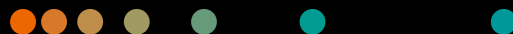


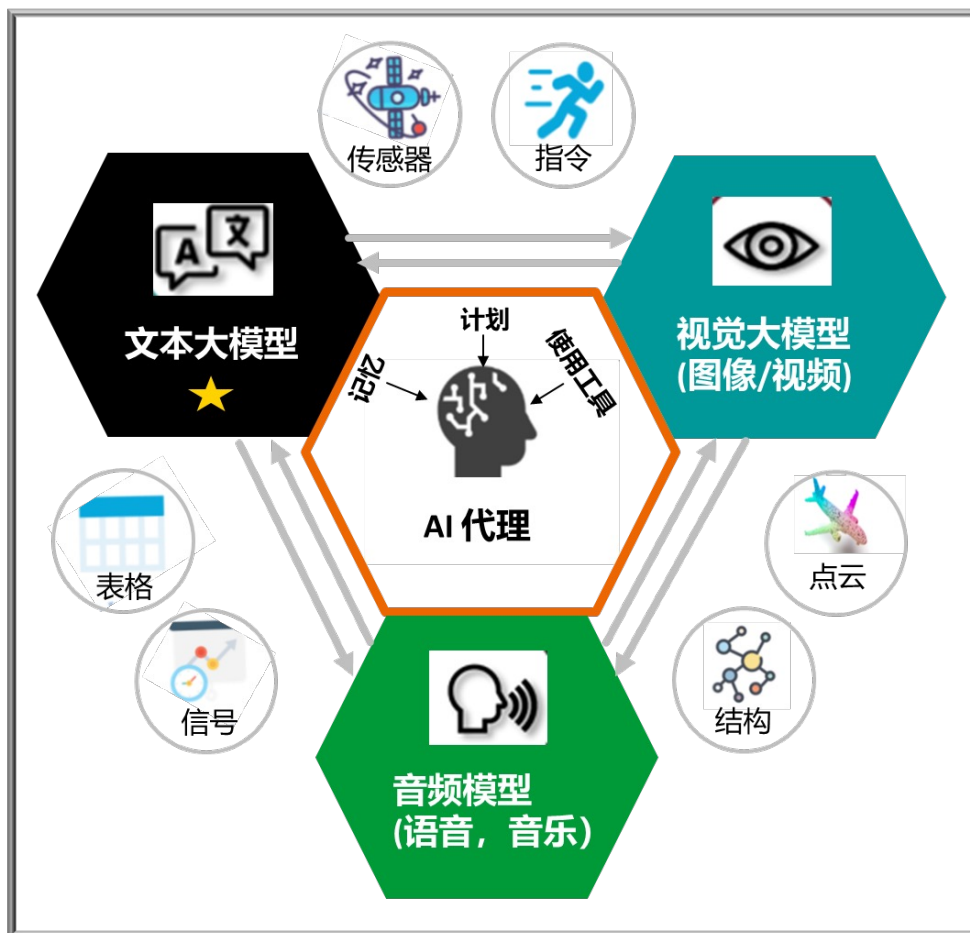
人工智能大模型

在医疗价值链上的应用场景和实践

2024/11/19
Yubo Ji



AI大模型概览



01 大语言模型 (LLM)

02 视觉大模型 (VLM)

03 语言视觉大模型 (VLLM)

04 多模态大模型 (Diffusion-related)

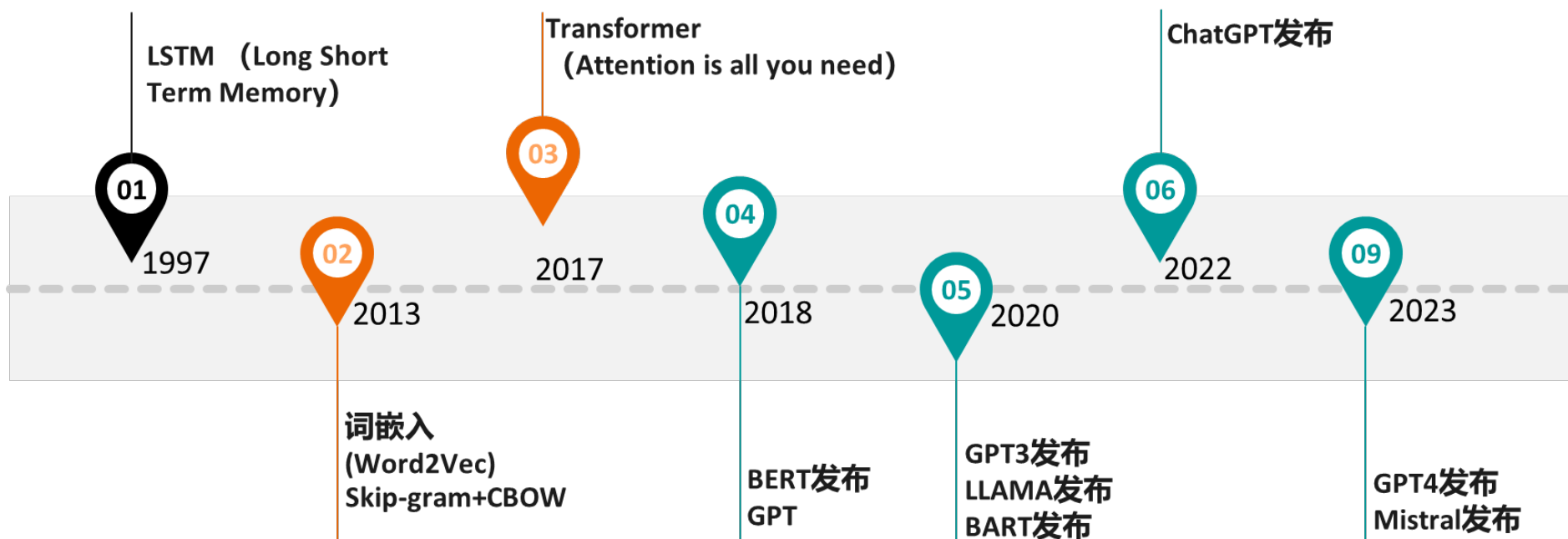
05 展望

Topic 1

大语言模型 LLM

LLM的发展之路

里程碑



国产语言大模型

国外语言大模型

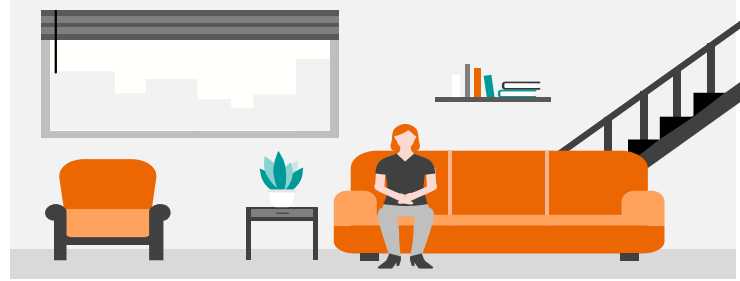
开源闭源混合	仅开源	仅闭源
<ul style="list-style-type: none"> 百川大模型 BAICHUAN DeepSeek GLM系列模型 moonshot Qwen Skywork 科大讯飞 星火 	<ul style="list-style-type: none"> 元象大模型 开源模型 	<ul style="list-style-type: none"> 商汤 sensetime 日日新 Baidu 百度 文心

开源闭源混合	仅开源	仅闭源
<ul style="list-style-type: none"> MISTRAL AI_ 8*22B Google Gemma 	<ul style="list-style-type: none"> Meta LLAMA 3 Grok-1 databricks DBRX 	<ul style="list-style-type: none"> Claude 3 Opus GPT 4 TURBO

LLM在医疗领域的使用场景

面向患者

患者助手



智能预问诊

预诊断常见疾病
症状评估

智能导诊/导医

就医指引
就诊服务

(体检) 报告解读
疾病描述

实验室结果解读

健康生活智慧管家

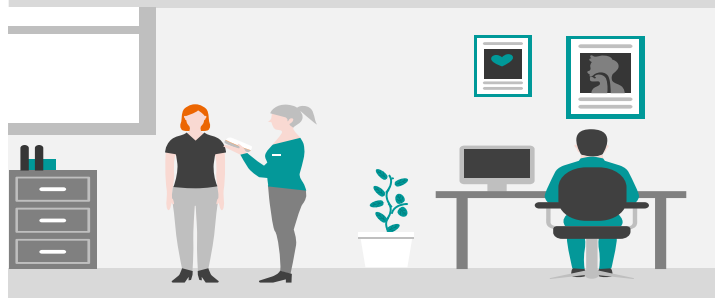
中医诊疗

健康风险预测

用药咨询与指导
洞悉药物相互作用

面向医生

医生助手



临床文档生成
(如电子病例,
临床笔记, EHR)

