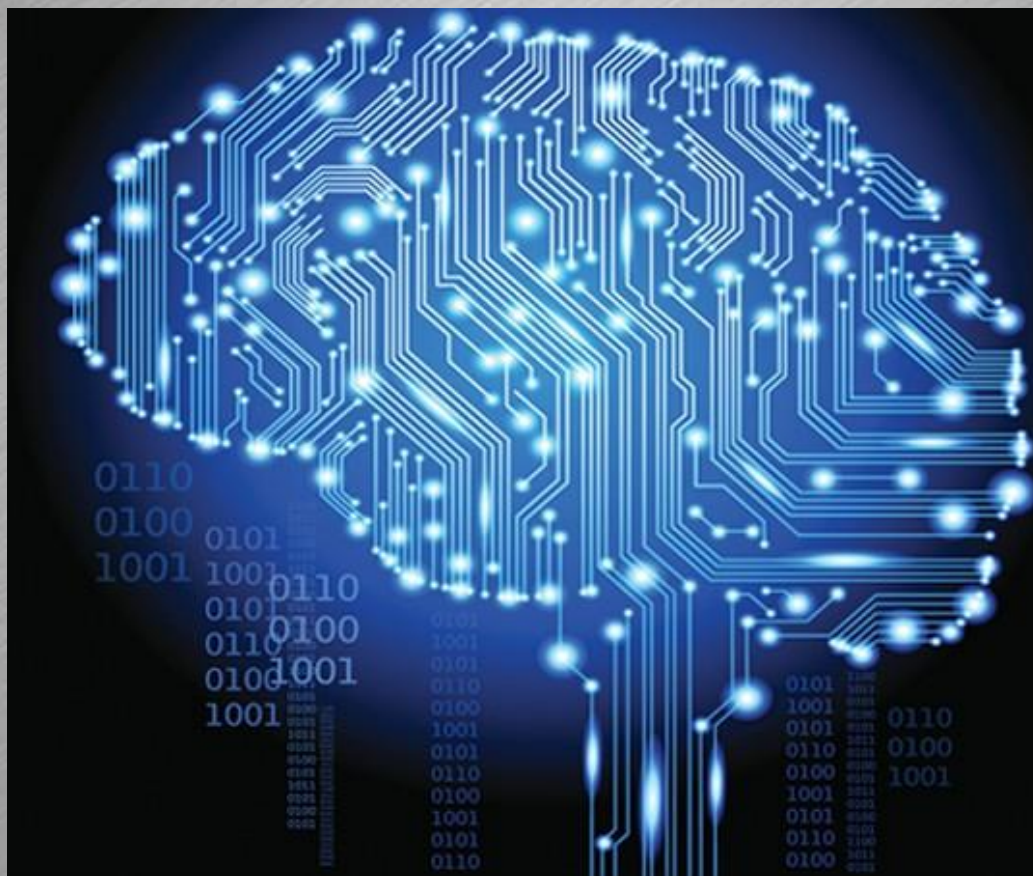


# ROS中的人工智能



马庆华

[956473807@qq.com](mailto:956473807@qq.com)

上海一坤

# 人工智能分支：

- 联结主义—CNN, DBN
- 符号主义—一阶/高阶谓词逻辑
- 行为主义—刺激和动作

# 人工智能要解决的问题：

- 自然语言处理
- 知识表示
- 推理
- 学习
- 规划
- 知觉

# 内容提要

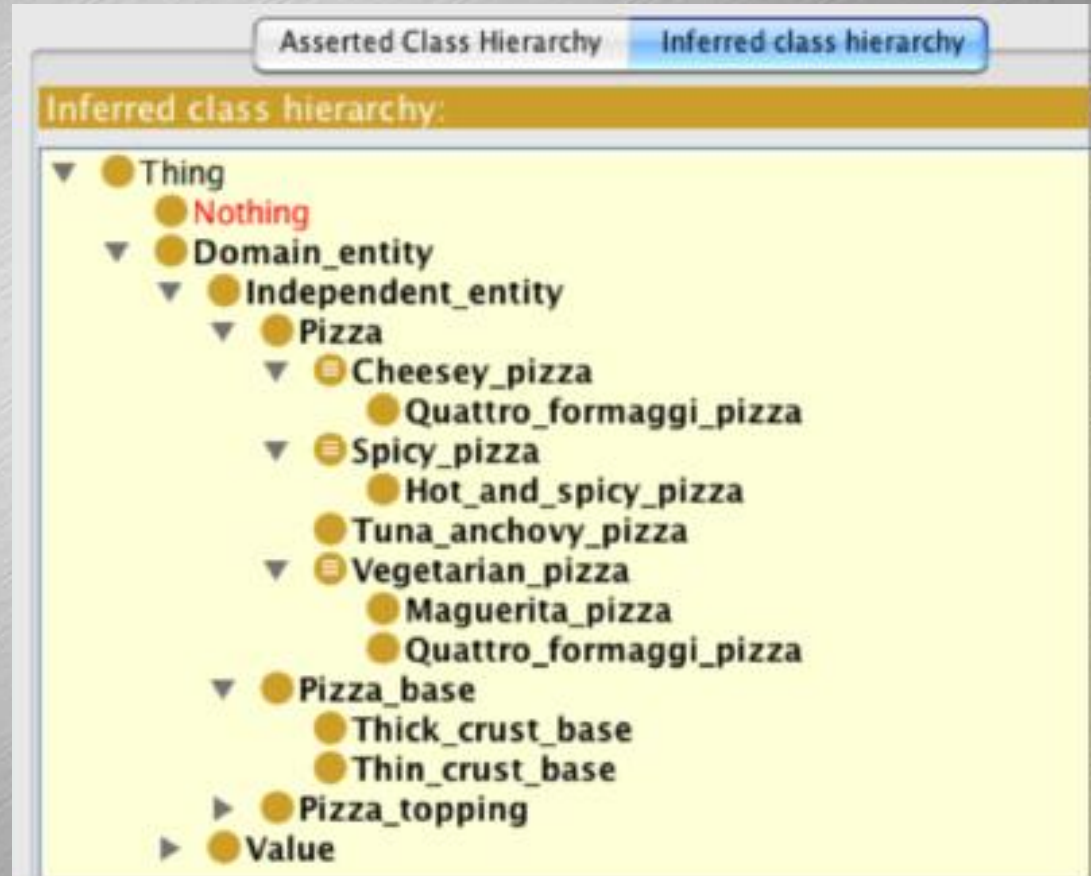
| 知识表示      | 谓词演算        | 语义地图     |
|-----------|-------------|----------|
| OWL与RDF   | 谓词演算与Prolog | 语义地图数据结构 |
| RoboEarth | KnowRob     | 构建语义地图   |
| RoboHow   | Rapyuta     | 语义地图推理   |

