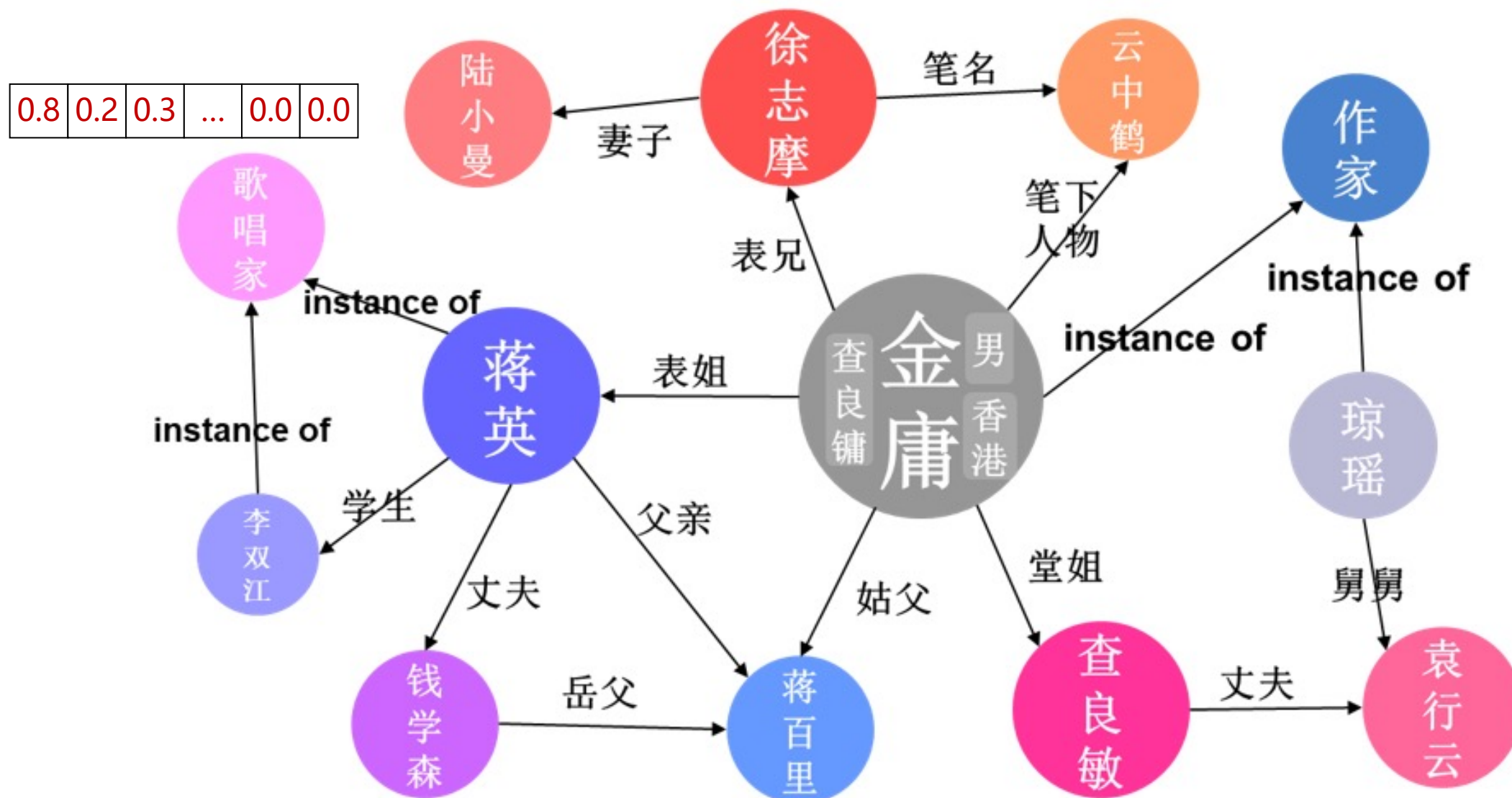
GitHub公布的超过500星的AI项目数排名



大模型的AGI之路

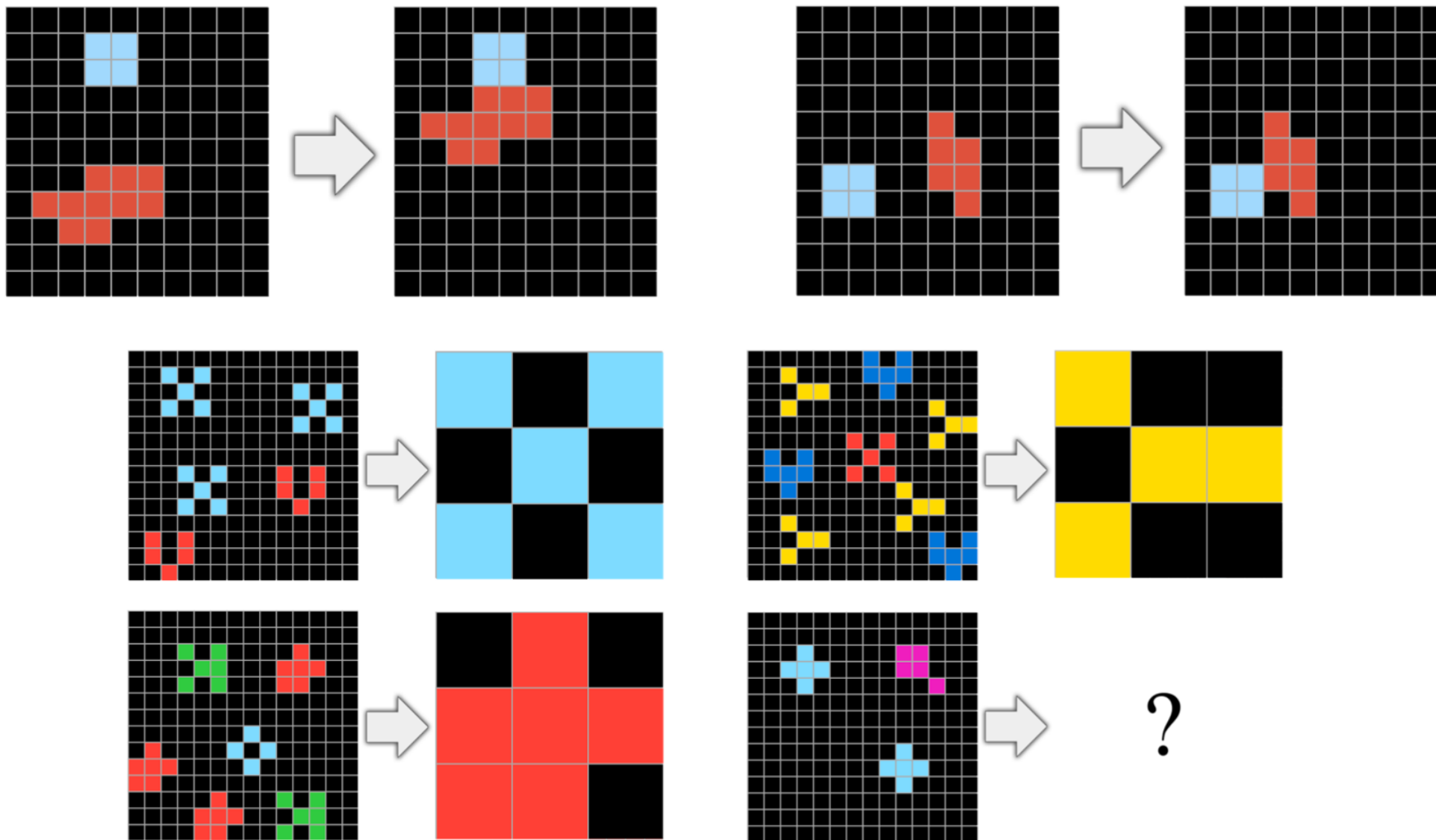
—Toward AGI

世界知识→一阶推理



$$W("China") - W("Beijing") \approx W("Japan") - W("Tokyo")$$

抽象与复杂COT推理