出院小结生成

获取临床洞见,
辅助诊断

辅助生成
检查建议和计划

报告规范化,
术语归一化

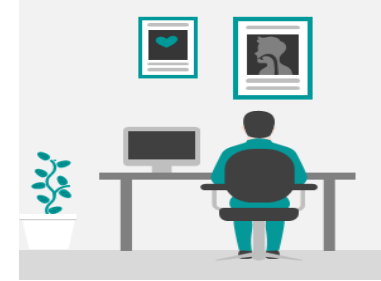
相似病例查询

智能随访

辅助生成
治疗建议和计划

面向科研

科研转化助手



医学文献/指南解读

科研方向预测

报告匿名化/结构化

代码辅助生成

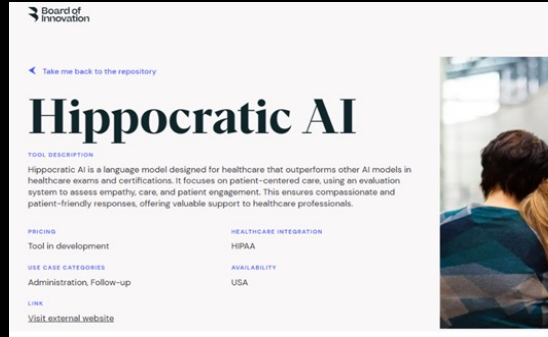
临床科普文生成

赋能临床试验

纯文本大模型在医疗中的产品



Microsoft + Nuance



Hippocratic AI



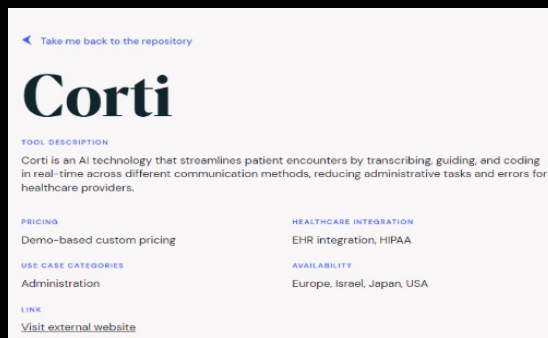
大医 (商汤)

工具与平台	EasyDL-大模型 零门槛AI开发平台	大模型轻量化
文心大模型	NLP大模型	CV大模型
领域/任务	医疗 ERNIE-Health 金融 ERNIE-Finance 对话 PLATO 信息抽取 ERNIE-IE	OCR结构化 VIMER-StrucTex
基础通用	跨语言 ERNIE-M 语言理解与生成 ERNIE 3.0	图像 VIMER-Image

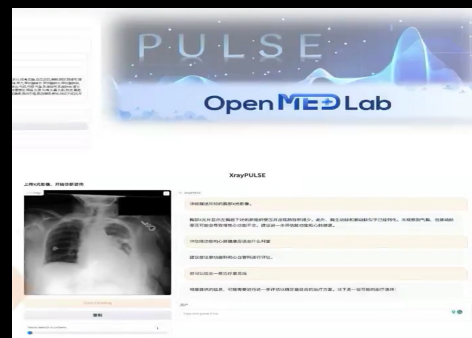
百度文心 - Ernie Health



三星 healthGPT HARMAN



Corti



上海人工智能实验室
OpenMEDLab浦医



科大讯飞-星火大模型

西门子医疗LLM实例1 – 自然语言报告 → 结构化报告

Original Report

Generate

Age : 70Y
MDCT SCAN OF ABDOMEN Multislice helical axial sections & multiplanar reformatted images of Abdomen were studied before & after administration of intravenous contrast media. Oral contrast was not given. Distended thick walled Appendix is seen posteromedial to the caecum in the right iliac fossa (13mm maximal diameter; 7cm length). No fecolith is seen. Severe oedema is seen in the periappendiceal fat planes. No extraluminal air pocket or fluid collection is seen. A calculus is seen in the distal right ureter close to the distended appendix (size 6mm; located about 8cm proximal to the uretero-vesical junction) with periureteral oedema. Distally, the right ureter shows normal caliber. Both Kidneys are in normal location and are normal in size with normal parenchymal thickness. Normal parenchymal contrast enhancement and excretion are seen. Perirenal space is normal. Minimal calyceal dilatation is seen in the right kidney. No calyceal calculus is seen. Proximal and mid segments of the right ureter are mildly dilated. No calyceal dilatation is seen in the left kidney. Small calculus (4mm) is seen in the lower calyx. Left ureter shows normal caliber throughout its course. No

Synoptic Report Generation

Highlighted Facts

Age : 70Y MDCT SCAN OF ABDOMEN Multislice helical axial sections & multiplanar reformatted images of Abdomen were studied before & after administration of intravenous contrast media. Oral contrast was not given.

Distended thick walled Appendix is seen posteromedial to the caecum in the right iliac fossa (13mm maximal diameter; 7cm length)

No fecolith is seen

Severe oedema is seen in the periappendiceal fat planes.

No extraluminal air pocket or fluid collection is seen

A calculus is seen in the distal right ureter close to the distended appendix (size 6mm; located about 8cm proximal to the uretero-vesical junction) with periureteral oedema

Distally, the right ureter shows normal caliber. Both Kidneys are in normal location and are normal in size with normal parenchymal thickness. Normal parenchymal contrast enhancement and excretion are seen. Perirenal space is normal. Minimal calyceal dilatation is seen in the right kidney. No calyceal calculus is seen. Proximal and mid segments of the right ureter are mildly dilated. No calyceal dilatation is seen in the left kidney. Small calculus (4mm) is seen in the lower calyx. Left ureter shows normal caliber throughout its course. No calculus is seen. Urinary bladder is empty. Prostate is mildly enlarged (volume 28cc). Seminal vesicles are normal.

Small amount of intraperitoneal free fluid is seen in the perisplenic region and the iliac fossae on both sides

Diffuse mesenteric oedema is seen. No significant mesenteric lymph nodal enlargement is seen. Mesenteric blood vessels are normal. Stomach is collapsed. All parts of the Duodenum are normal. Jejunal loops show

Synoptic Report

RDES26_Acute Appendicitis

RDE195_Presence

Value-RDE195.2_nonruptured

Source Text-Acute Appendicitis. Distended, thick walled Appendix located posteromedial to the caecum in the right iliac fossa

RDE196_Appendiceal diameter

Value-13.0

Source Text-Distended thick walled Appendix is seen posteromedial to the caecum in the right iliac fossa (13mm maximal diameter; 7cm length)

RDE197_Fat stranding

Value-RDE197.1_present

Source Text-Severe oedema is seen in the periappendiceal fat planes.

RDE198_Free fluid

Value-RDE198.2_absent

Source Text-No extraluminal air pocket or fluid collection is seen

11
Restricted © Siemens Healthineers, 2023

在右侧髂窝内，盲肠的后内侧可见扩张的厚壁阑尾（最大直径13毫米；长度7厘米）。

西门子医疗LLM实例2 – 自动扫描协议生成 -> 质控/提速

Recommend a 10 minutes MRI protocol as list of contrasts.

A 10-minute MRI protocol for this patient might include the following sequences:

1. **Axial T2-weighted (T2W) fast spin-echo (FSE) or turbo spin-echo (TSE):** This is a key sequence to detect any abnormalities in the brain parenchyma and offers good contrast between gray and white matter.
2. **Axial T2 fluid-attenuated inversion recovery (FLAIR):** The FLAIR sequence aids in detecting demyelinating or inflammatory lesions, small ischemic areas, or high signal intensity areas that may be missed in a T2W sequence.
3. **Axial T1-weighted (T1W) spin-echo (SE):** This sequence captures the detailed anatomy of the brain and can detect potential lesions associated with the patient's symptoms. As the requested protocol is limited to 10 minutes, it may not be feasible to include contrast administration.
4. **DWI (Diffusion-weighted imaging):** This sequence can provide information about early ischemic events, as well as other lesions with restricted diffusion (such as abscesses, tumors).
5. **ADC (Apparent Diffusion Coefficient) map:** The ADC map should be included when acquiring DWI sequences to help differentiate true restricted diffusion from T2 shine-through.