# OWL与RDF

RDF: 主体—属性—客体三元组

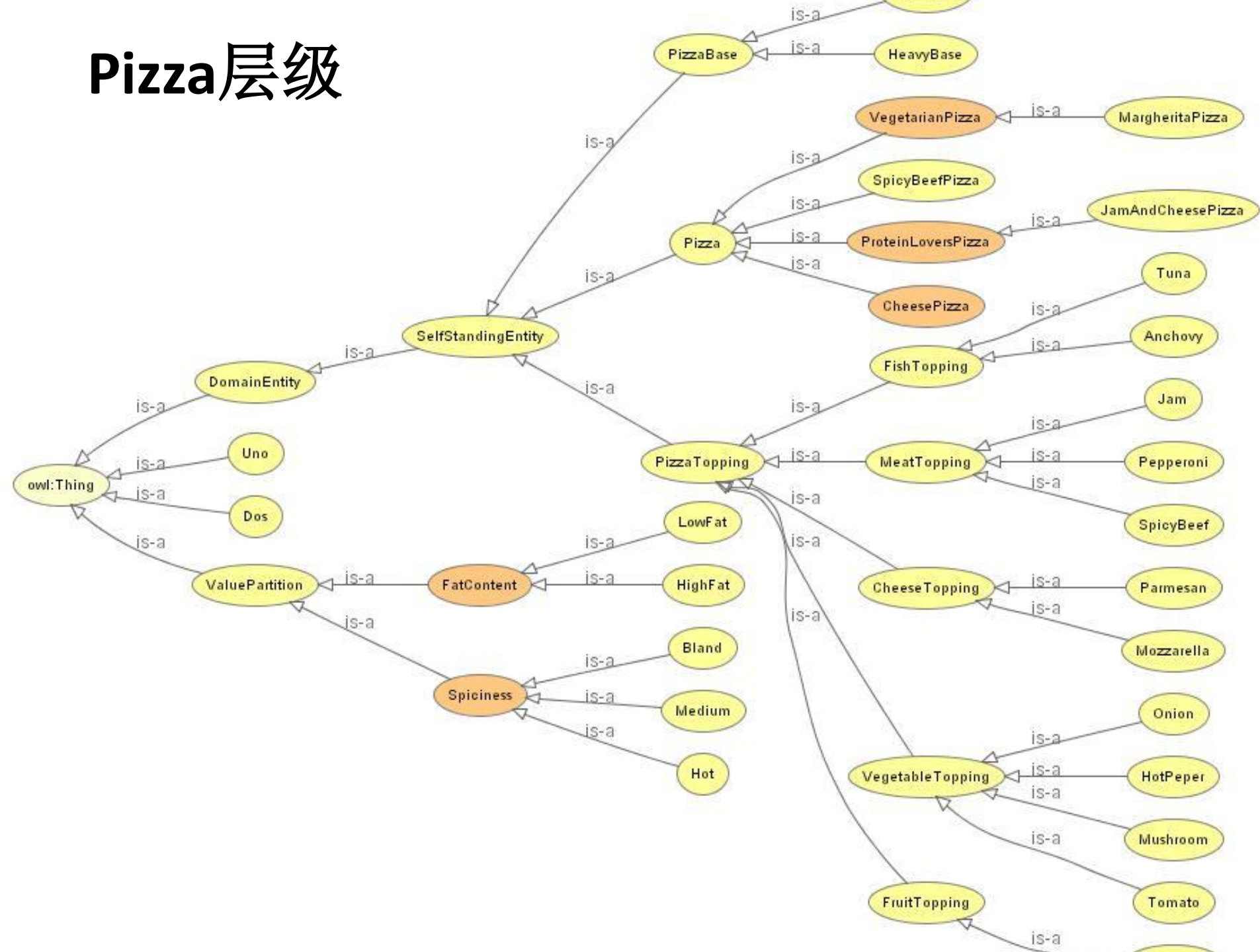
OWL: 类关系, 属性关系

结构化数据!