能力涌现

GLM-10B

一斤西瓜10元钱，5斤西瓜多少钱？

一斤西瓜十元，五斤西瓜30元

一斤苹果10元，一斤西瓜5元，那么2斤苹果和3斤西瓜多少钱？

总共30元

我把可口可乐洒在了桌子上，接下来该如何清楚桌面？

把桌上的东西都拿走，用湿抹布擦桌子看，然后喷上酒精，再拿抹布擦,最后用酒精再擦一遍

GLM-130B

一斤西瓜10元钱，5斤西瓜多少钱？

$5 \times 10 = 50(\text{元})$

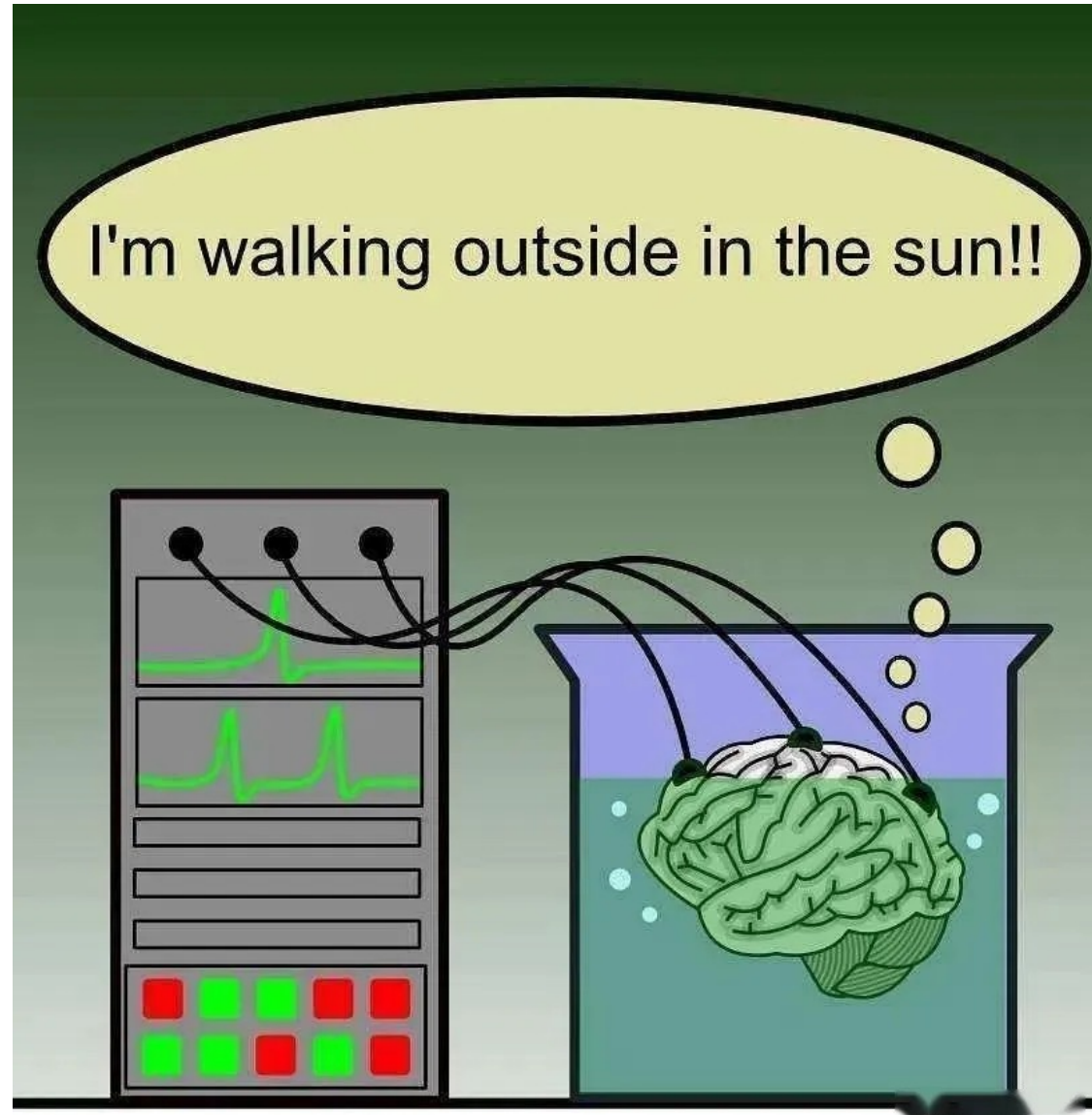
一斤苹果10元，一斤西瓜5元，那么2斤苹果和3斤西瓜多少钱？

$2 \times 10 + 3 \times 5 = 35(\text{元})$

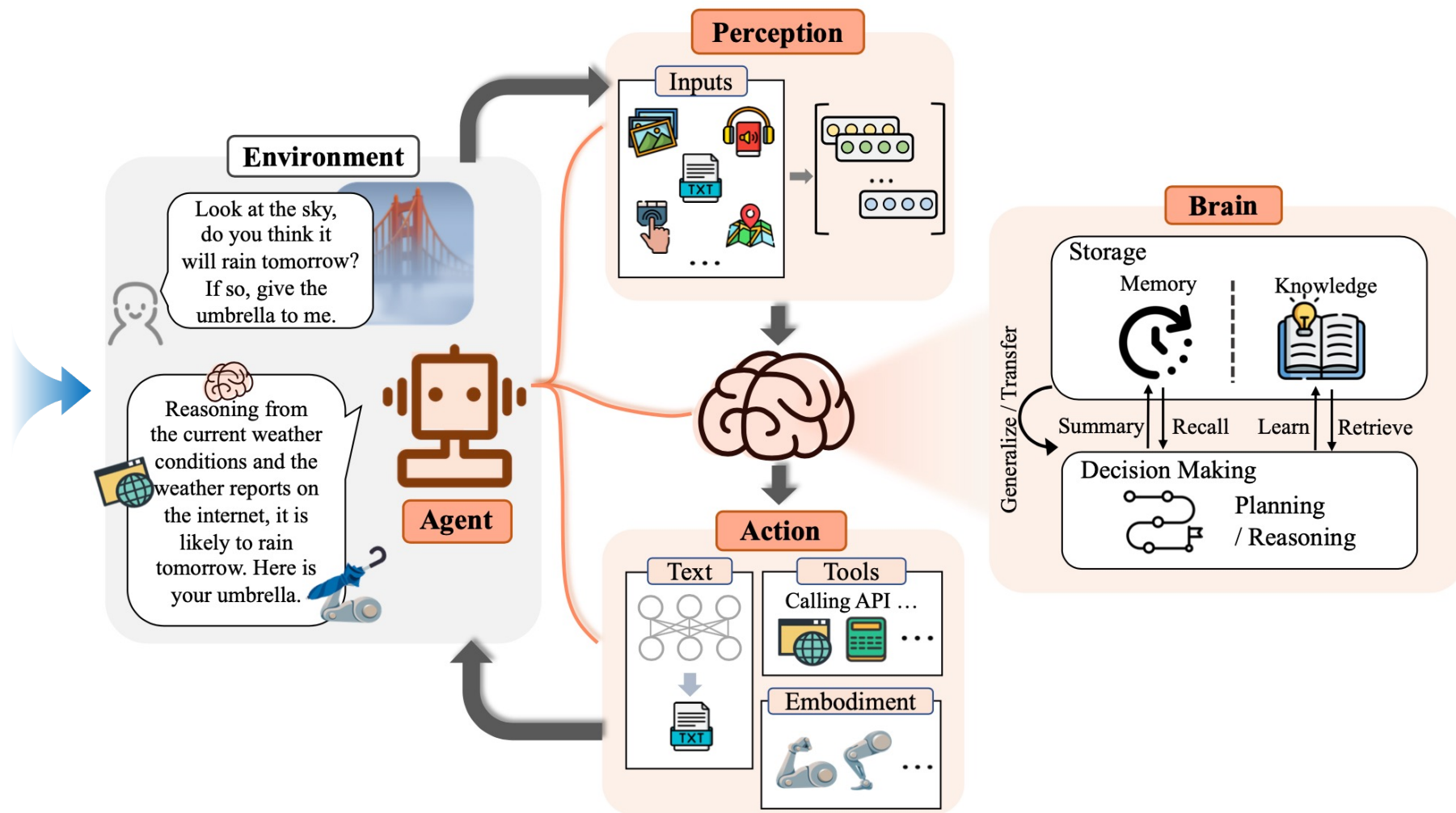
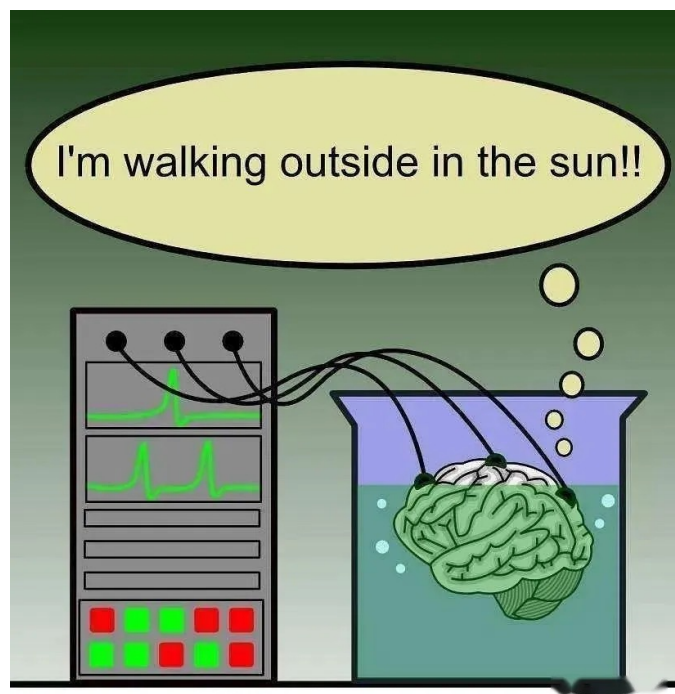
我把可口可乐洒在了桌子上，接下来该如何清楚桌面？

