



中国农业科学院

CHINESE ACADEMY OF AGRICULTURAL SCIENCES

智能图书馆时代空  
间服务创新的思考

孙 坦

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2 智能化馆藏基础设施建设

3 图书馆创新服务功能分析

4 图书馆空间服务方案设想



ONE

# 智能时代图书馆发展趋势

# Libraries around the world are undergoing significant transition.....

In urban planning the library functions as icon, placemaker and contributor to community vitality

*The role of public libraries in urban development and culture led regeneration (2010)*

Libraries today are less about where to put stuff and more about providing access to tools and resources people need.

*DC Public Library Services and Facilities: A Framework for continuing success. DC Office of Planning (2010)*

A public library should encompass four spaces:  
The inspiration space  
The learning space  
The meeting space  
The performative space

*A new model for the public library in the knowledge and experience society (2012)*

图书馆是城市规划中社区活力的象征、创造者和贡献者

Oodi Helsinki Central Library  
Finland

Service and buildings need to fit into the bigger picture, e.g. different service delivery models, community hubs, joint use and partnership opportunities.

*People Places: a Guide for Public Library Buildings in New South Wales (2012)*

A new library should have 'oomph' or 'wow' factor.

*IFLA Library Building Guidelines: Developments and Reflections (2007)*

图书馆是数字素养的“扩展图书馆”和推动者，是跨文化和全年龄段的图书馆和创新学习中心



- Architectural Quality and WOW factor (建筑质量和出彩的因素)
- Flexibility (灵活性): 以适应新趋势及需求, 适用各种功能
- Digitisation (数字化): 多样性实体空间
- Sustainability (可持续性): 在建筑、服务、规划和合作关系方面的可持续性
- Interaction with the surroundings (与环境交互): 建筑需与社区需求和功能结合
- Learning space (学习空间): 提供内容创建空间, 如创客空间、工作坊、编程空间

Building Libraries for tomorrow

<https://rendezvousbiblio.ca/2019/pdf/LAERKESJakob.pdf>

### 第一代图书馆

馆藏空间 + 阅读空间

藏阅分离，以馆藏为中心，单向阅读



### 第二代图书馆

开放空间 + 活动空间

藏阅合一，双向互动



### 第三代图书馆

藏用互补

人机交互、人人交互、沉浸式阅读



**回归+创新：**“密集型仓储或将重新成为图书馆馆藏趋势，释放更多的空间用于多元的读者活动”



# The NMC Horizon Report: 2017 Library Edition 新媒体联盟地平线报告：2017图书馆版

## 技术趋势

### Trends Accelerating Technology Adoption in Academic and Research Libraries

**Short-Term** Driving technology adoption in academic and research libraries over the next one to two years

- Research Data Management 提升对研究数据管理的关注度
- Valuing the User Experience 评估用户体验

**Mid-Term** Driving technology adoption in academic and research libraries over the next three to five years

- Patrons as Creators
- Rethinking Library Spaces

反思图书馆空间  
图书馆用户角色的转变

**Long-Term** Driving technology adoption in academic and research libraries for five or more years

- Cross-Institution Collaboration 跨机构合作
- Evolving Nature of the Scholarly Record 学术记录的发现本质

2017 2018 2019 2020 2021

**Time-to-Adoption Horizon: One Year or Less**

- Big Data
- Digital Scholarship Technologies

**Time-to-Adoption Horizon: Two to Three Years**

- Library Services Platforms
- Online Identity

**Time-to-Adoption Horizon: Four to Five Years**

- Artificial Intelligence
- The Internet of Things

人工智能+物联网

Important Developments in Technology of Academic and Research Library

## ✓ 智能化馆藏基础设施建设

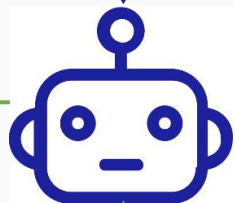
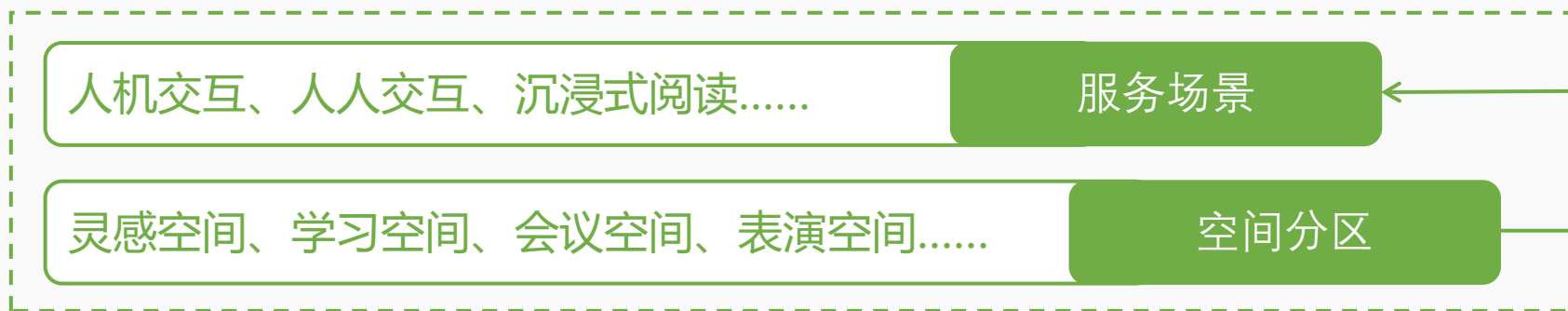
图书馆知识管理：智能化、机械化