# Pizza层级



```
<owl:ObjectProperty rdf:about="#hasTopping">
<rdf:type rdf:resource="http://www.w3.org/2002/07/owl#InverseFunctionalProperty"/>
<rdfs:domain rdf:resource="#Pizza"/>
<rdfs:subPropertyOf rdf:resource="#hasIngredient"/>
<rdfs:range rdf:resource="#PizzaTopping"/>
<owl:inverseOf rdf:resource="#isToppingOf"/>
</owl:ObjectProperty>
```

```
<owl:Class rdf:about="#OliveTopping">
<rdfs:label xml:lang="pt">CoberturaDeAzeitona</rdfs:label>
<rdfs:subClassOf rdf:resource="#VegetableTopping"/>
```



## RoboEarth特色

- 基于Hadoop和Hue集群的非关系型数据库系统
- 基于LXC技术的云端处理集群
- 机器人互相分享信息地图、物体模型
- 机器人互相学习彼此的行为与环境
- 支持OWL（本体描述语言）和RDF(资源描述框架)等语义语言
- Knowrob一阶谓词逻辑运算

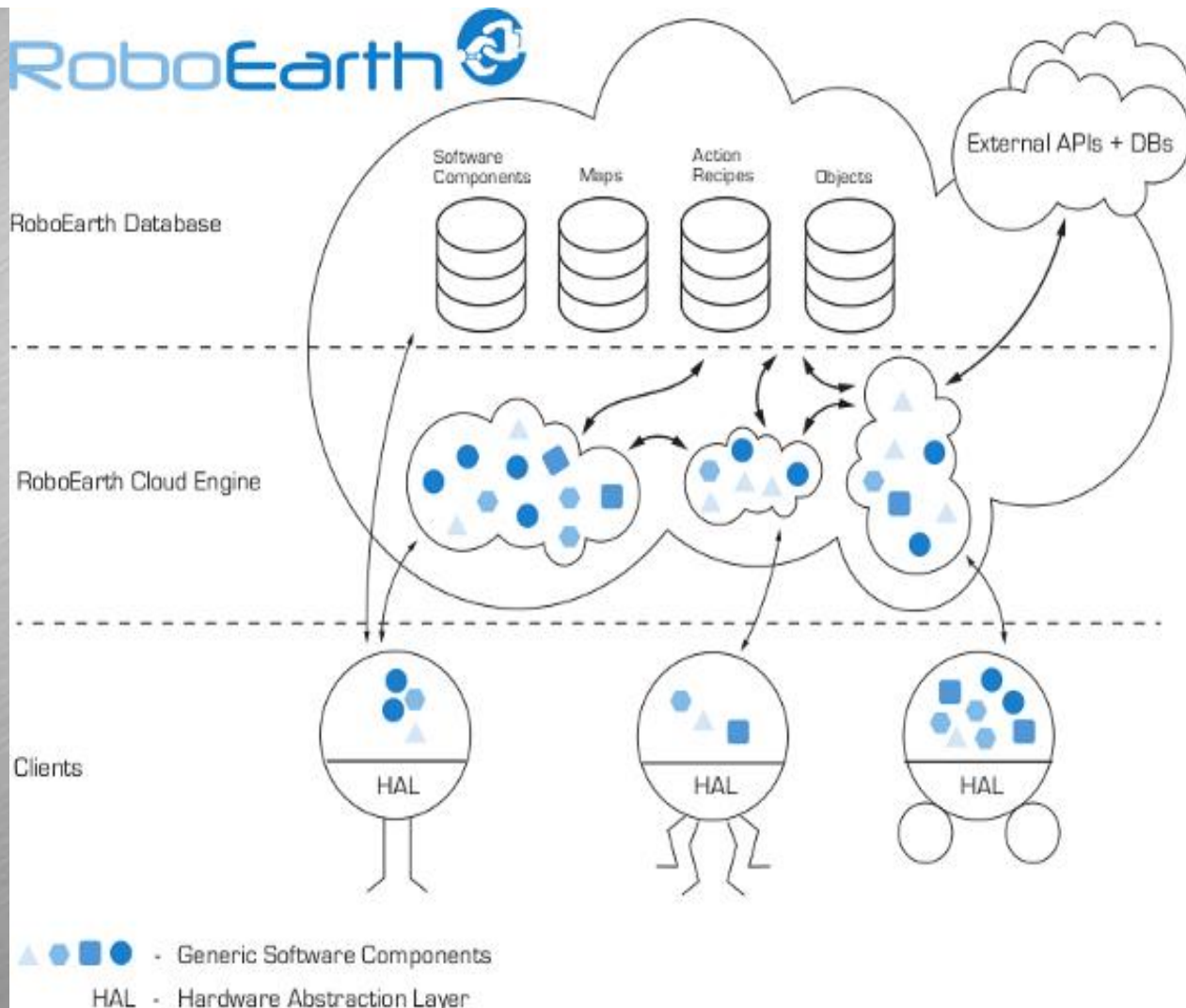


# RoboEarth

connecting robots worldwide



RoboEarth 



## RoboEarth架构

- 客户端
  - eg.ARM CPU
- 云处理
  - Rapyuta
- 云存储
  - hadoop集群