先用抹布擦干净，然后用湿抹布再擦一次，最后用干抹布再擦一次

“思考” 的大模型

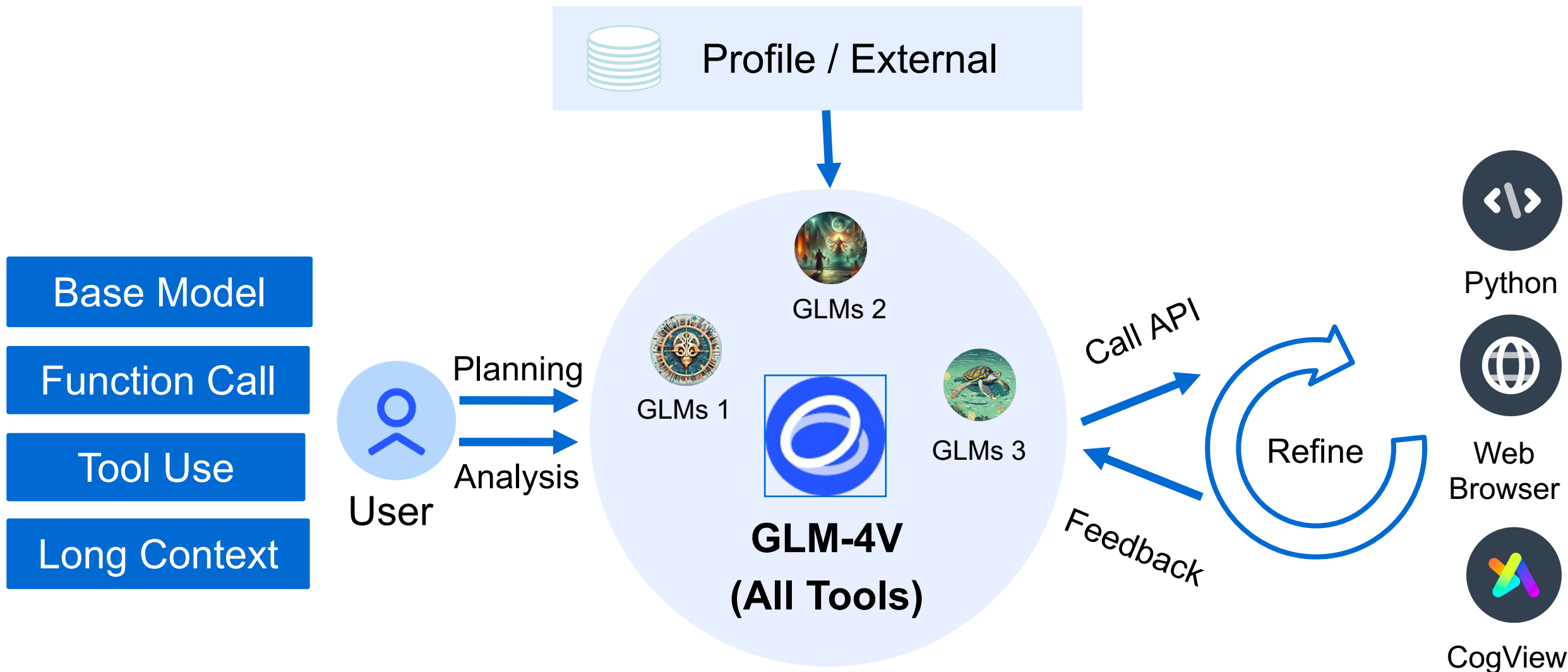


大模型与环境的交互

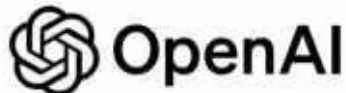


教会大模型使用工具

GLM-4(语言)→ GLM-4V(多模态)→GLM-4V-All Tools(使用工具)