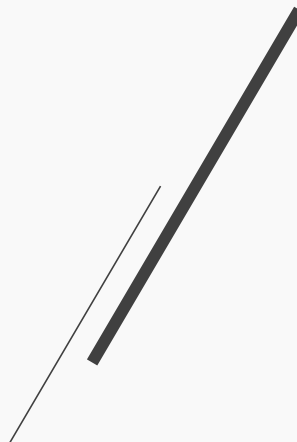


促进知识流通  
注重多元素养  
创新交流环境  
激发社群活力

AI+IoT

## ✓ 图书馆服务、空间功能设计

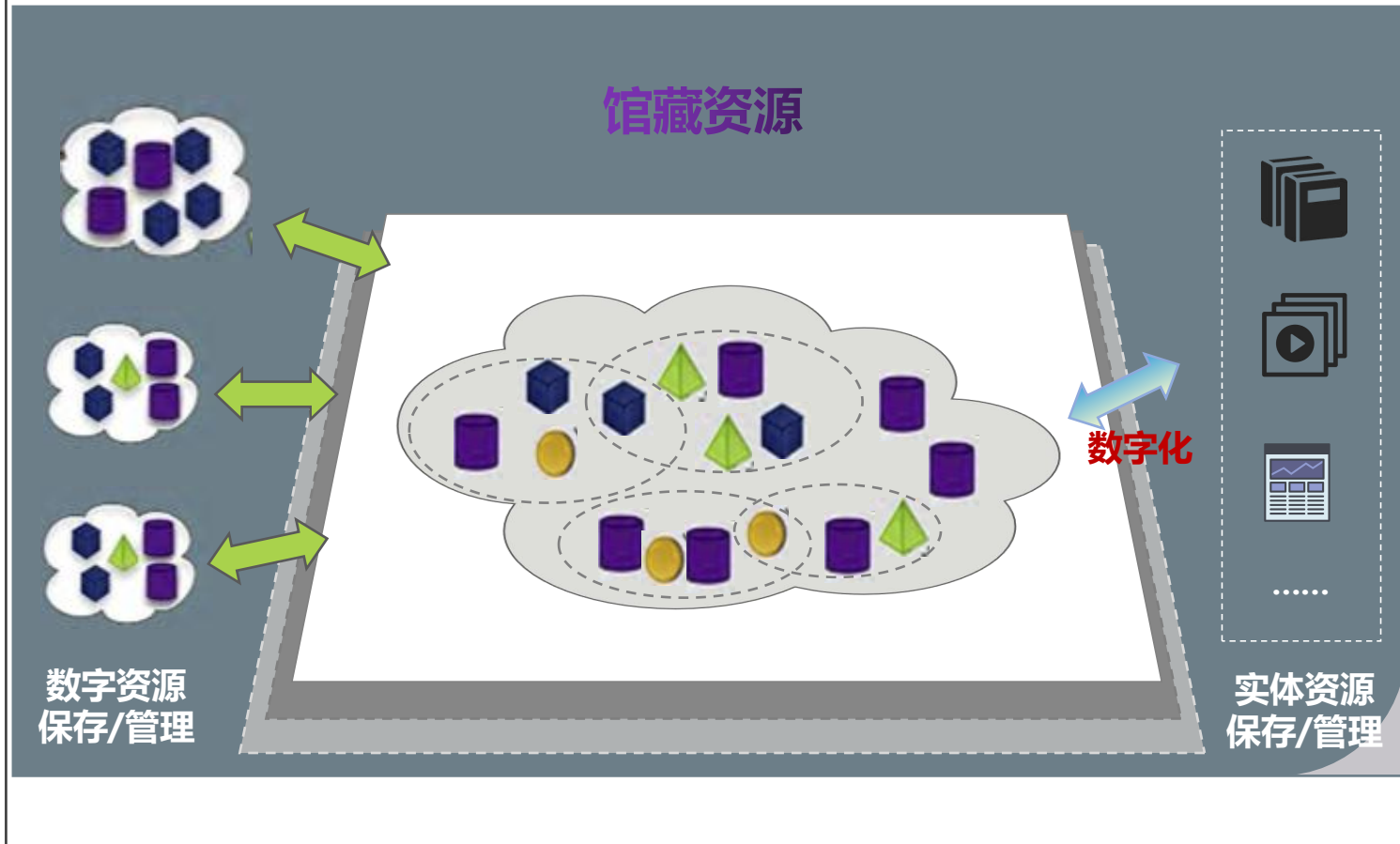




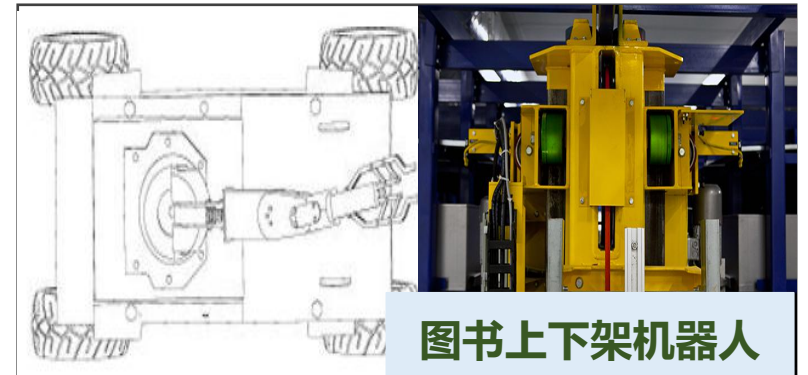