Provide scan parameters for a MPRage for this usecase. Output as JSON.

```
Json
{ "sequence_name": "MP-RAGE",
  "sequence_type": "3D T1-weighted",
  "image_orientation": "sagittal",
  "repetition_time_ms": 1900,
  "echo_time_ms": 2.48,
  "inversion_time_ms": 900,
  "flip_angle_degrees": 9,
  "resolution": { "pixel_spacing_xy_mm": [0.977, 0.977],
  "slice_thickness_mm": 1.0 },
  "matrix_size": { "frequency_encoding_direction": 256, "phase_encoding_direction": 256, "partition_encoding_direction": 176 },
  "acceleration_factor": 1,
  "sequence_duration_min": "Approximately 5 minutes (depending on desired resolution and field of view),"
}
```


Topic 2

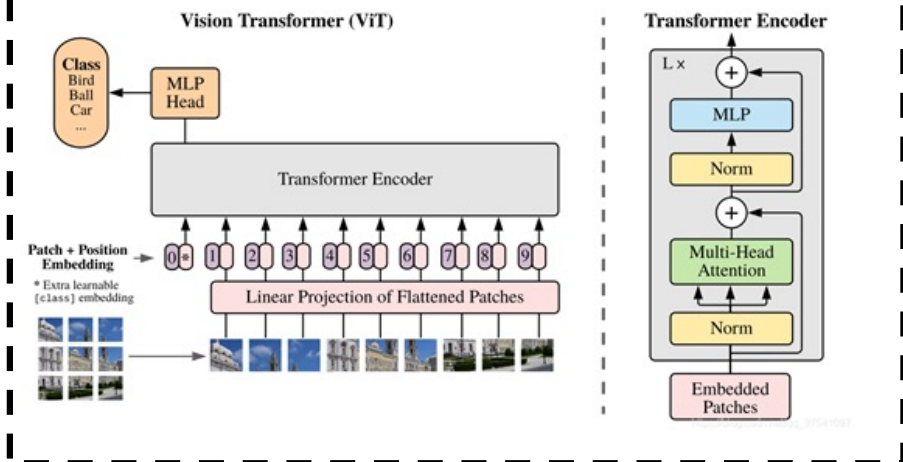
视觉大模型 VLM

VLM的发展之路 (密集预测类任务)

视觉大模型技术路线

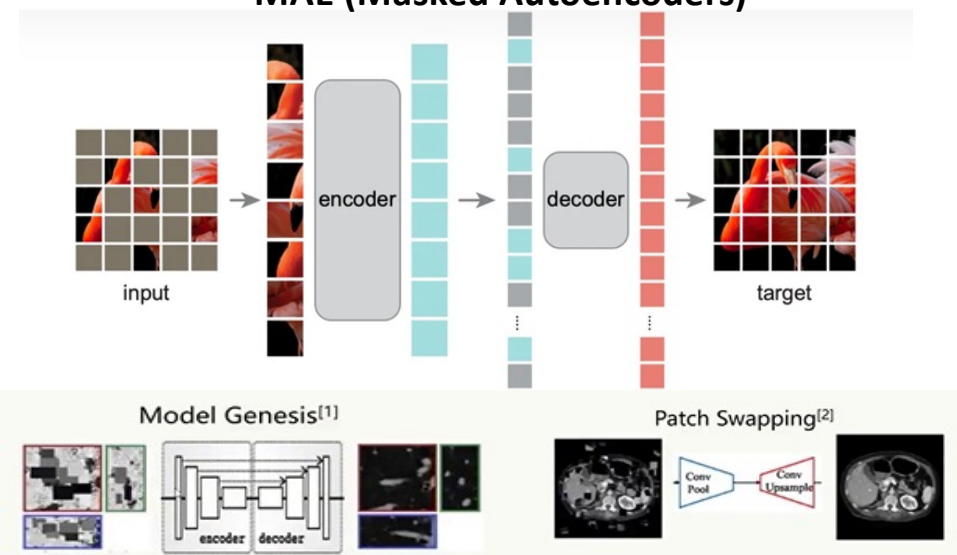


Compared with CNN, ViT is a more universal architecture

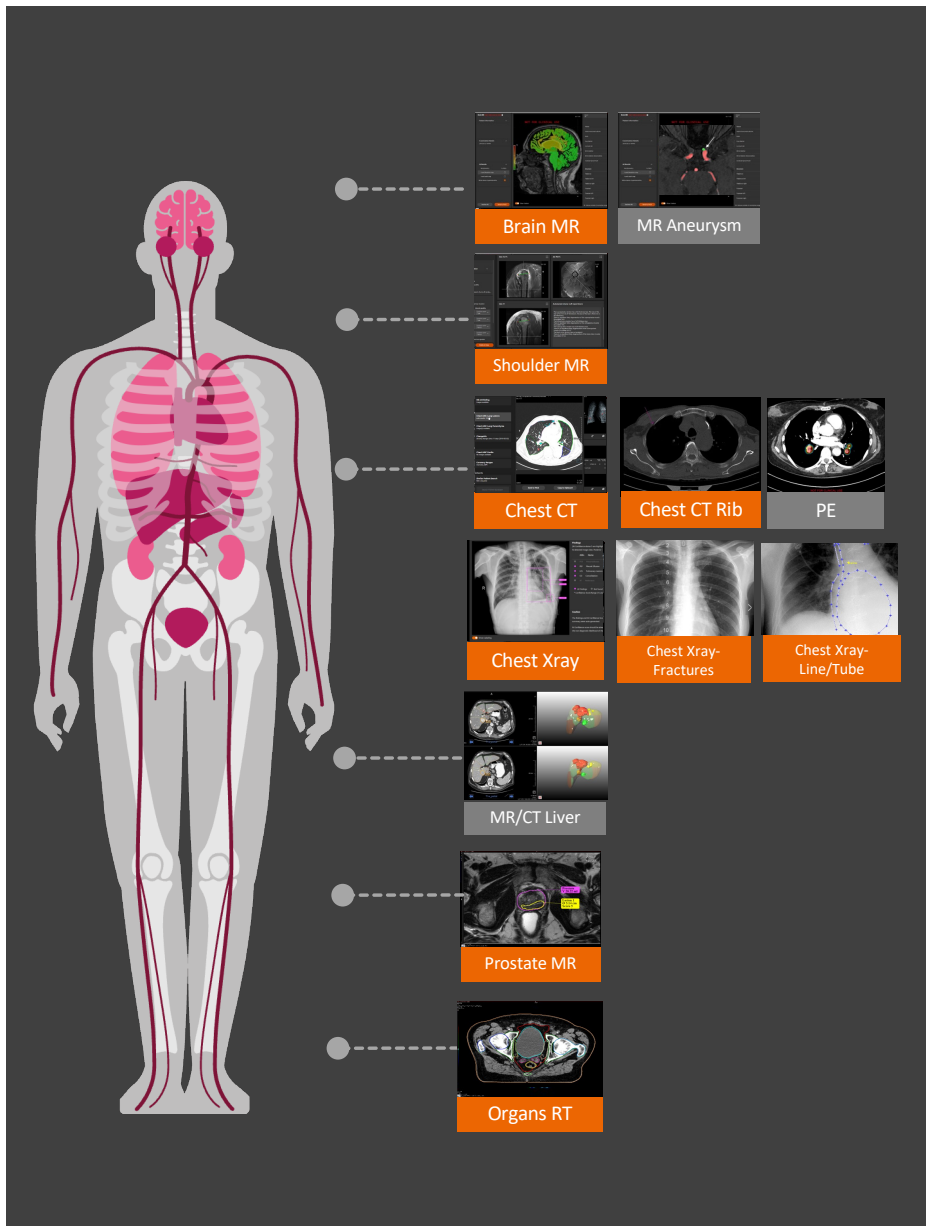


Prove ViT architecture can perform well in Dense Prediction tasks

MAE (Masked Autoencoders)



AIRC Frontier Research Platform 西门子医疗锐眼科研平台

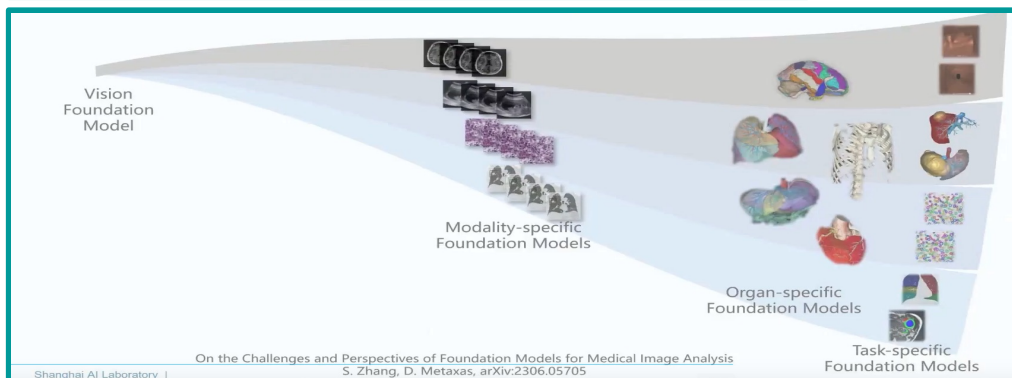


- **Brain MR**
Detection and quantification of volumetric changes in the brain for morphometry analysis/脑区体积形态学分析及脑白质高信号识别
- **Shoulder MR**
Automated assessment of the rotator cuff/肩袖撕裂检测分析及肌肉退行性程度评估
- **Chest CT**
Assist in evaluating the Lung, heart, aorta and spine in chest CT/基于平扫CT的肺部、心脏、主动脉、脊柱自动化评估
- **Chest CT Rib Fracture Detection**
Detection and provide location of rib fractures/基于CT的肋骨骨折检出及定位
- **Chest X-ray**
Localization and characterization of findings on upright chest posterior anterior images/基于X-ray的胸部疾病（占位性病变、实变、肺不张、胸腔积液、气胸）定位及分析
- **Chest X-ray Bone Fracture Detection**
Highlight visible rib and clavicle fractures/基于X-ray的肋骨、锁骨骨折检出及定位
- **Chest X-ray Lines & Tubes**
Automated assessment the positioning of central venous catheters and tubes/快速定位胸片图像中为维持生命目的插入的设备及并发症
- **Prostate MR**
Automated segmentation of the prostate gland and lesions for biopsy planning/前列腺轮廓定位及病灶自动检出，助力前列腺穿刺活检
- **Organs RT**
High-quality contouring of target lesions and organs at risk/自动化放疗危及器官轮廓勾画
- **MR Aneurysm**
Automatic detection of potential aneurysm/动脉瘤自动化检出
- **CT Pulmonary Embolism**
Automated detection of the mass filling defects on CTPA images/肺栓塞自动检出及定位
- **MR/CT Liver**
Automated assessment and segmentation of focal liver lesions on CT and MR images/肝段分割及体积分析、原发性肝脏病灶自动检出及定位