AGI 分级



AI System Level



Level of AGI



AI Safety Level (ASL)

Level 1	Chatbots AI with conversational language 有语言对话能力的 AI	Emerging equal to or somewhat better than an unskilled human 相当于一个不熟练的新人	ASL-2 Present Large Models 当前的大模型
Level 2	Reasoners human-level problem solving 人类水准的问题解决能力	Competent at least 50th percentile of skilled adults 有能力的 - 具备 50% 的成年人的能力	ASL-3 Significantly higher risk 大幅增加灾难性误用风险 或显示出低级别自主能力的系统
Level 3	Agents systems that can take actions 系统可以执行动作	Expert at least 90th percentile of skilled adults 专家级 - 具备 90% 的成年人的能力	
Level 4	Innovators AI that can aid in invention AI 将能自己发明创新	Virtuoso at least 99th percentile of skilled adults 大师级 - 具备 99% 的成年人的能力	ASL-4+ Speculative 推测而已，与现有系统相差太远，可能涉及灾难性误用可能性和自主性的质的升级
Level 5	AI that can do the work of an organization AI 可以融入组织工作 or 自成组织	Superhuman outperforms 100% of humans 超人 - 100% 超越人类的能力	ASL-5 + Doomer 毁灭者

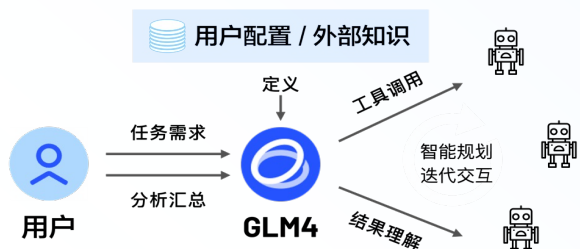


AGI之路

未来通用人工智能AGI之路在哪里？

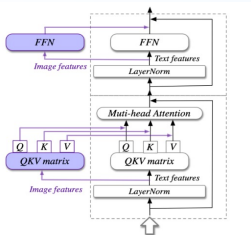