# 智能化馆藏基础设施建设



# 智能化馆藏基础设施 E-infrastructures



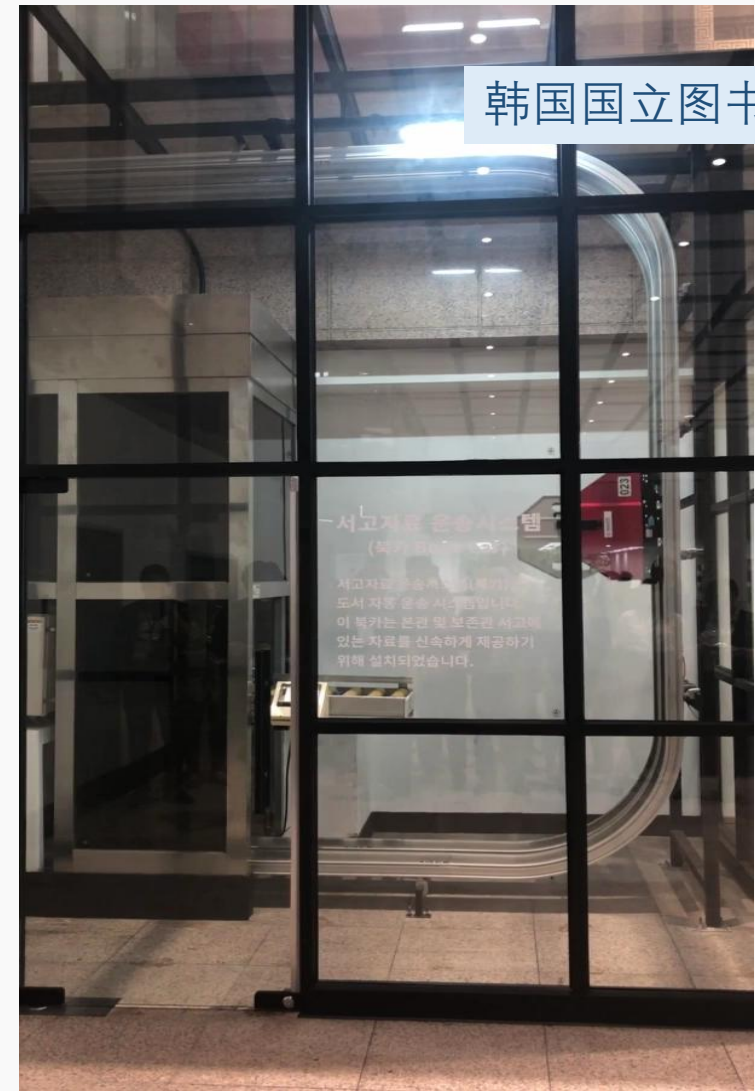
密集型书库



图书上下架机器人



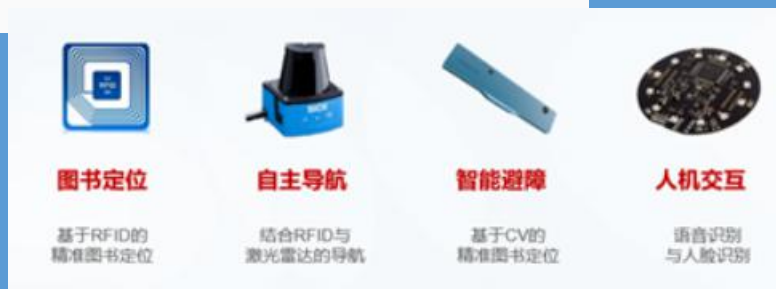
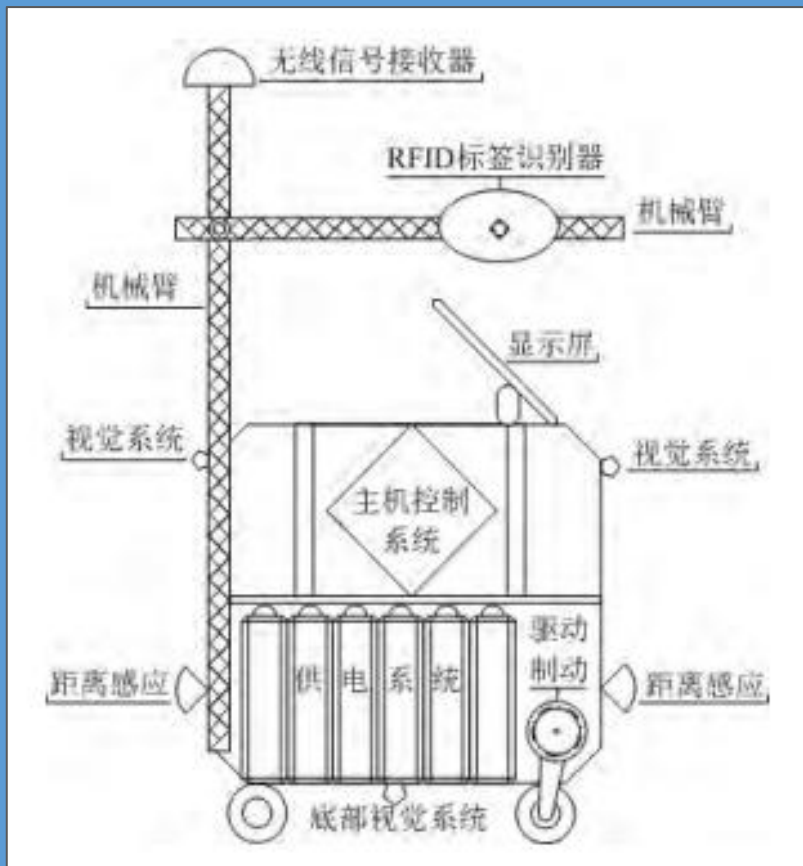
移动盘点机器人/系统