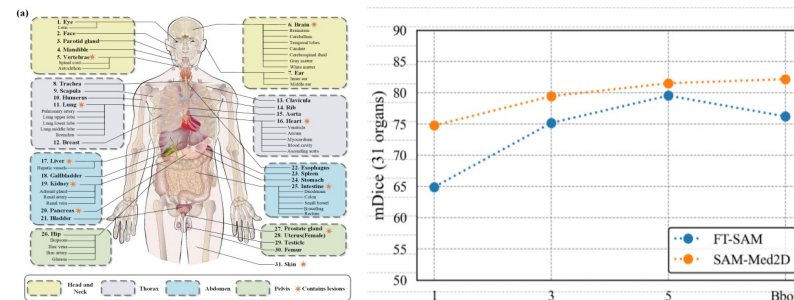


VLM 医学领域的应用

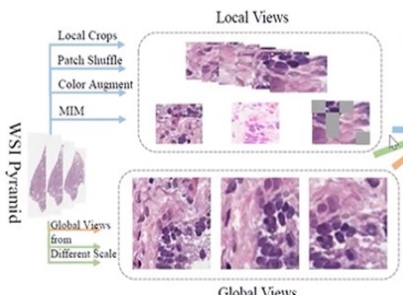
医学影像分析图谱



SAM-Med2D (Finetuned SAM in 4.6M medical images and 19.7M masks)

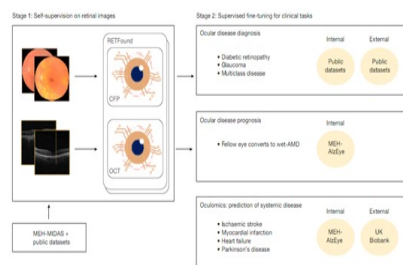


病理大模型



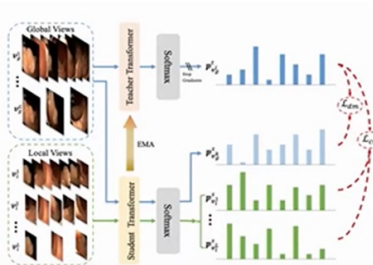
<https://arxiv.org/pdf/2309.07778.pdf>

眼科大模型



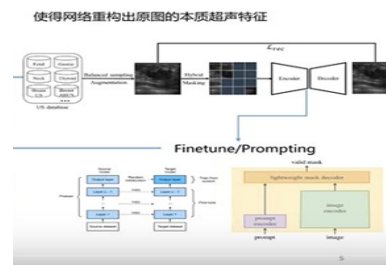
https://www.researchgate.net/publication/373901629_A_foundation_model_for_generalizable_disease_detection_from_retinal_images

内窥镜大模型



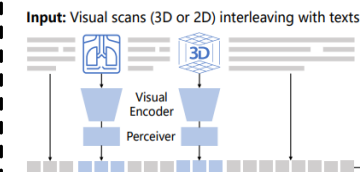
<https://arxiv.org/pdf/2306.16741.pdf>

超声大模型



Ultrasound Foundation Modelling and Its Clinical Applications

2D/3D RadFM

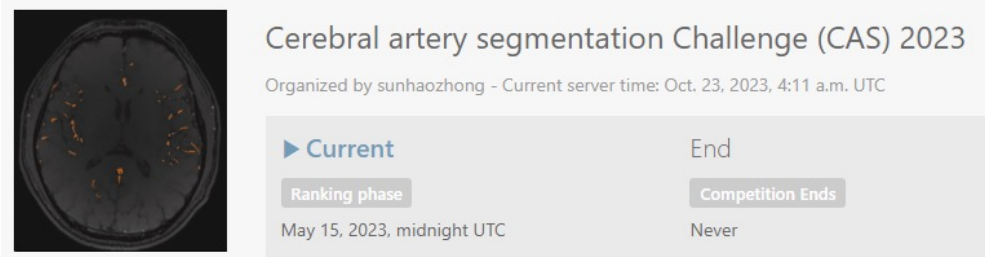
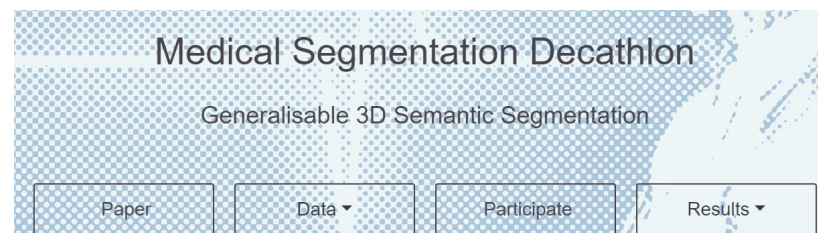


Towards Generalist Foundation Model for Radiology by Leveraging Web-scale 2D&3D Medical Data

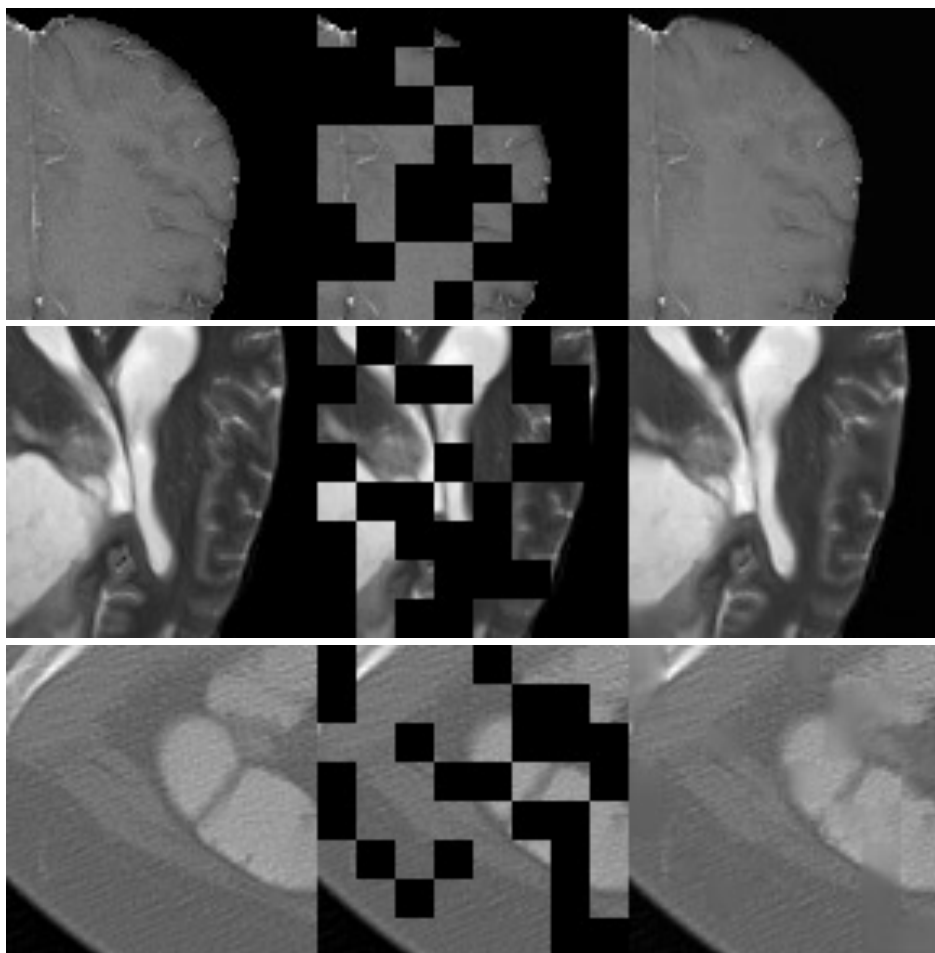
西门子VLM实例 -> 基于掩膜的自监督影像大模型 -> 加速模型开发

数据集： 内部+公共混合数据集

数据集名称	模态	Case数量	描述
BraTS21	MRI	5004	Brain Tumor Segmentation
LTS	CT	131	Liver Tumor Segmentation
MSD	CT+MRI	2627	Medical Segmentation Decathlon
CAS2023	MRI	150	Intracranial Vessel Segmentation
RibFrac2020	CT	500	Rib Fracture Detection and Classification
		...	
Sum		*****	