如何实现符合人类价值观的超级对齐（SuperAlignment）？

瞄向AGI的超级智能与超级对齐

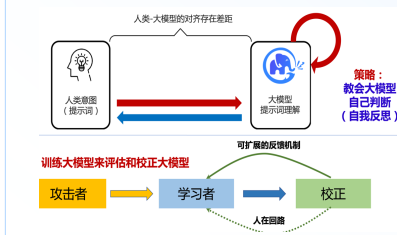


针对复杂任务的AIOS

系统研究

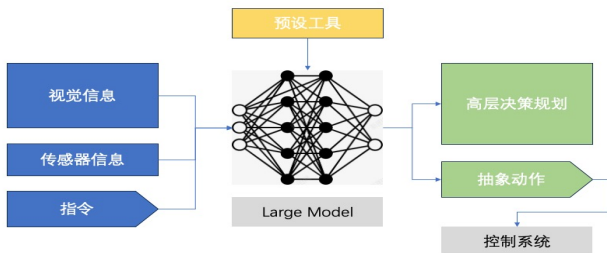


构建原生多模态基座模型，建模世界知识



研究超级对齐，解决超级智能的安全问题

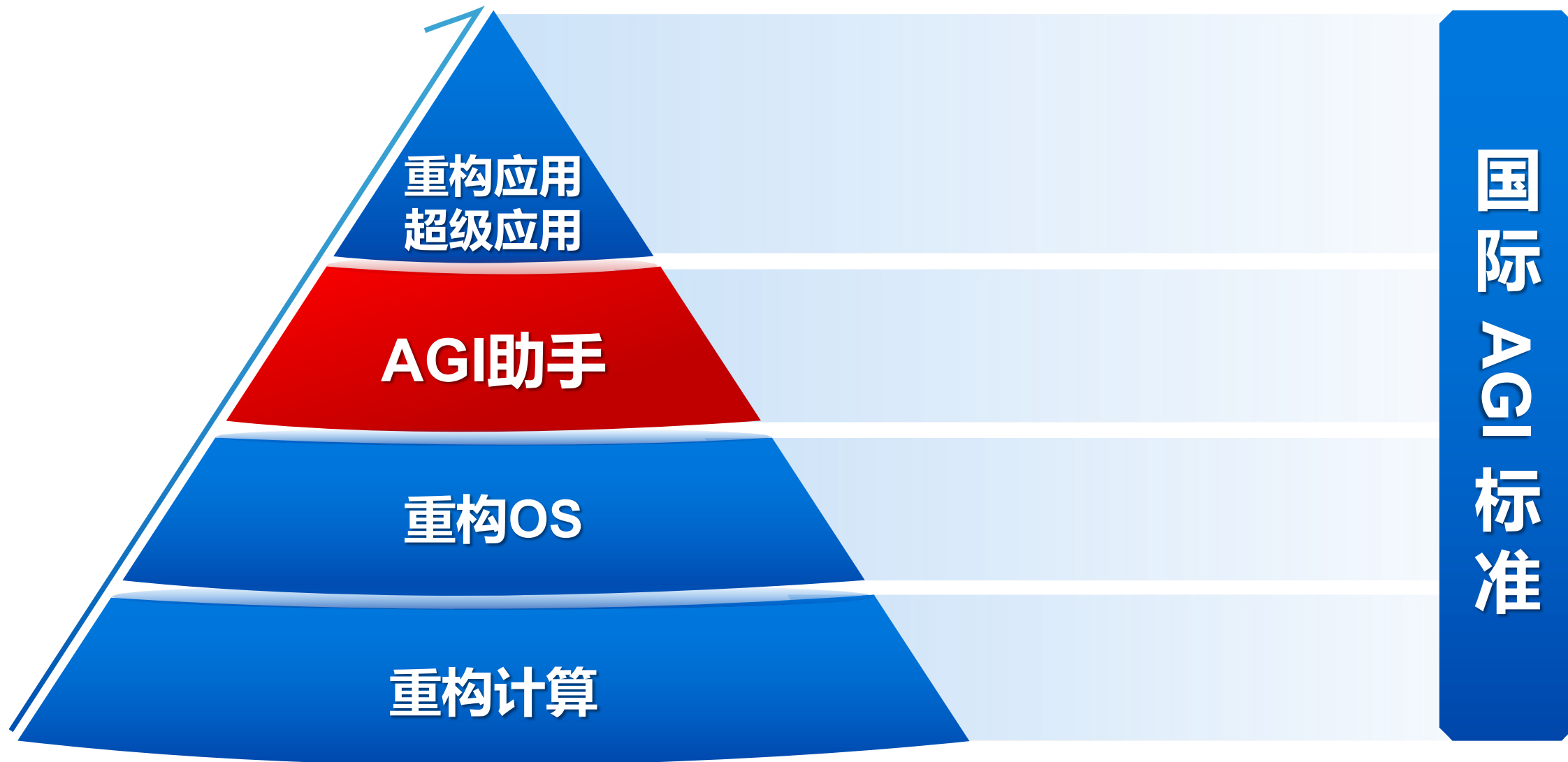
理论研究



国产自研超大规模预训练模型架构GLM

已有基础

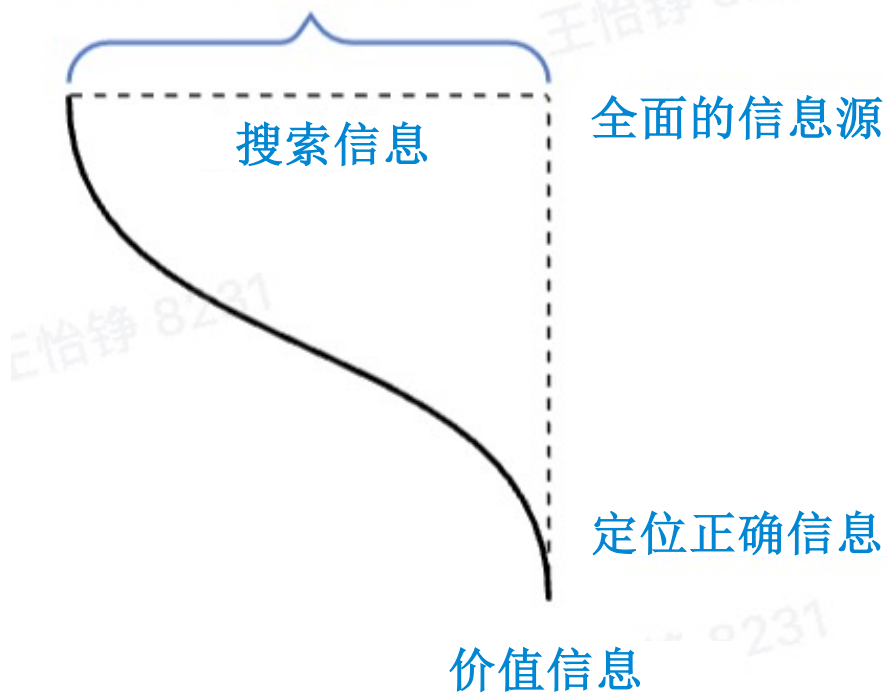
AGI应用栈



搜索的革命

- 精准定位信息、可靠、快速
- 避免幻觉、可追溯

信息价值 = 找到需要的信息

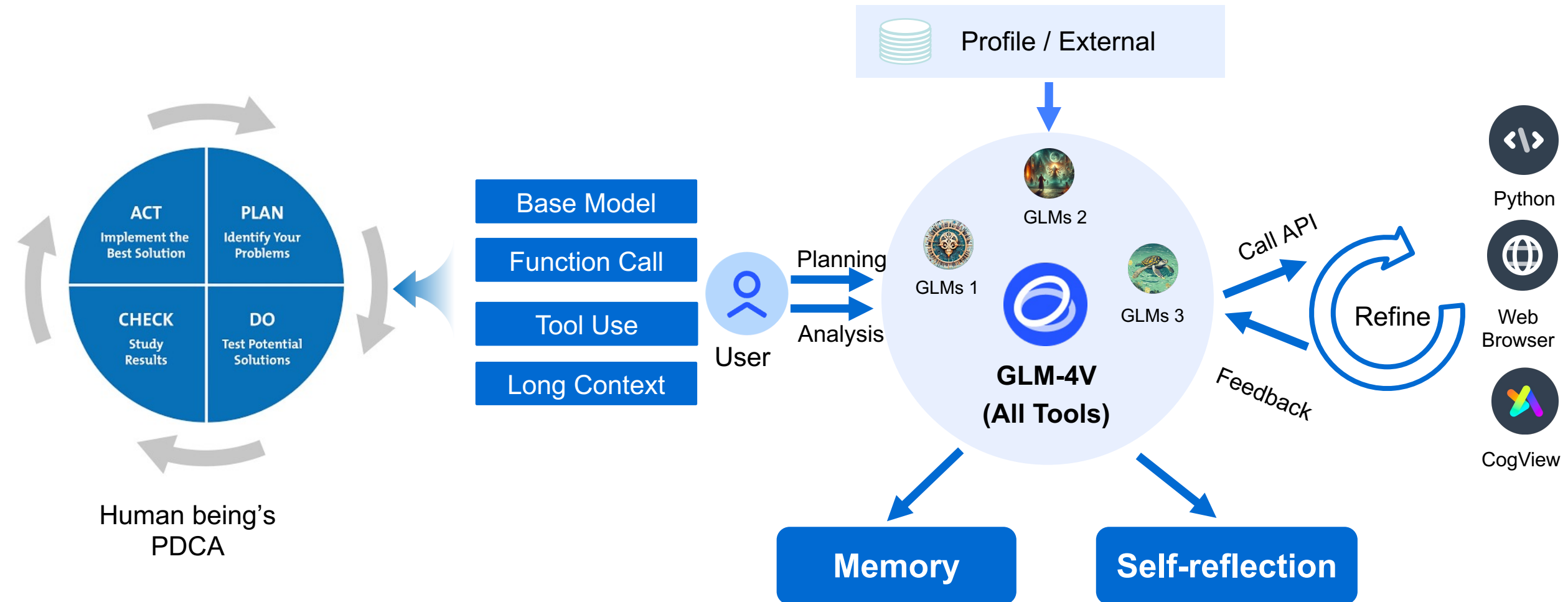


助手的革命



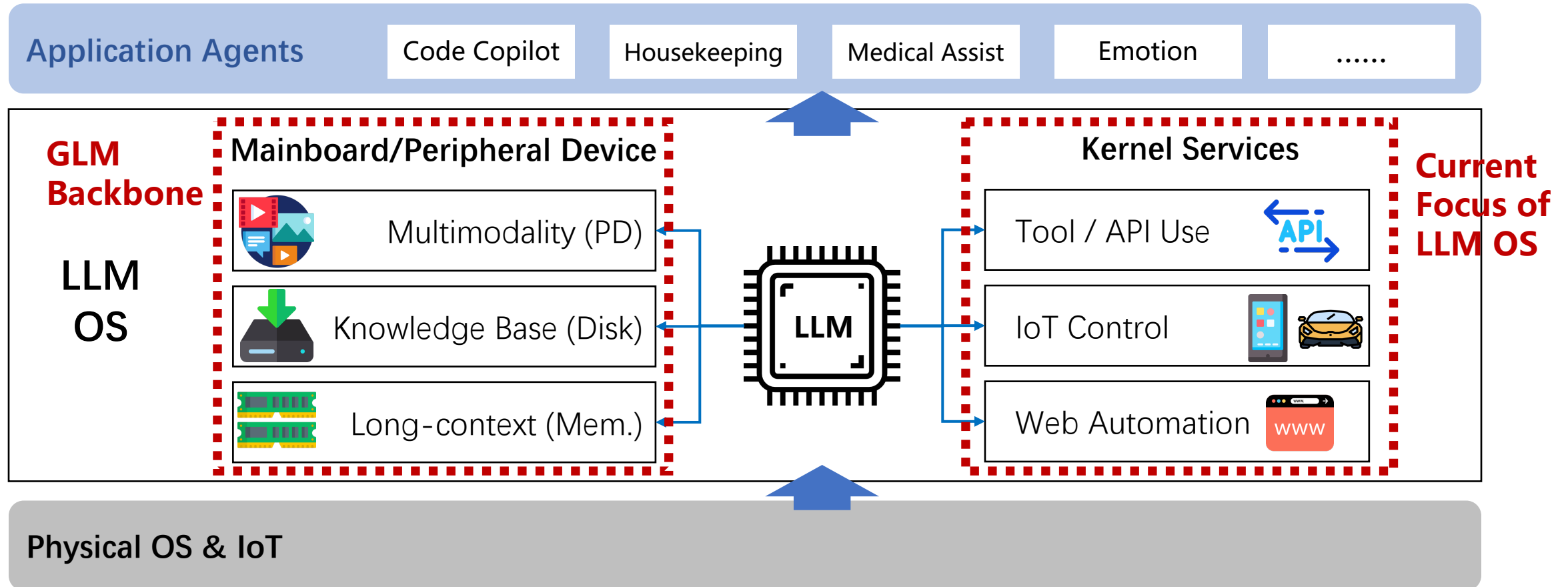
OS的革命

GLM OS: LLM-centric General Computing System



OS的革命

GLM OS: LLM-centric General Computing System



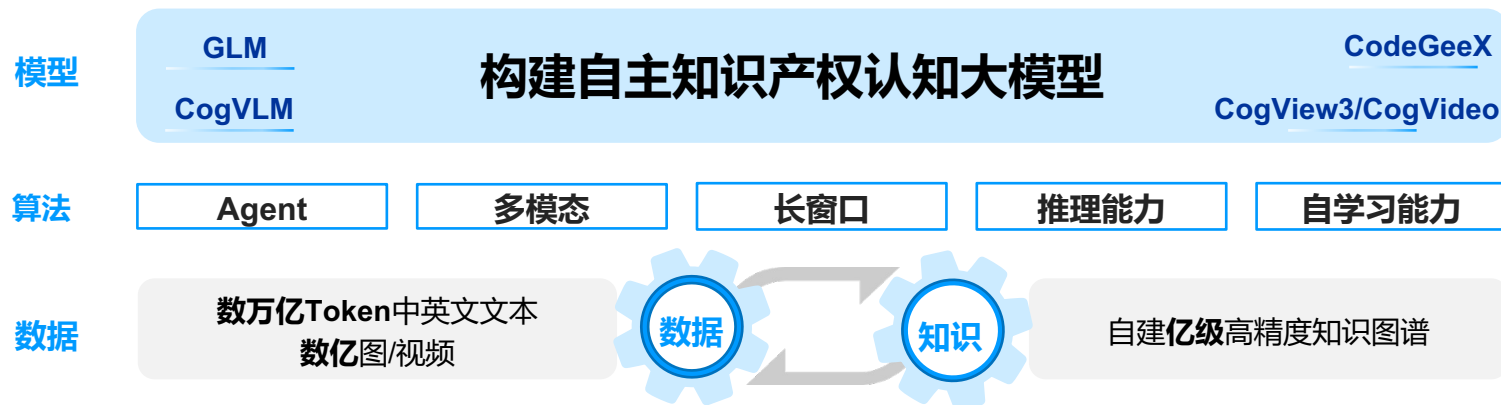
计算的革命—MaaS（模型即产品）

应用



MaaS
模型即
产品

认知大模型



算力

智谱智算平台

大模型软硬结合自研架构

自建算力中心

硬件生态

大模型芯算一体专用芯片

跨平台支持多处理器

2024-AGI元年?

趋 势

用计算模型可描述的认知问题，AI很快超过人类水平

很快=5-20年（2019年）

趋 势

通用问题上，AI通过自我学习，实现GPT到GPT-zero的升级，能力全面超越人类，实现超级智能；**探究科学规律、世界起源等终极问题？**

很快=5-20年（2023年）

相关文献