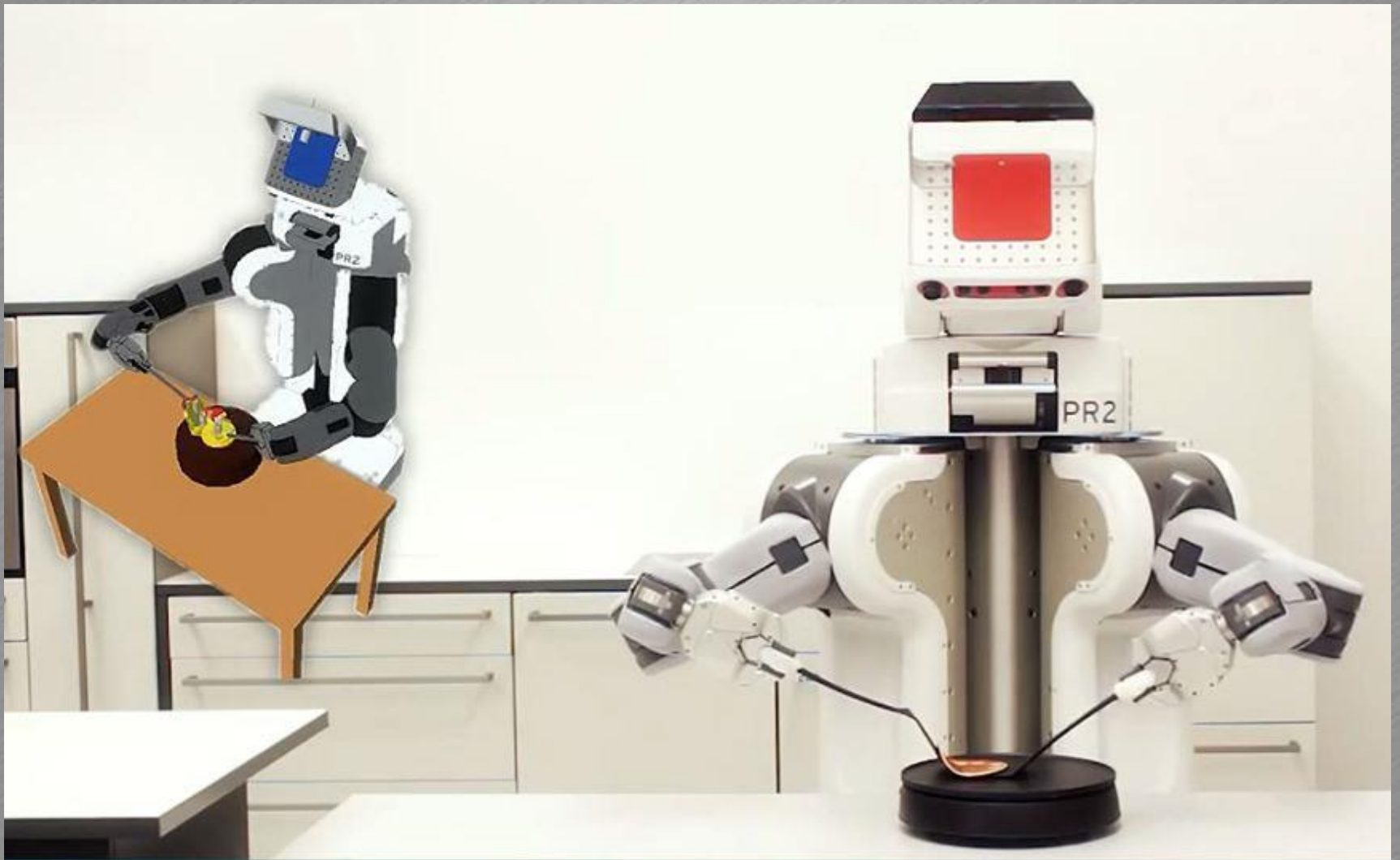
- **RoboHow**是一个为期四年的欧盟研究项目；
- 旨在使机器人能够完成人类工作和生活中的各种任务；
- **RoboHow**采用基于知识的机器人编程和控制方案；
- 目标是构建认知机器人系统，自主执行复杂的日常操作任务；
- 它能够通过网络和观察人类学习新技能。



# RoboHow核心组件

- **3D hand tracking library**—用于人类经验学习
- **CRAM**—行为规划
- **iTASC**—约束条件下动作生成
- **KnowRob**—知识表示与推理
- **PARMA**—物理感知操作，后续参数化行为推理
- **Semantic relations checking**—语义关系检测

# RoboHow 演示



These information sources are combined ...

# 谓词演算

|                      |     |
|----------------------|-----|
| 人皆有死.                | $P$ |
| 苏格拉底是人.              | $Q$ |
| <hr/>                |     |
| $\therefore$ 苏格拉底会死. | $R$ |

## 命题的局限

- 类—人
- 个体—苏格拉底
- 论域—所有
- 谓词—是 (is-a), 有 (has)
- 属性—死

## 谓词、连词、量词

### 消解原理

# Prolog

事实:

`human(kate).`

`human(bill).`

`likes(kate,bill).`

规则:

`friend(X,Y):-likes(X,Y),likes(Y,X).`

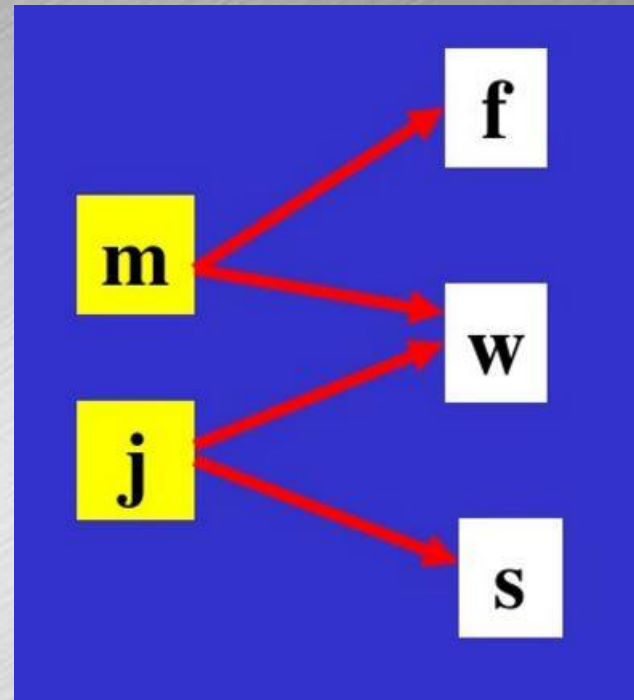
询问:

`?- likes(kate,X)`

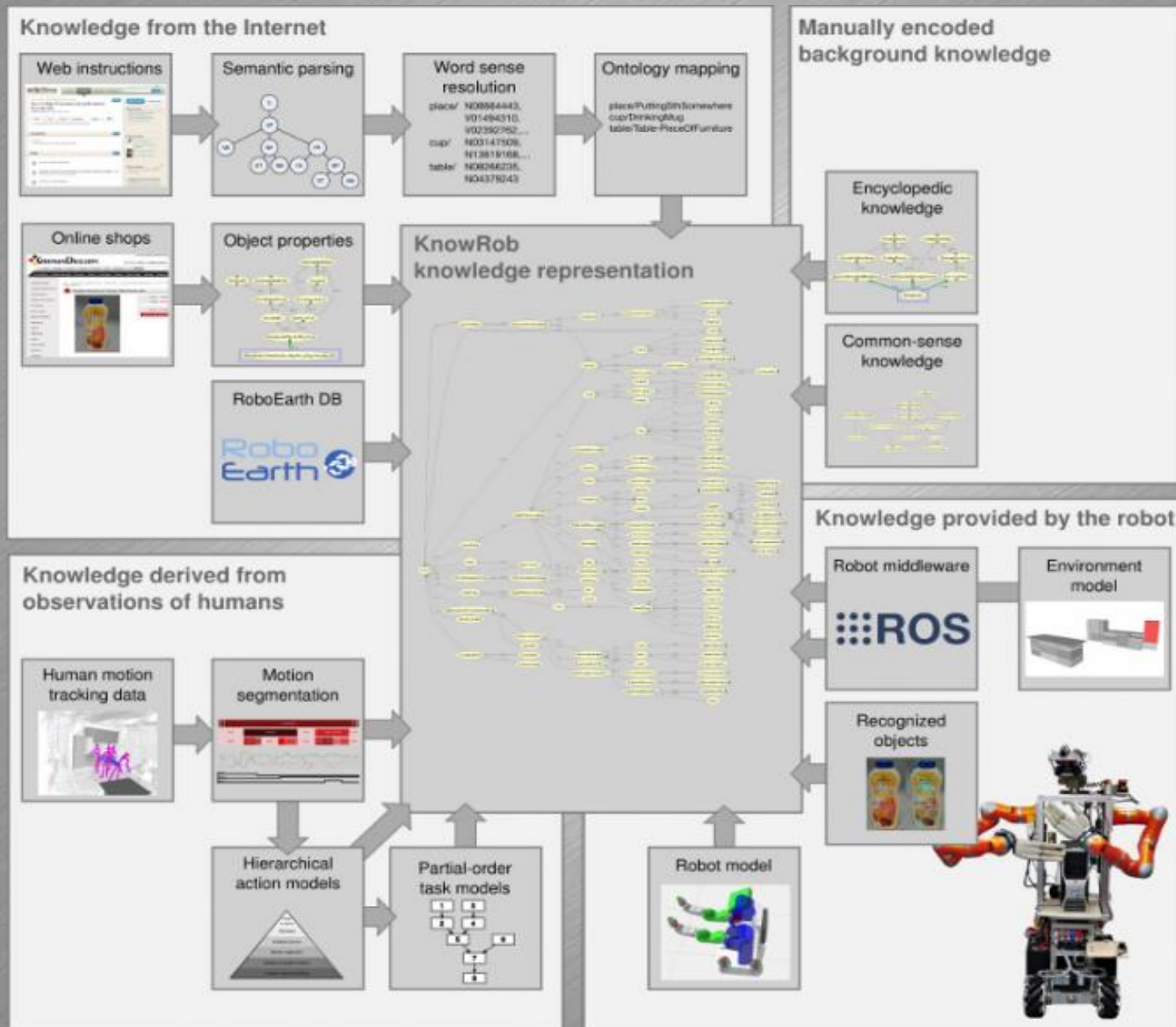
- bill

`?- friend(kate,X)`

- bill



# KnowRob: Knowledge processing for robots



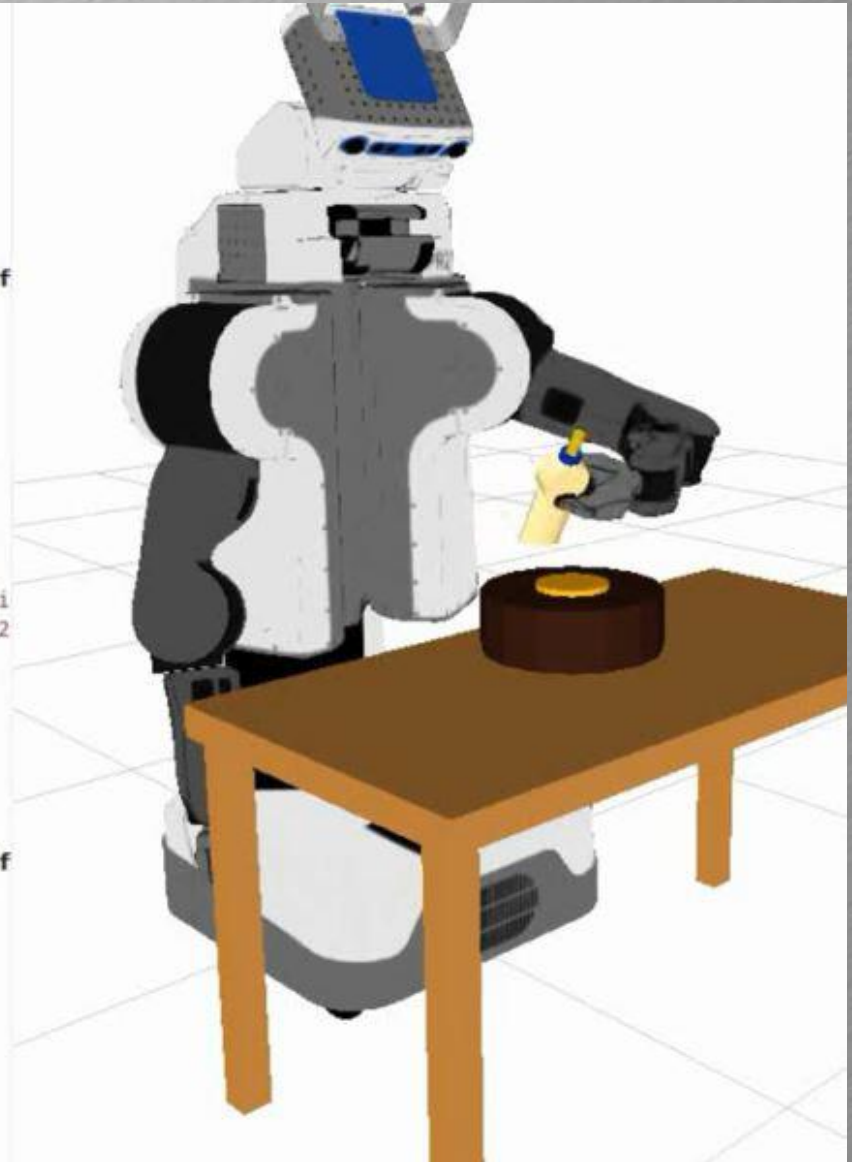
# KnowRob: Knowledge processing for robots

```
(sleep* 1)
(wait-for constraints-fulfilled-fluent :timeout 15)
(cram-fccl:cancel-motion controller))))))

et* ((controller (get-left-arm-controller))
      (motions (query-motion-description
                "motion:'PouringSomething'"
                "knowrob:'BottleCap'"
                "knowrob:'PancakeMaker'"))
      (constraints-fulfilled-fluent (cram-fccl:get-constraints-fulf
roller)))
(top-level
 (ensure-vel-controllers)
 (loop for motion in motions do
  (pursue
   (cram-fccl:command-motion controller motion)
   (seq
    (sleep* 1)
    (wait-for constraints-fulfilled-fluent :timeout 15)