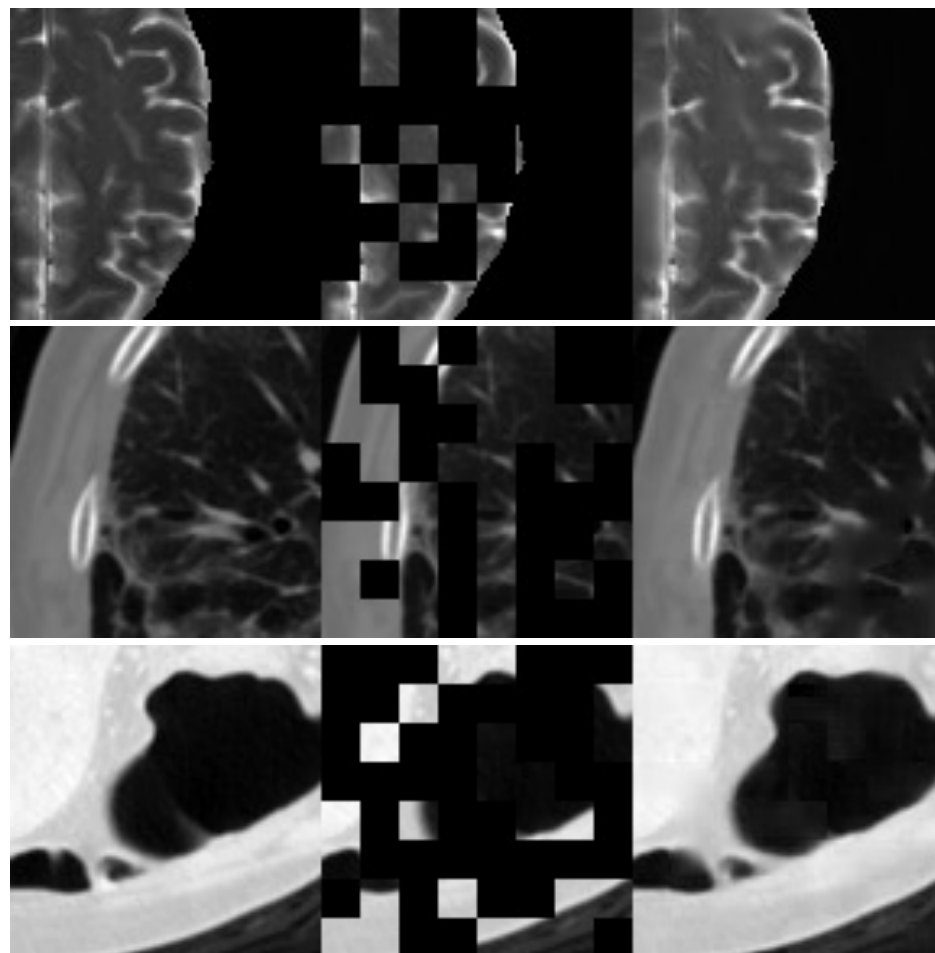
VLM -> 掩膜恢复结果 -> 提取优秀特征



输入图像

掩膜图像

恢复图像

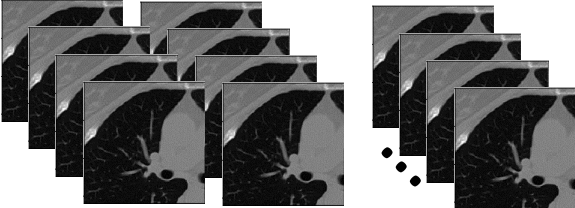
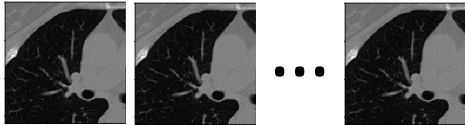


输入图像

掩膜图像

恢复图像

VLM --- 对比实验结果

	Without Pre-train	With Pre-train	Comparison
Data Used:	200 data 	50 data 	Fewer data needed
Annotation time:	16 hours	4 hours	Manual labeling labor reduced
Training epochs:	4500 iterations	2200 iterations	Energy cost saved
Performance:	Dice=0.899	Dice=0.931	Performance Improved

<Advanced Diagnose & Therapy >

纯影像大模型在医疗领域的使用场景



基于掩膜自监督方法
快速迭代下游任务

基于大模型的密集预测任务
(赋能科研标注, 产品研发)

病理/影像诊断大模型

影像数据质量评估

相似影像检索



Topic 3

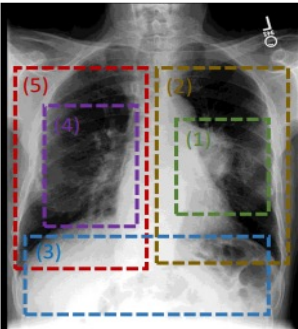
视觉语言大模型 VLLM

VLLM的发展之路



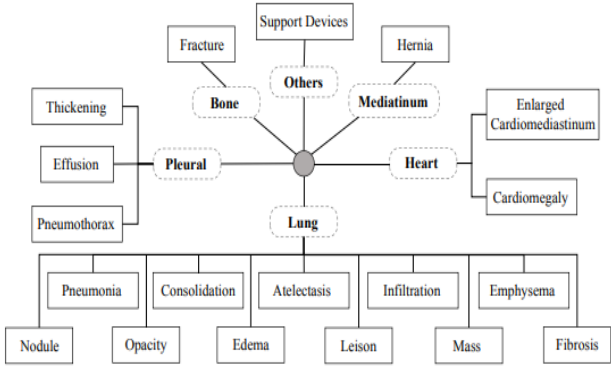
模型	发布日期	预训练模型		微调	
		阶段1	阶段2	阶段1	阶段2
Flamingo-80B	22.04	ALIGN 1.8B + LTIP 312M图文对, 1536 TPUv4 * 15天		M3W 185M 图片文本对 27M 视频文本对	
BLIP-2 ViT0g FlanT5XL	23.01	129M 图片文本对	129M 图片文本对	N/A	
LLaVA - V1	23.04	595k 图像文本对		156k 图像文本对	
MiniGPT - V1	23.04	5M 图像文本对, 4*A100-80G * 10小时		3500 图像文本对, 1*A100 7分钟	
VisualGLM - 6B	23.04	30M 图像文本对 (中文) + 300M 图像文本对 (英文)		不明确	
Qwen - VL23.08	23.05	1.5M 图像文本对	69M 图像文本对	350K 图像文本对	
InternLM	23.08	1.1B 图像文本对 + 67.7B 文本 + 10B 文本		2.6M 图像文本对	260k 图像文本对
LLaVA - v1.5	23.09	LCS 558k 图像文本对, 8*A100*6/小时		665k 图像文本对, 8*A100*20/小时	
GPT - 4V	23.09	不明确			
MiniGPT - v2	23.10	38M 图像文本对	3.2M 图像文本对	38M 图像文本对	
Gemini 1.5	24.02	不明确			

挑战：VLLM在医学领域的局限性



[From MIMIC-CXR]

(1) A mass is present in the superior segment of the left lower lobe and therefore malignancy must be considered. (2) Elsewhere, the left lung appears clear. (3) There is no effusion. (4) Calcified pleural plaque is present in the right mid zone. (5) The right lung appears clear.



多尺度信息

医学图像解读需重视多尺度特征，局部特征对诊断影响显著

数据稀缺

开源的医学图像数据集规模较小，会限制影像语言大模型在该领域的性能。

知识专业密集

专业知识需求高，临床概念层级复杂，缺乏深入理解可能影响性能

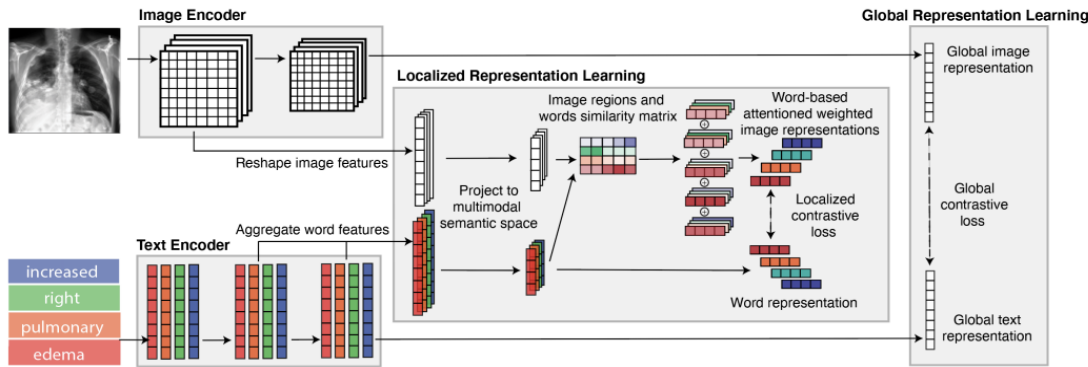
CLIP in medical imaging: A comprehensive survey