- Qinkai Zheng, Xiao Xia, Xu Zou, Yuxiao Dong, Shan Wang, Yufei Xue, Lei Shen, Zihan Wang, Andi Wang, Yang Li, Teng Su, Zhilin Yang, and Jie Tang. **CodeGeeX**: A Pre-Trained Model for Code Generation with Multilingual Benchmarking on HumanEval-X. KDD' 23.
- Xiao Liu, Hanyu Lai, Yu Hao, Yifan Xu, Aohan Zeng, Zhengxiao Du, Peng Zhang, Yuxiao Dong, and Jie Tang. **WebGLM**: Towards An Efficient Web-enhanced Question Answering System with Human Preference. KDD' 23.
- Jing Zhang, Xiaokang Zhang, Daniel Zhang-Li, Jifan Yu, Zijun Yao, Zeyao Ma, Yiqi Xu, Haohua Wang, Xiaohan Zhang, Nianyi Lin, Sunrui Lu, Jie Tang, and Juanzi Li. **GLM-Dialog**: Noise-tolerant Pre-Training for Knowledge-grounded Dialogue Generation. KDD' 23.
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- Ming Ding, Wendi Zheng, Wenyi Hong, and Jie Tang. **CogView2**: Faster and Better Text-to-Image Generation via Hierarchical Transformers. NeurIPS' 22.
- Jifan Yu, Xiaohan Zhang, Yifan Xu, Xuanyu Lei, Xinyu Guan, Jing Zhang, Lei Hou, Juanzi Li, and Jie Tang. **XDAI**: A Tuning-free Framework for Exploiting Pre-trained Language Models in Knowledge Grounded Dialogue Generation. KDD' 22.