    (cram-fccl:cancel-motion controller))))))

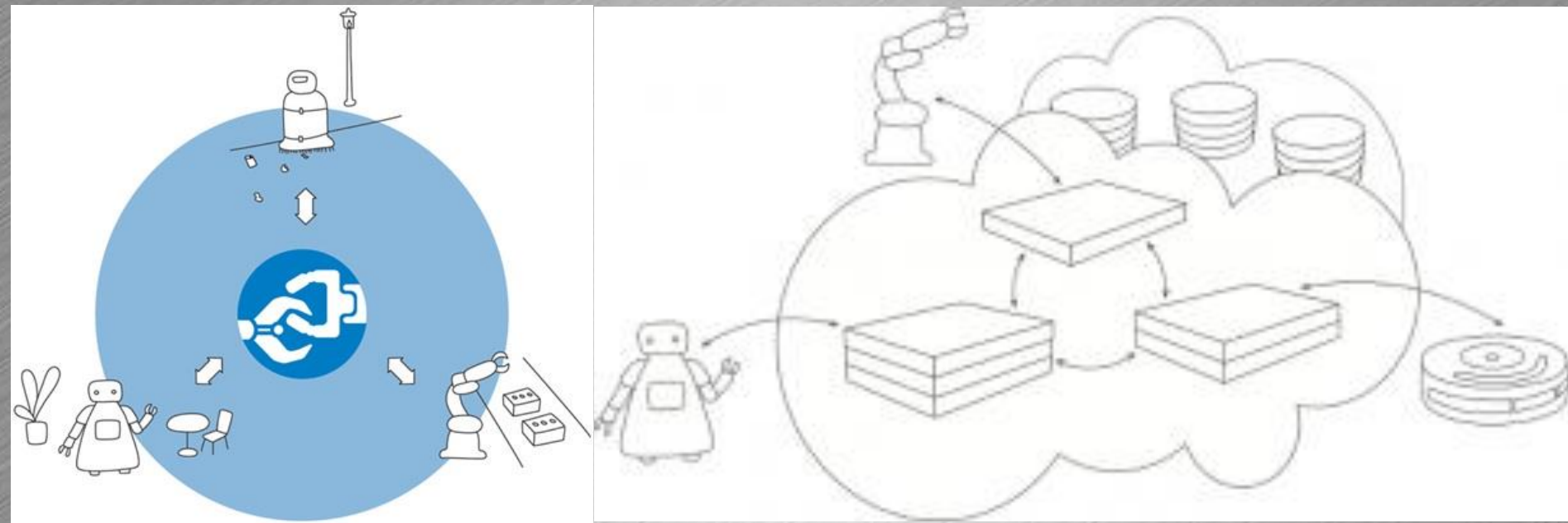
FOJ 1394118033.754: Ignoring connection attempt due to error parsi
f file on #<SB-SYS:FD-STREAM for "socket 127.0.1.1:45975, peer: 12
002AA2B33">'

et* ((controller (get-left-arm-controller))
      (motions (query-motion-description
                "motion:'PouringSomething'"
                "knowrob:'BottleCap'"
                "knowrob:'PancakeMaker'"))
      (constraints-fulfilled-fluent (cram-fccl:get-constraints-fulf
roller)))
(top-level
 (ensure-vel-controllers)
 (loop for motion in motions do
  (pursue
   (cram-fccl:command-motion controller motion)
   (seq
    (sleep* 1)
    (wait-for constraints-fulfilled-fluent :timeout 15)
    (cram-fccl:cancel-motion controller))))))
```