Zihao Zhao^{a,1}, Yuxiao Liu^{a,1}, Han Wu^{a,1}, Yonghao Li^a, Sheng Wang^{a,b,c}, Lin Teng^a, Disheng Liu^a, Zhiming Cui^a, Qian Wang^a, Dinggang Shen^{a,c,d,*}

^aSchool of Biomedical Engineering, ShanghaiTech University, Shanghai, China.
^bSchool of Biomedical Engineering, Shanghai Jiao Tong University, Shanghai, China.
^cDepartment of Research and Development, Shanghai United Imaging Intelligence Co., Ltd., Shanghai, China.
^dShanghai Clinical Research and Trial Center, Shanghai, China

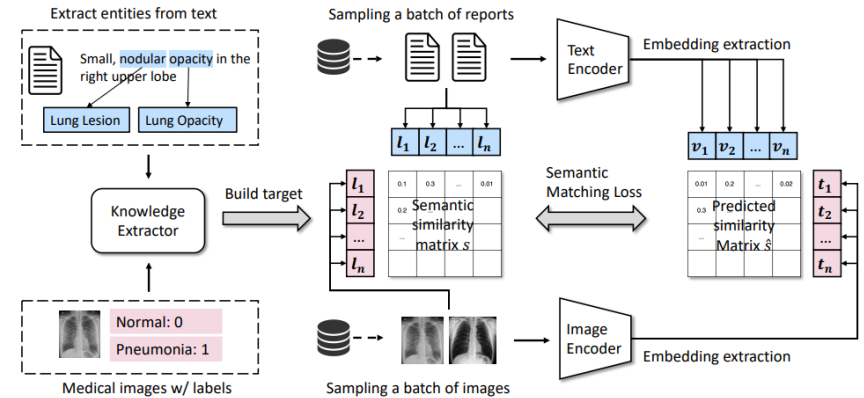
VLLM的代表论文

[1]



GLoRIA / Shih-Cheng Huang,

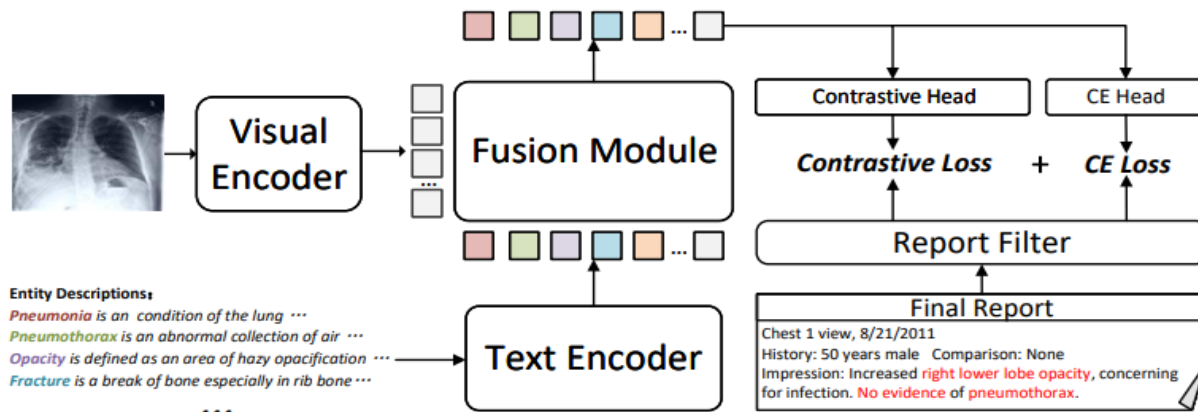
[2]



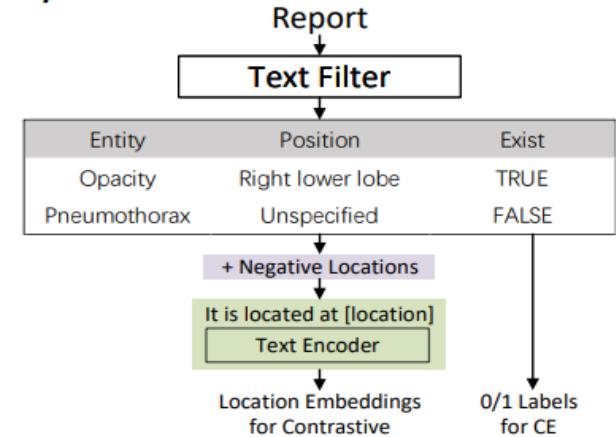
MedCLIP: Contrastive Learning from Unpaired Medical Images and Text / Zifeng Wang

Main Framework

[3]

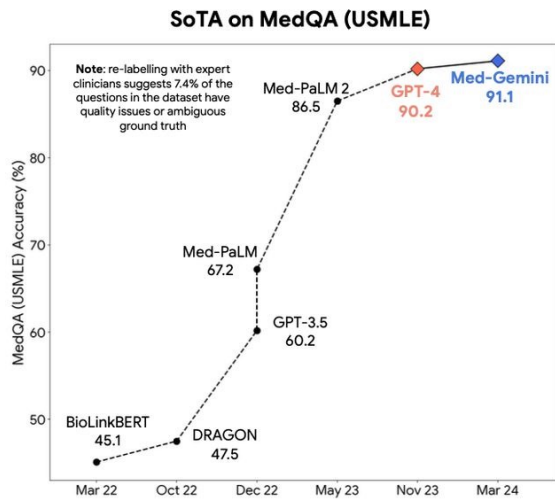
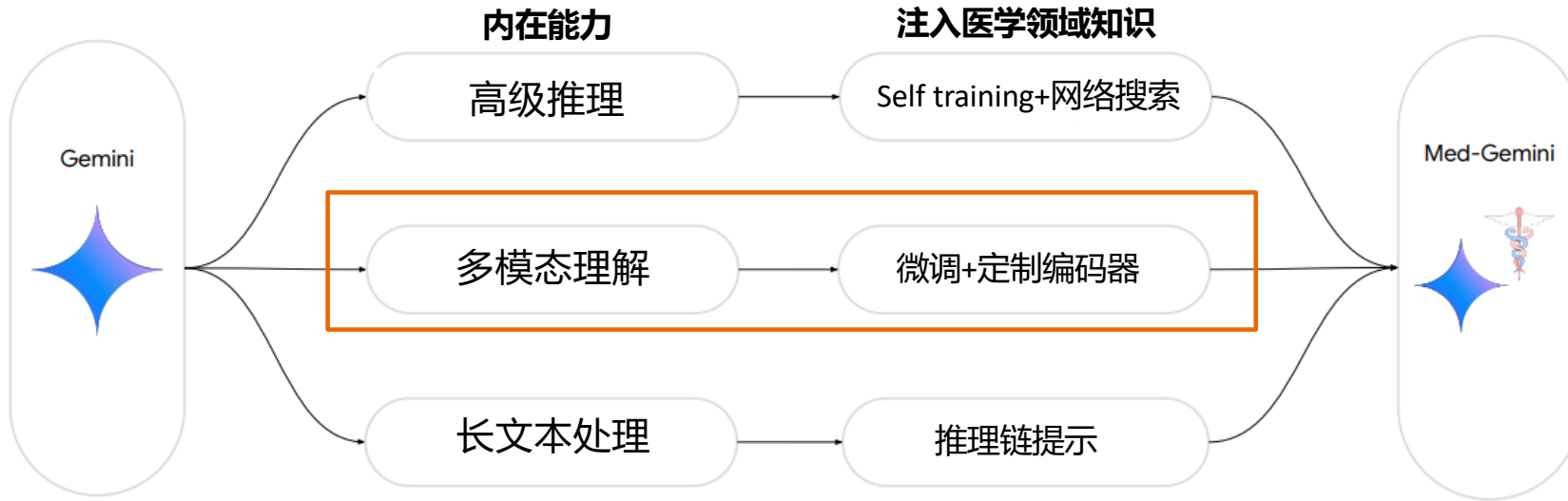


Report Filter



MedKLIP: Medical Knowledge Enhanced Language-Image Pre-Training / Chaoyi Wu, Xiaoman Zhang, Ya Zhang, Yanfeng Wang, Weidi Xie

Med-Gemini – 性能最好，未来趋势



Prompt

You are a helpful medical video assistant.

Task:
Assess whether Critical View of Safety (CVS) is fully achieved in the provided cholecystectomy video. The Critical View of Safety (CVS) is fully achieved if the following three criteria are met:

- C1: Clear view of 2 tubular structures connected to the gallbladder.
- C2: A carefully dissected hepatocystic triangle presenting an unimpeded view of only the 2 cystic structures and the cystic plate.
- C3: The lower third of the gallbladder is dissected off the cystic plate.

Instructions:

1. Watch the video carefully, and answer which of the Critical View of Safety (CVS) criteria are met.
2. Output Format:
 - CVS Assessment:
 - C1 - achieved / partially achieved / not achieved (Optional explanation)
 - C2 - achieved / partially achieved / not achieved (Optional explanation)
 - C3 - achieved / partially achieved / not achieved (Optional explanation)

Response

CVS Assessment:
 C1 - partially achieved: Two tubular structures are visible but the view is not entirely clear due to some bleeding obscuring the area.
 C2 - not achieved: The hepatocystic triangle is not clearly dissected, and there is not an unimpeded view of only the two cystic structures and the cystic plate.
 C3 - not achieved: The lower third of the gallbladder is not dissected off the cystic plate.