- Zhengxiao Du, Yujie Qian, Xiao Liu, Ming Ding, Jiezhong Qiu, Zhilin Yang, and Jie Tang. **GLM**: General Language Model Pretraining with Autoregressive Blank Infilling. ACL' 21.
- Zixuan Ma, Jiaao He, Jiezhong Qiu, Huanqi Cao, Yuanwei Wang, Zhenbo Sun, Liyan Zheng, Haojie Wang, Shizhi Tang, Tianyu Zheng, Junyang Lin, Guanyu Feng, Zeqiang Huang, Jie Gao, Aohan Zeng, Jianwei Zhang, Runxin Zhong, Tianhui Shi, Sha Liu, Weimin Zheng, Jie Tang, Hongxia Yang, Xin Liu, Jidong Zhai, and Wenguang Chen. **BAGUALU**: Targeting Brain Scale Pretrained Models with over 37 Million Cores. PPOPP' 22.
- Ming Ding, Zhuoyi Yang, Wenyi Hong, Wendi Zheng, Chang Zhou, Da Yin, Junyang Lin, Xu Zou, Zhou Shao, Hongxia Yang, and Jie Tang. **CogView**: Mastering Text-to-Image Generation via Transformers. NeurIPS' 21.

致谢

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(GLM-130B)

ChatGLM 训练：智谱AI