韩国国立图书馆机器人

Books and other materials are stored in bins that are retrieved robots

# RFID 图书盘点智能机器人结构





基于机器视觉的自动分类分拣和上下架机器人



THREE

# 图书馆创新服务功能分析

# 智能图书馆创新服务模式

Stadtbibliothek Stuttgart  
Germany

人机交互

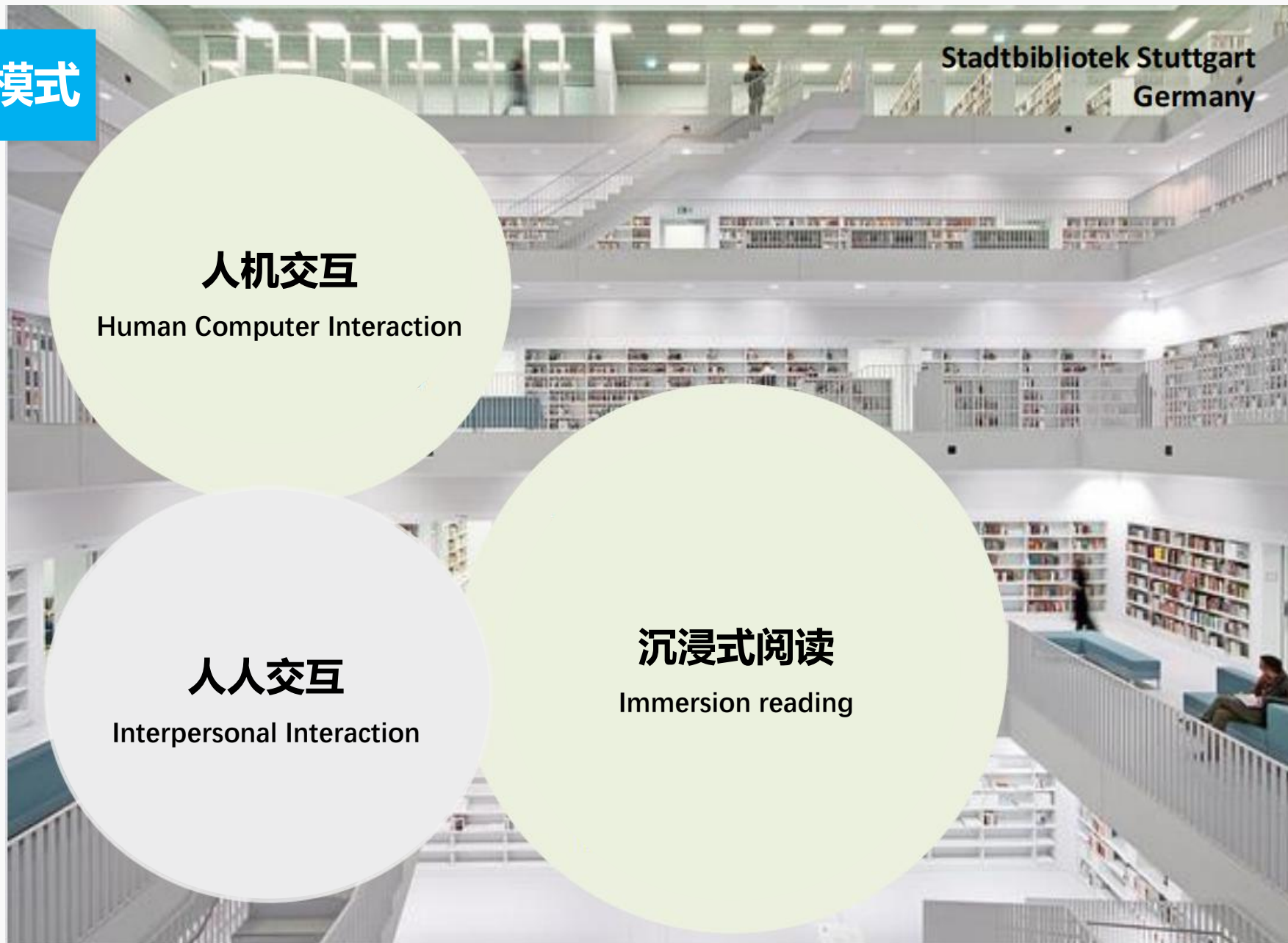
Human Computer Interaction

人人交互

Interpersonal Interaction

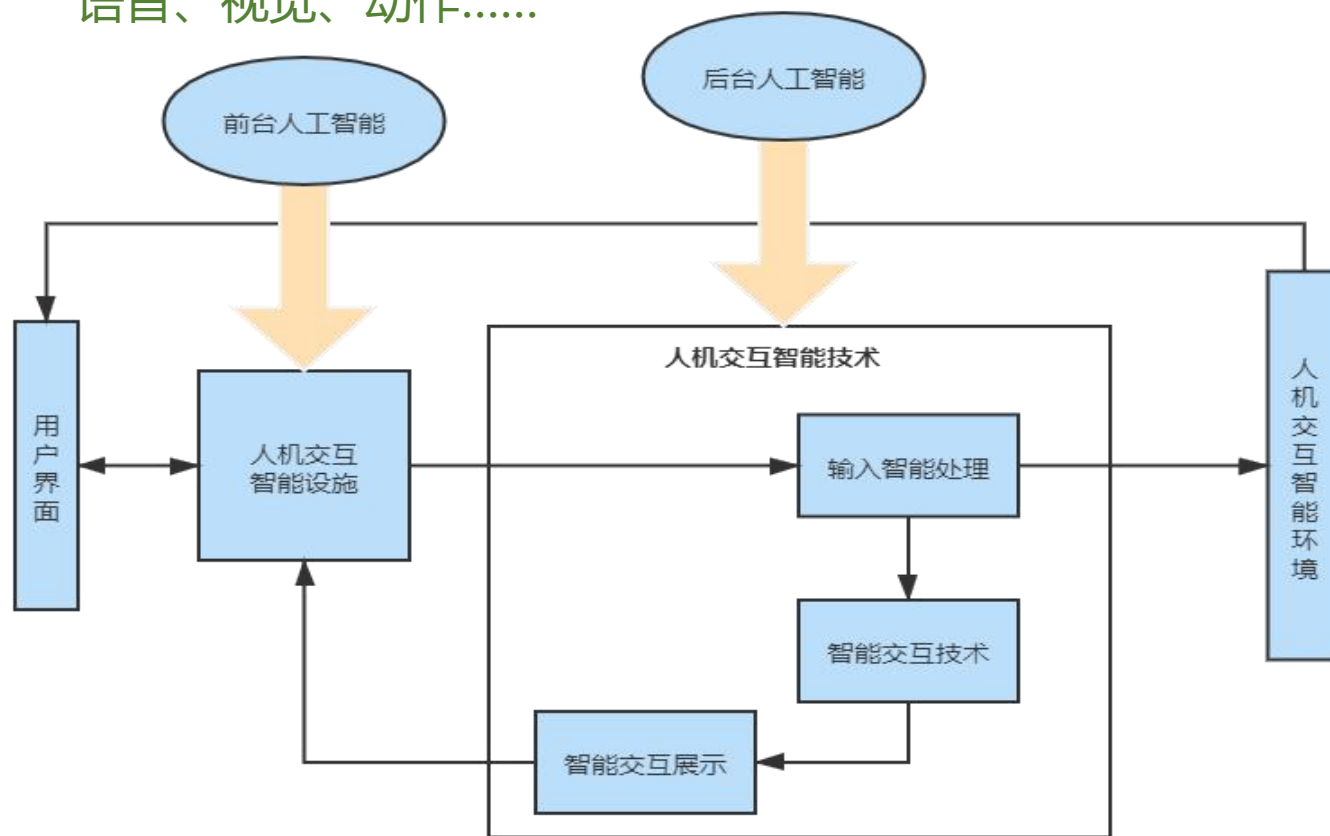
沉浸式阅读

Immersion reading





语音、视觉、动作.....



图书信息查询 + 自主借书 + 咨询 + 导引 + 智能问答 .....



小图PC端



小图APP

小图微信



- 拥有听、说、视觉、运动和双屏互动显示能力
- 实现了人脸识别、迎宾讲解、智能交互、书籍检索、读者卡信息查询等功能
- 可以和公众智能交互，解答公众提出的图书馆的相关业务问题

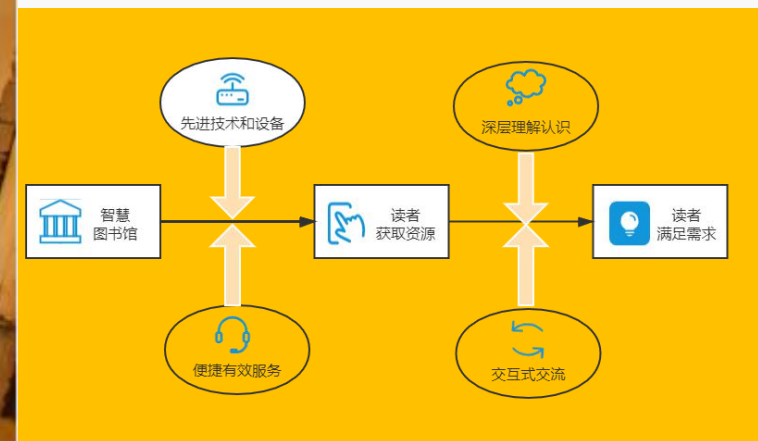
国家图书馆机器人



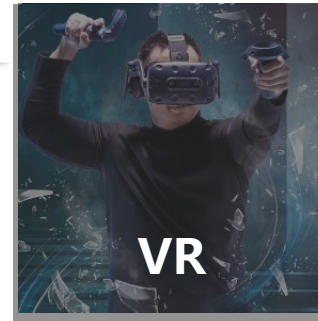
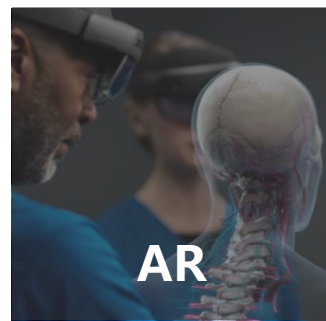
机器人“吵架”