Hello, I am a primary care physician and this is a chest x-ray for a patient of mine. The formal radiology report is still pending and I would like some help to understand the x-ray. Please write a radiology report for me.

FINDINGS: The heart is at the upper limits of normal size. The mediastinal and hilar contours appear within normal limits. The lungs appear clear. There are no pleural effusions or pneumothorax. Mild degenerative changes are noted along the lower thoracic spine. IMPRESSION: No evidence of acute disease.

What evidence do you see for degenerative changes?

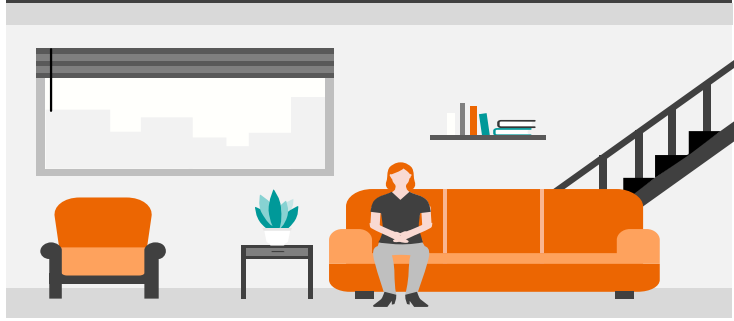
Mild degenerative changes are noted along the lower thoracic spine. This can be seen by the slight narrowing of the intervertebral disc spaces and the presence of small osteophytes (bone spurs) along the anterior margins of the vertebral bodies.

My patient has a history of back pain. Might this explain the back pain?

VLLM在医疗领域的使用场景

面向患者

患者助手

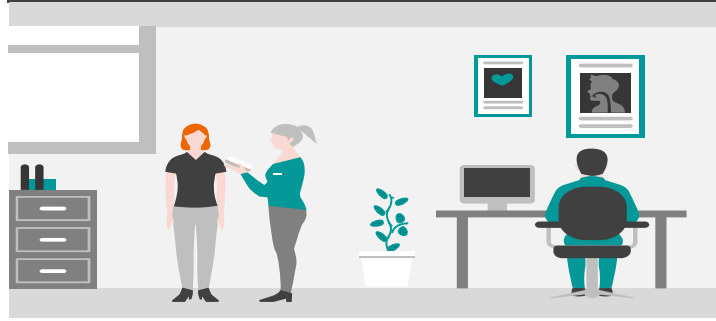


智能预问诊和常见疾病预诊断
(可处理包含视觉信息的多轮问答)

患者健康监测：结合可穿戴设备数据和患者视觉体征。

面向医生

医生助手 (诊断+手术)



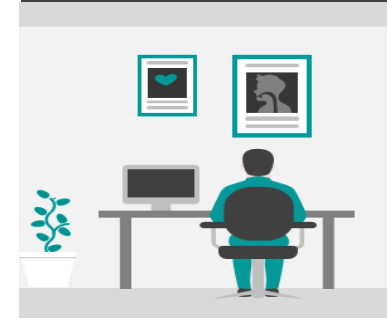
多模态影像报告解读和生成

结合患者医疗影像和历史健康记录
辅助制定个性化治疗方案

视频理解 (如手术视频)

面向科研

科研与教育

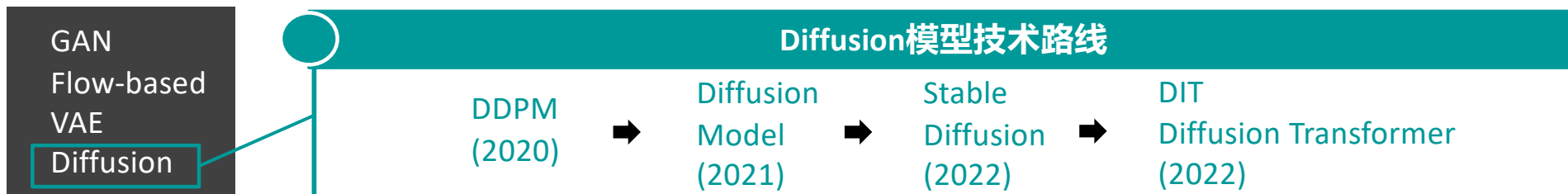


图文医疗文献
解读与挖掘

Topic 4

AIGC (Diffusion Model)

Diffusion模型的发展之路



文(图)生图

Midjourney

OpenAI | DALLE-3

Google | Imagen

AI Stability | Stable Diffusion

文(图)生视频

Runway ML

Pika Labs

OpenAI | Sora

Synthesia

国外Diffusion模型

文(图)生图

商汤 | 秒画

腾讯 | 混元助手

百度 | 文心一格

阿里 | 通义万象

智谱清言 | AI画图

科大讯飞 | 星火绘画大师

文(图)生视频

Tencent 腾讯 | VideoCrafter2

Alibaba | ModelScope T2V

Baidu 百度 | UniVG

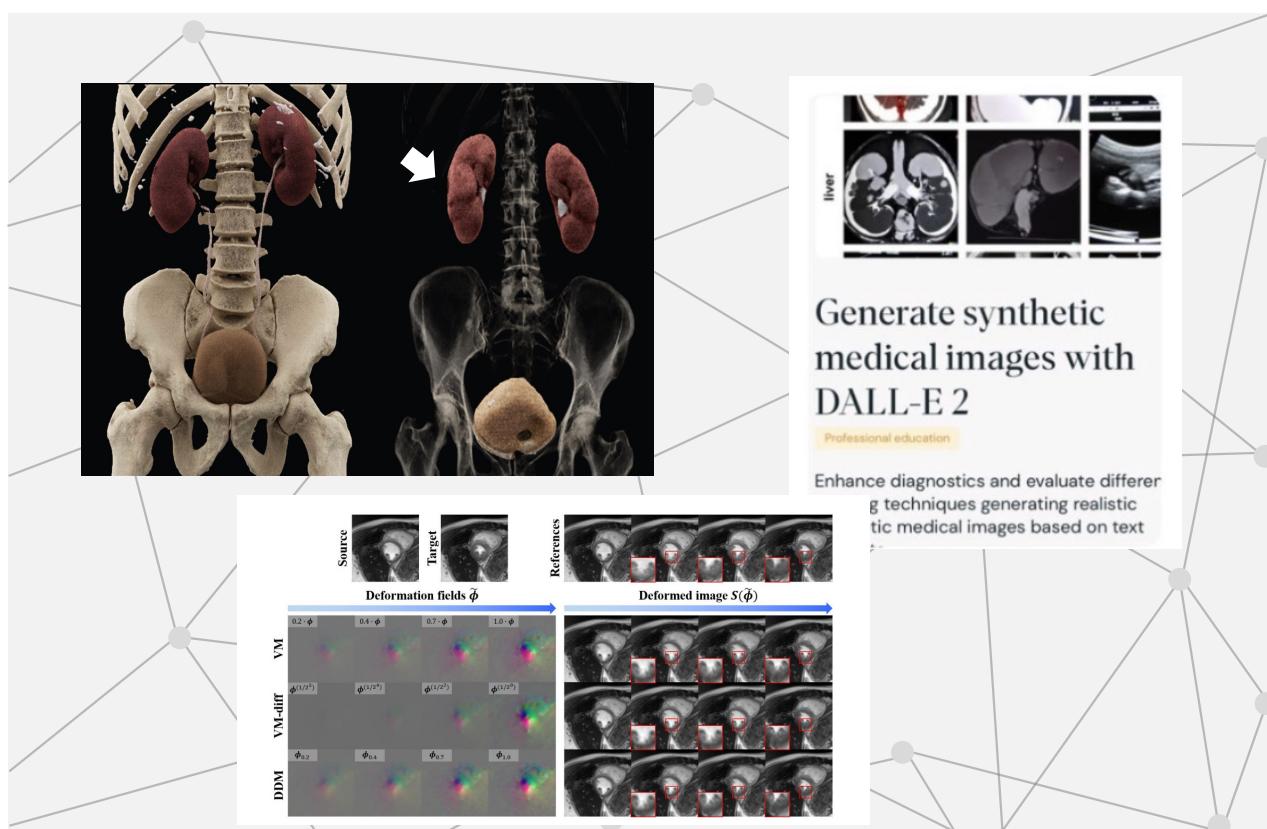
ByteDance 字节跳动 | CapCup AI Video

meitu 美图 | WHEE

wondershare 万兴科技 | 天幕多媒体大模型

国内Diffusion模型

Diffusion在医疗领域的使用场景



跨模态生成

跨模态生成 (MR-伪CT, 低场MR-高场MR...)