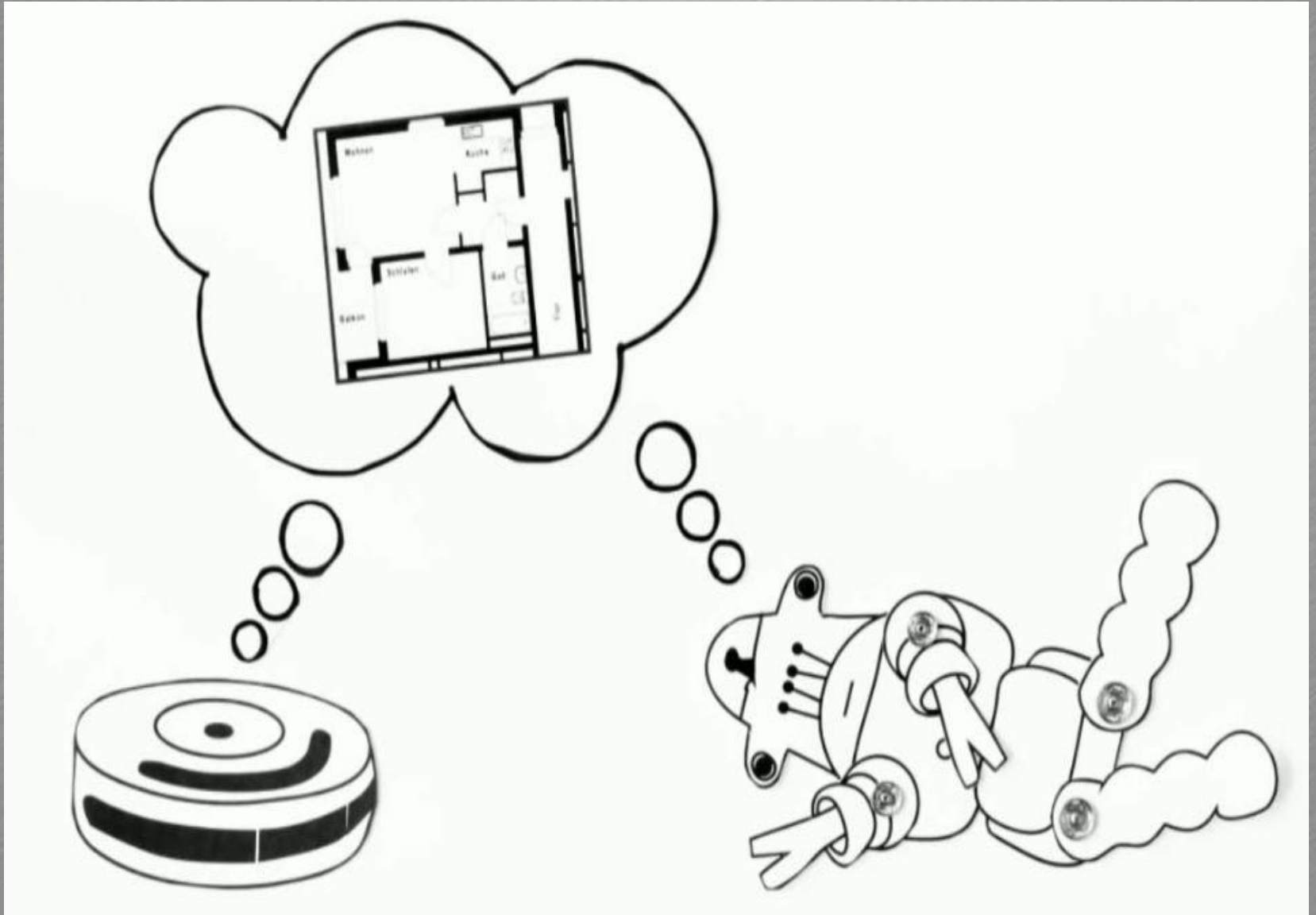


# Rapyuta云机器人框架



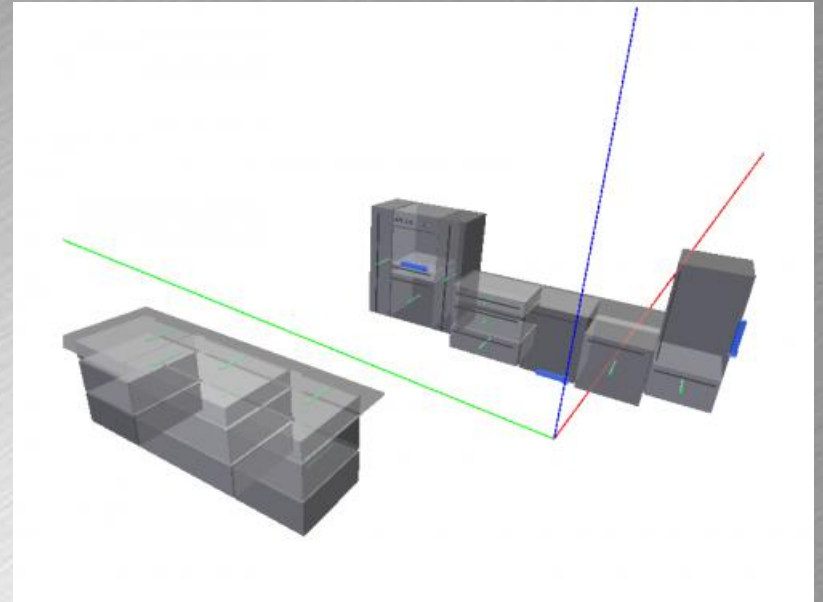
- 帮助机器人处理复杂计算
- 系统级复制
- 基于LXC，Linux轻量级虚拟化技术
- 与机器人通过websocket通讯，全双工
- 可运行任意多ROS节点

# Rapyuta 演示



# 语义地图

- 描述环境
- 保存物体位置
- OWL格式



## 构建语义地图

- 人工编辑
- 机器人感知并自主构建

# 语义地图结构

物体定义:

```
<owl:NamedIndividual rdf:about="&map_obj;sausage1">
  <rdf:type rdf:resource="&knowrob;Sausage"/>
  <knowrob:widthOfObject
rdf:datatype="&xsd;double">0.1</knowrob:widthOfObject>
  <knowrob:depthOfObject
rdf:datatype="&xsd;double">0.1</knowrob:depthOfObject>
  <knowrob:heightOfObject
rdf:datatype="&xsd;double">0.25</knowrob:heightOfObject>
  <knowrob:pathToCadModel
rdf:datatype="&xsd;string">package://knowrob_tutorial/cad/salame.kmz<
/knowrob:pathToCadModel>
  </owl:NamedIndividual>
```

物体变换矩阵

```
<owl:NamedIndividual rdf:about="&map_obj;RotationMatrix3D107">
  <rdf:type rdf:resource="&knowrob;RotationMatrix3D"/>
```

.....