清华智能聊天机器人



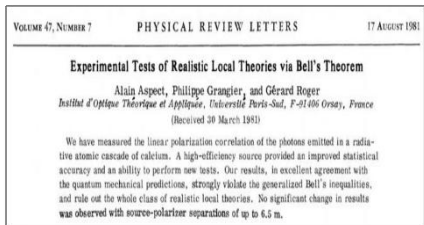


图书馆的用户从被动的媒介使用者转变为主动的参与者和内容生产者

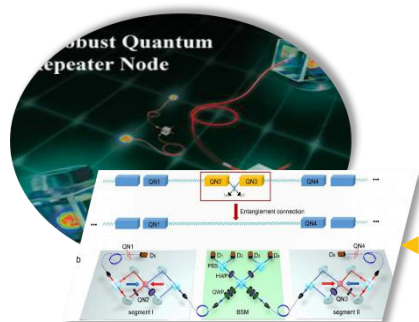


系统性/休闲式阅读外的革命性  
阅读空间功能

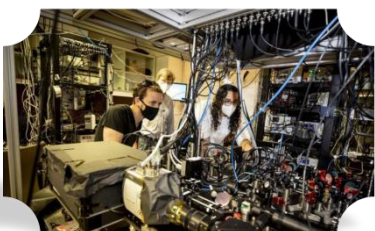
沉浸式阅读



阿兰·阿斯佩克特在1981年发表的实验论文



量子中继器  
Quantum Repeater



哈佛-麻省理工学院  
联合超冷原子中心



公式



图片



表格



视频



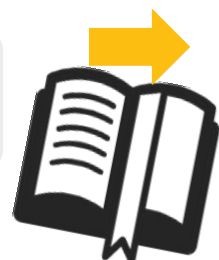
音频



# 沉浸式阅读

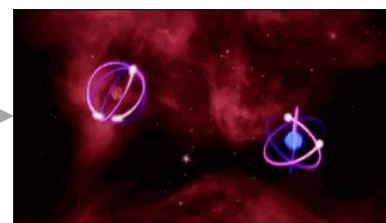
Immersion Reading

Linked Multimodal Knowledge  
关联的多模态知识

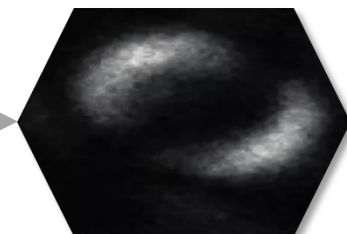


VR、AR、MR  
沉浸式技术

Intelligent Infrastructure  
智能化基础设施



量子纠缠  
Quantum Entanglement



首次拍摄到量子纠缠的照片-“幽灵般的超距作用”

$$\psi = \delta(x_1 - x_2 - L)\delta(p_1 + p_2)$$

二粒子纠缠态



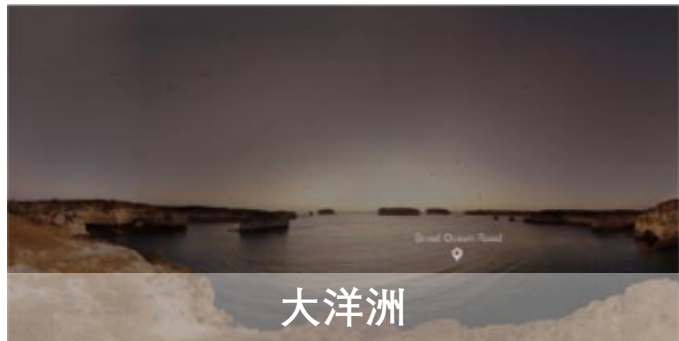
薛定谔的猫  
Schrödinger's Cat

--以量子相关电子/实体读本为例

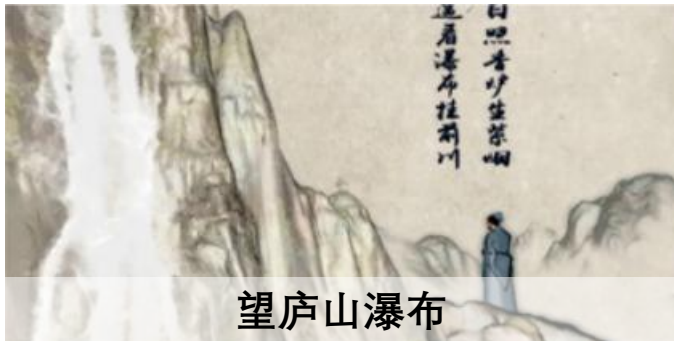
通过多模态知识的关联给予读者具象的释义、联想、甚至体验

不仅限于阅读的一本书、一篇论文……

### 看中国/世界



大洋洲



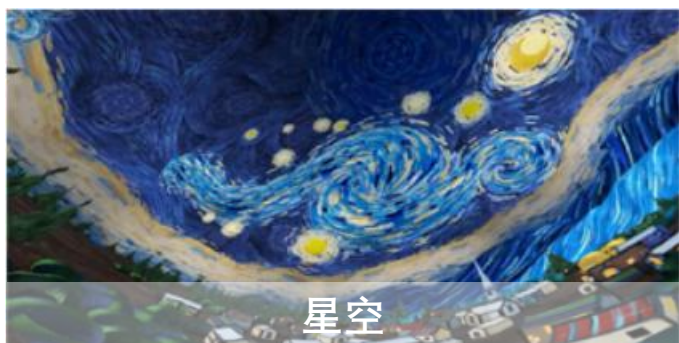
望庐山瀑布

### 神话与科普



愚公移山

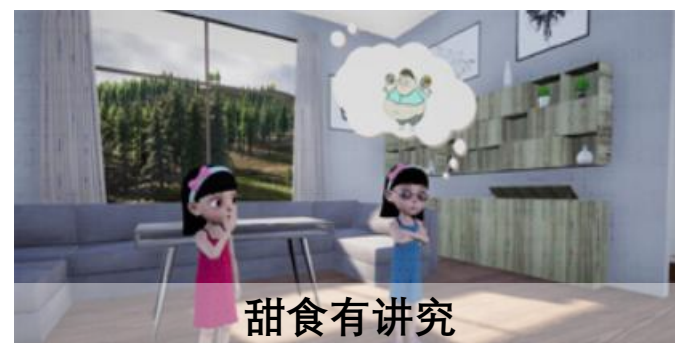
### 艺术与科幻



星空

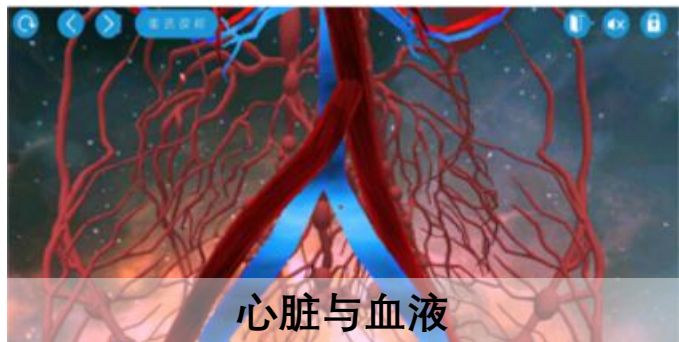


梦境



甜食有讲究

### 科学、地理、历史等科普内容



心脏与血液



肛肠生物



青铜时代



沉浸式学习体验：故宫博物馆——清明上河图全景VR



# 图书馆空间服务方案设想

查借、阅读

人机交互

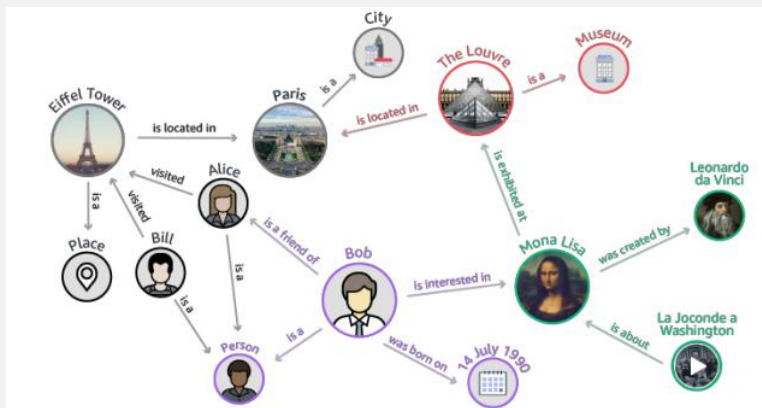
人人交互

沉浸式阅读

人工智能

大数据

数据库/知识库/知识图谱.....