医学影像去噪/去伪影

MR, OCT, PET-CT, 支架伪影等

患者报告解释(layman translation)

通过渲染的视频, 帮助患者更好地了解他们的健康状况、诊断结果和治疗选项。

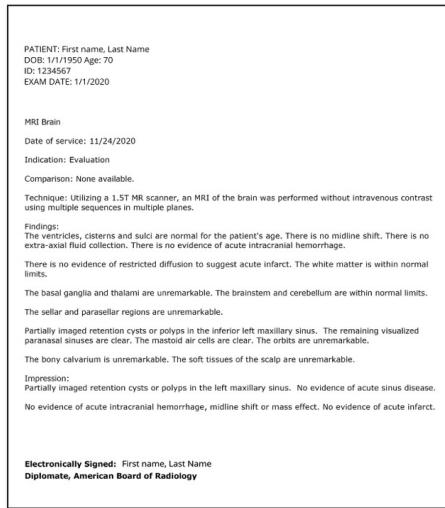
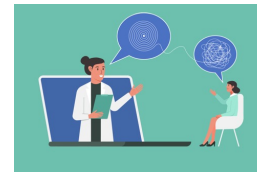
Diffusion技术在西门子医疗的应用：以文生视频

目标:

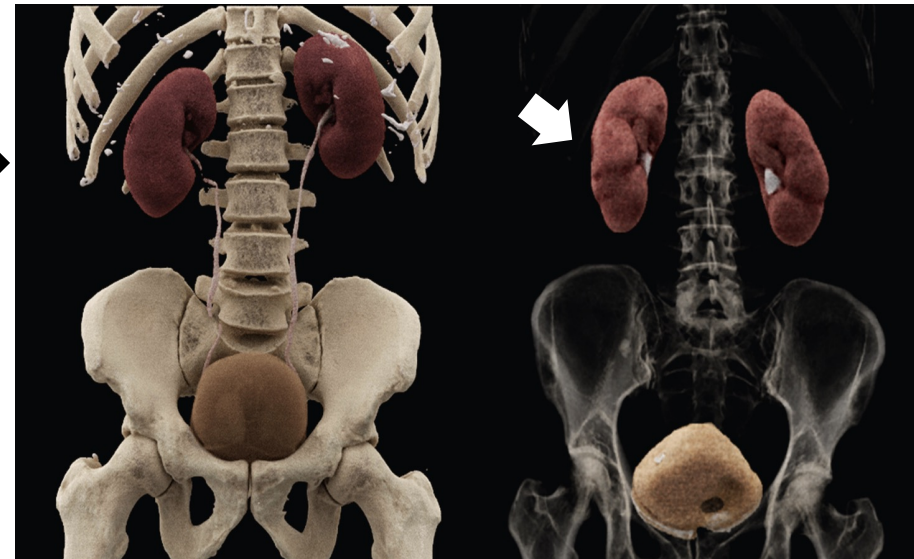
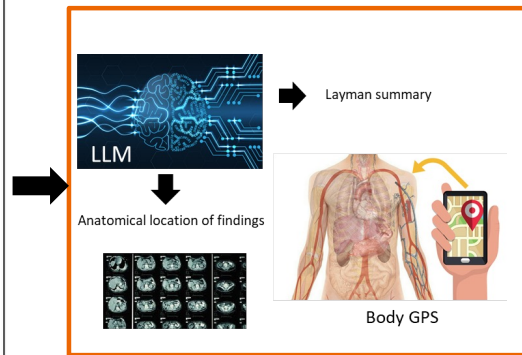
微调SHS语言模型进行报告摘要

BodyGPS - 自动识别并展示报告中的检查结果

基于报告，生成展示和解释检查结果的解剖学信息的视频。

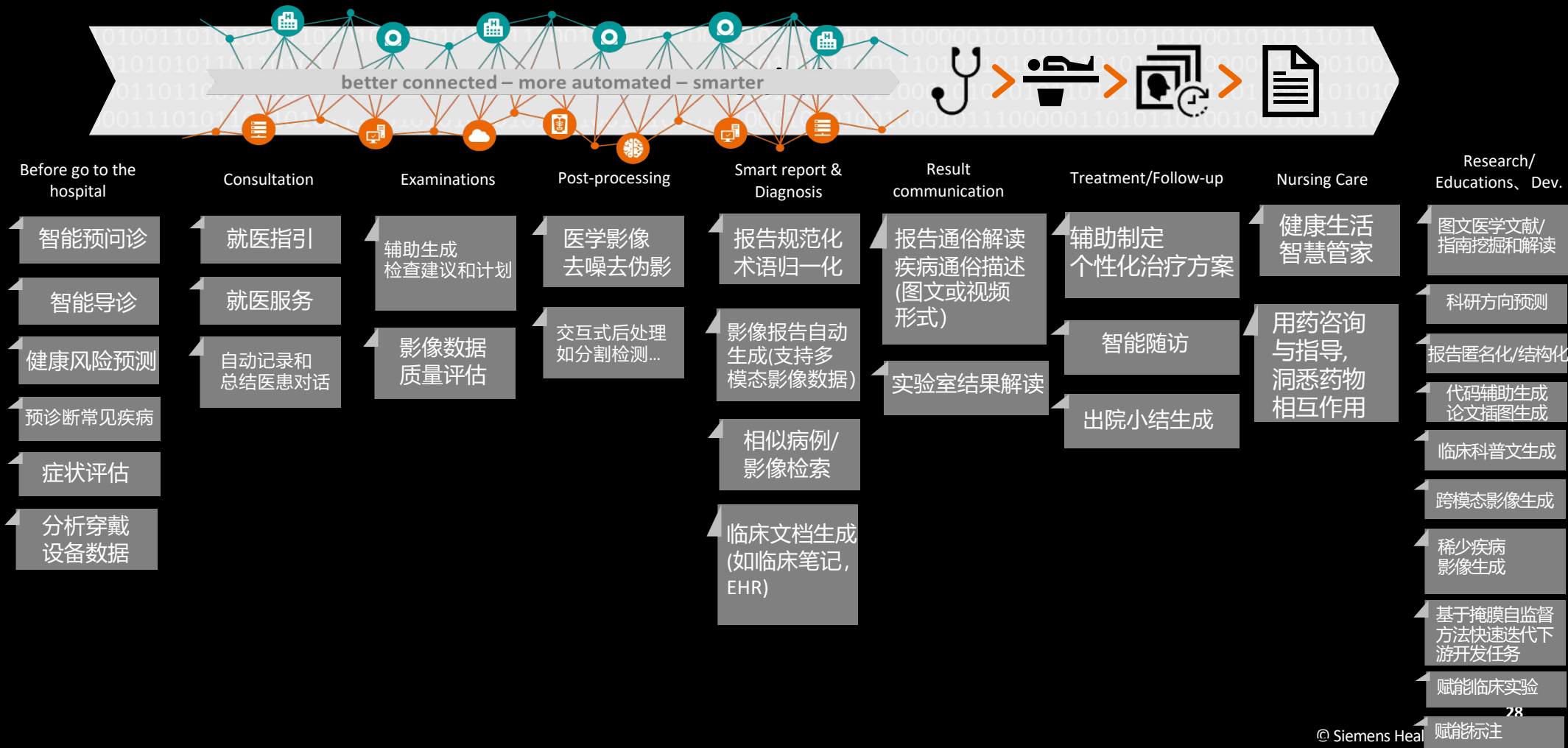


Radiology report

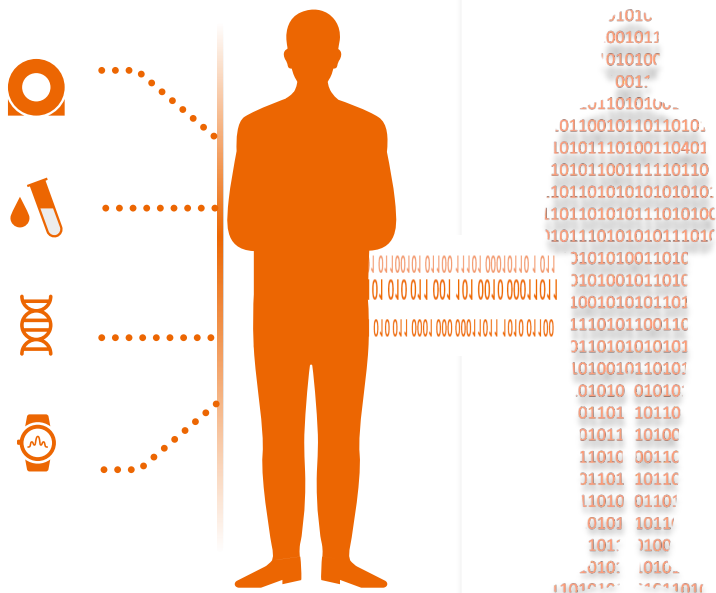


For Future...

AI大模型赋能医疗影像价值链 --- 医疗服务全流程



多维度 高精度的数据价值，构建患者数字孪生



**基于多维数据
构建患者数字孪生 Digital Twin
赋能精准治疗**

This feature is based on research, and is not commercially available. Due to regulatory reasons its future availability cannot be guaranteed.

Thanks for your
attention

谢谢