# 从云端加载语义地图

endation

EXECUTE ON THE PLATFORM

```
graph TD; A[ ] --> B[listen-to-answer]; B --> C[answer-question]; C --> D[nod-towards-product];
```

**listen-to-answer**  
type: SpeechRecognitionRoIS  
conditionXml: speech-recognition.xml

**answer-question**  
type: SpeechSynthesisRoIS  
conditionXml: speech-synthesis.xml  
spokenText: Green tea can be found in the shelf over there.

**nod-towards-product**  
type: ReactionRoIS  
reactionType: NOD\_TO\_REMOTE\_1  
conditionXml: reaction.xml

**RECIPE PROPERTIES**

<http://www.mindwear.com/robotwear.html>

SPACE ID

default1 SELECT

START ACTION


nod-towards-product SELECT

END ACTION

**NO NOD ACTION TO RECIPE**

**CREATE NEW RECIPE**

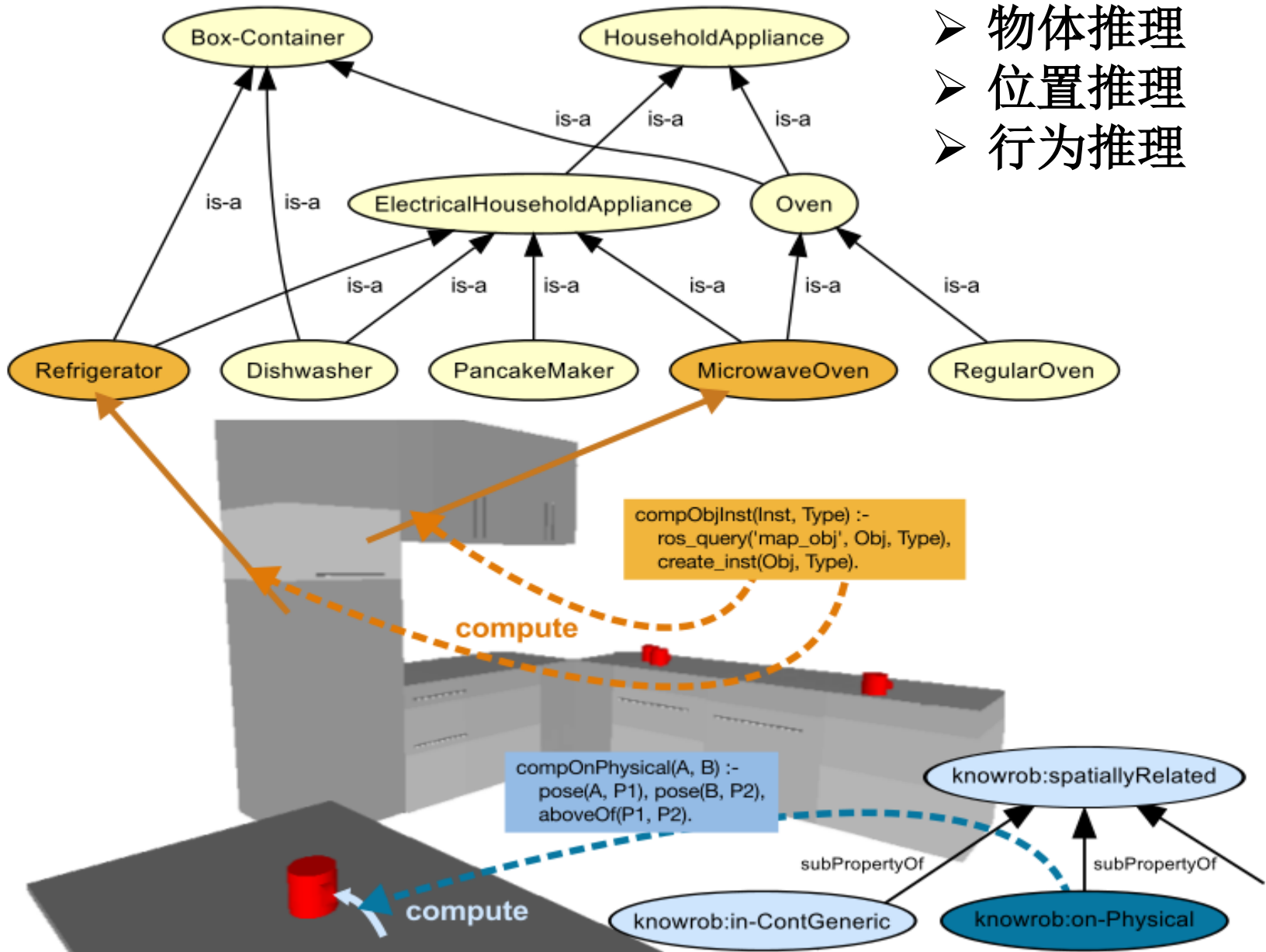
UnassignedRoISForRecipe



The image shows a robot with a black and red body and a white head with a large eye, standing in a store aisle. The robot is facing right, looking towards a shelf of products. The background shows shelves stocked with various items, including what appears to be tea or coffee packages.

# 语义地图推理

- 物体推理
- 位置推理
- 行为推理



# RoboEarth 演示



# QUESTIONS?

马庆华

13564147965

[956473807@qq.com](mailto:956473807@qq.com)

上海一坤电气工程有限公司