智慧图书馆馆藏基础设施



多模态多来源馆藏资源

实体资源

数字资源

XROS (VR/AR/MR)

交互界面XRUI

Luncher

AppStore

Setting

MediaCenter

OtherApps

WebXR

XRBroser

DevTools

Unity Plugin

UE4 Plugin

沉浸式多媒体XRMedia

Video/Audio

Streaming

Network

XRServer

沉浸式技术XRCore

ATW

ASW

Overlay&

Compositor

Optical&

Display

Input&

Haptics

3D Rendering

Opengl GLES

Vulkan

Spacial Perception

Sensor Fusion

SLAM

NativeOS(Android/Windows/Linux.....)

硬件Hardware

Display

CPU

GPU/DSP/VPU

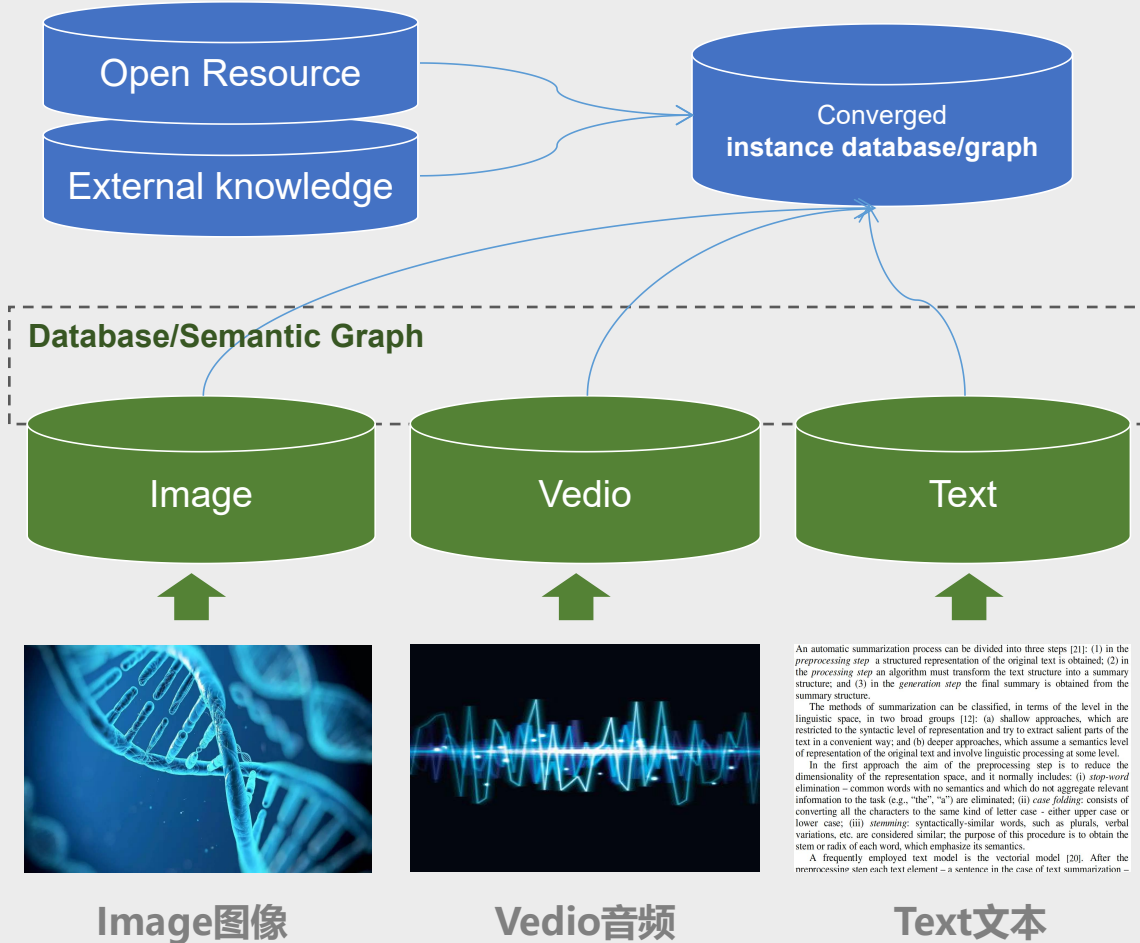
Camera

IMU

Controller

# 多模态知识关联——ALL IN ONE

## ➔ All Things Connected



## ➔ All Things Intelligent





$$e_{agg} = \sum_{(h,r,t) \in N_h} \pi(h,r,t)e(h,r,t)$$

where we perform a linear transformation on the initial  $e_h$  and add it to the  $e_{agg}$ .  $W_3$  is a weight matrix that transfers the current representations into the common space, which denotes the trainable model parameters. This operation is similar to that in the residual network [6].

Full Paper Track  
 CSM 20, October 19–21, 2020, Virtual Event, Ireland

Next consider...  
 High-order propagation...  
 4.1 Knowledge Graph Embedding...  
 4.2 Recommendation...  
 4.3 Effect of Model Depth...  
 5.3 Case study

Table 5: Performance of recommendation: effect of combination layers

combine method	Movielens		Dianping	
	recall	ndcg	recall	ndcg
ADD	0.4134	0.5181	0.1646	0.1433
CONCAT	<b>0.4162</b>	<b>0.5209</b>	<b>0.1657</b>	<b>0.1452</b>

Table 5: Performance of recommendation: effect of model depth

Model	Movielens		Dianping	
	recall	ndcg	recall	ndcg
one layer	0.4113	0.5169	0.1632	0.1424
KGE two layer	0.4134	0.5181	<b>0.1646</b>	<b>0.1433</b>
three layer	<b>0.4162</b>	<b>0.5202</b>	0.1646	0.1433
one layer	0.4082	0.5152	0.1634	0.1425
REC two layer	0.4134	0.5181	<b>0.1646</b>	<b>0.1433</b>
three layer	0.4134	0.5162	0.1628	0.1420

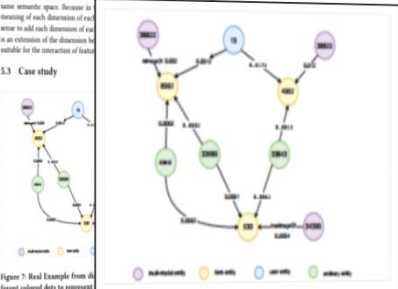
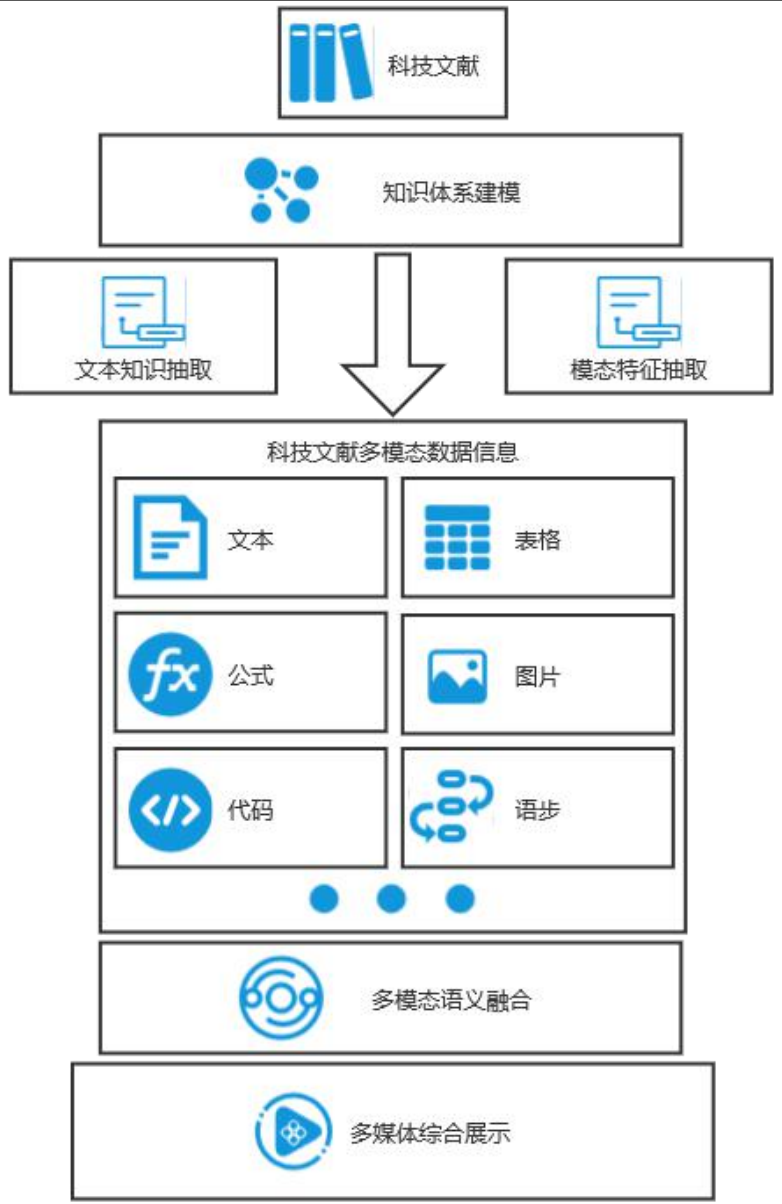


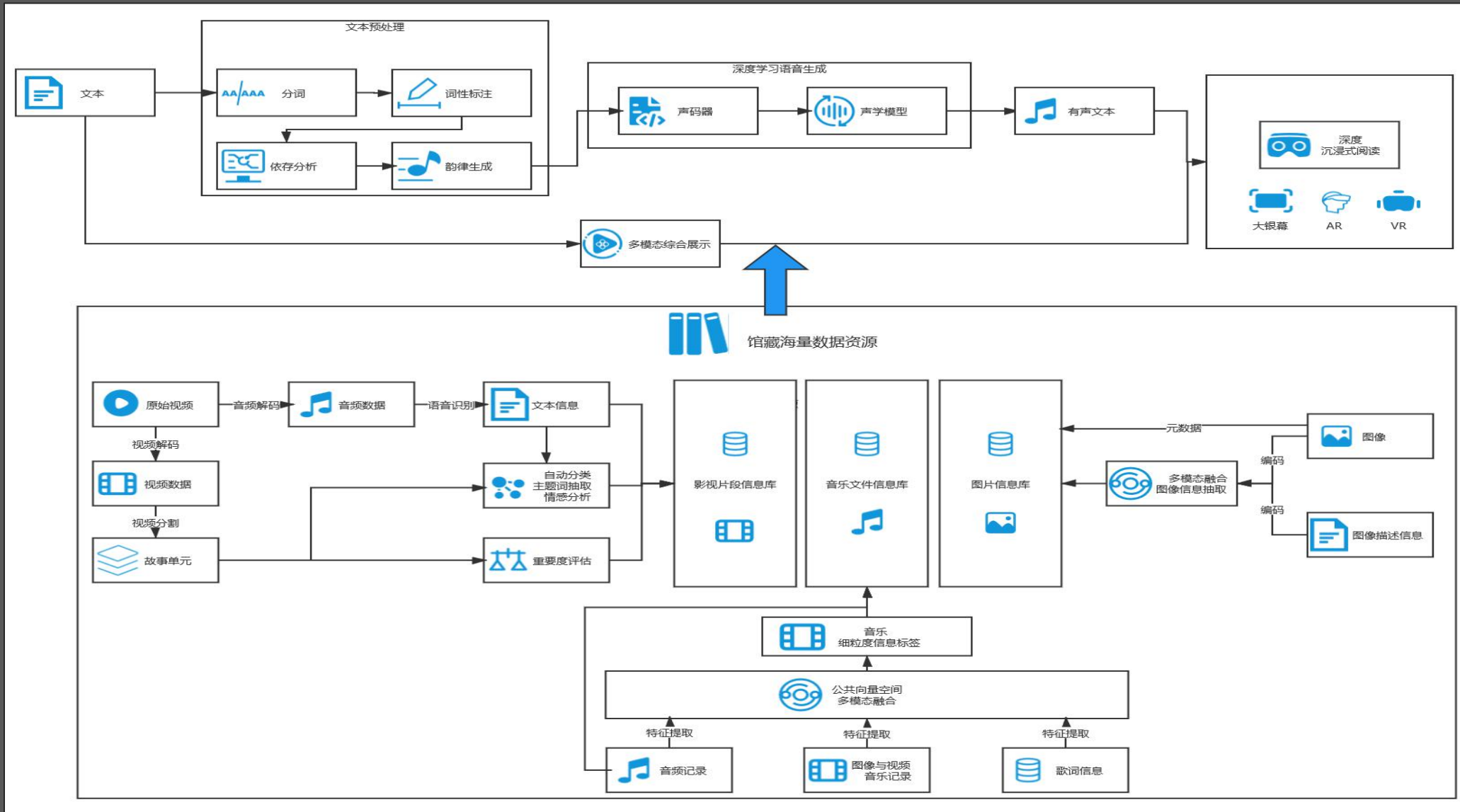
Figure 7: Real Example from dianping datasets, we use different colored dots to represent different types of entities.

5.3 Case study...  
 The effect of different model depth...  
 For knowledge graph embedding...  
 When inferring the recommendation path...  
 5.3.1 Effect of Model Depth...  
 5.3.2 Effect of Combination Layers...



# 科技文献知识挖掘、组织与呈现

# 多模态资源库建设及沉浸式多媒体生成技术路径



张宪海,吴玲达,谢毓香,老松杨.基于分类的个性化视频故事的自动生成与表现技术研究[J].计算机应用研究,2000(07):18-20+85.

张小峰,谢钧,罗健欣,杨涛.深度学习语音合成技术综述[J].计算机工程与应用,2021,57(09):50-59.

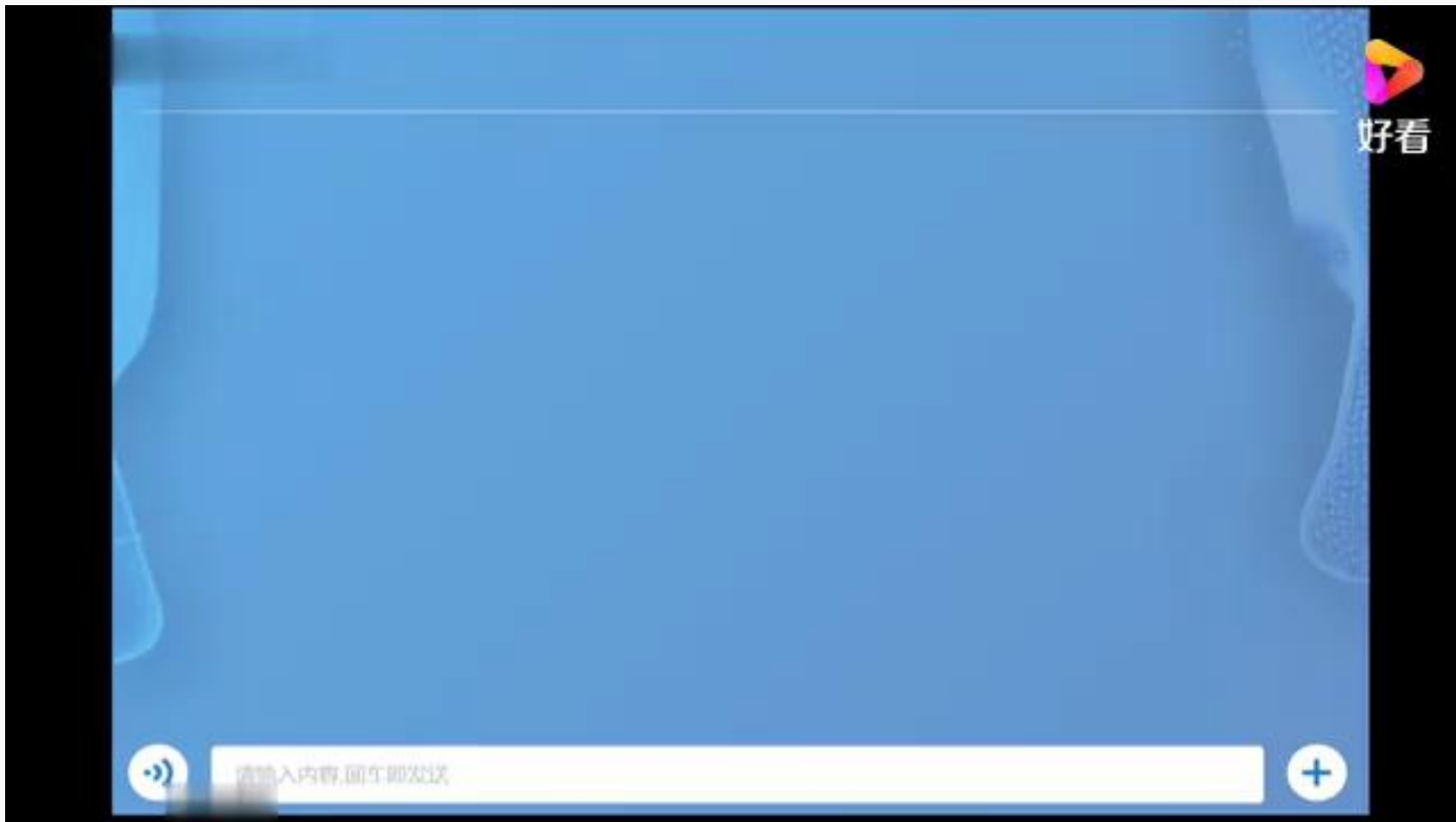
Simonetta, Federico et al. "Multimodal Music Information Processing and Retrieval: Survey and Future Challenges." 2019 International Workshop on Multilayer Music Representation and Processing (MMRP) (2019): 10-18.

# 多模态资源库建设及沉浸式多媒体生成技术路线

## 未来已来

2021年7月9日，中国科学院自动化研究所在2021世界人工智能大会（WAIC2021）上发布了跨模态通用人工智能平台“紫东太初”

打造的虚拟人“小初”，形象展示出不同模态间的互相转换和生成实例，涵盖视频描述、智能问答、图像检索、吟诗作赋、中文续写、双语翻译、语音识别等多个功能。



**Tūranga – Christchurch Central Library**

New Zealand



**Bibliotheek LoHal**

Netherlands



Technology  
becomes a  
tool rather  
than a goal



**Oodi Helsinki Central Library**

Finland



**Green Square Library and Plaza**

Australia

当我们在思考和讨论图书馆空间服务创新时，必须遵循的基本逻辑：牢记初心，不忘使命——传播知识。因此，当知识的形态和载体发生变化时，图书馆的服务也必须相应改变。通过前面的讨论我们可以得出这样一些观点：

图书馆始终保持对新技术的敏感性，但是技术是图书馆的工具而非目标

图书馆浩瀚的馆藏是图书馆空间服务创新的依托和来源，更是一种归宿

多模态知识融合是下一个支撑图书馆实体空间与虚拟空间知识服务的主体技术，而知识单元的语义处理技术，包括识别、抽取、描述、组织与融汇则成为核心关键。

智能问答与智能综述将成为图书馆满足用户碎片化知识需求的主体方式，而沉浸式阅读必将成为图书馆满足用户系统化知识需求的实体空间和虚拟空间服务的核心

数字化网络化对传统图书馆产生了颠覆式的影响，智能化必将对图书馆员带来颠覆式影响，如何重新塑造图书馆员的角色十分紧迫而艰巨！

**谢谢！**