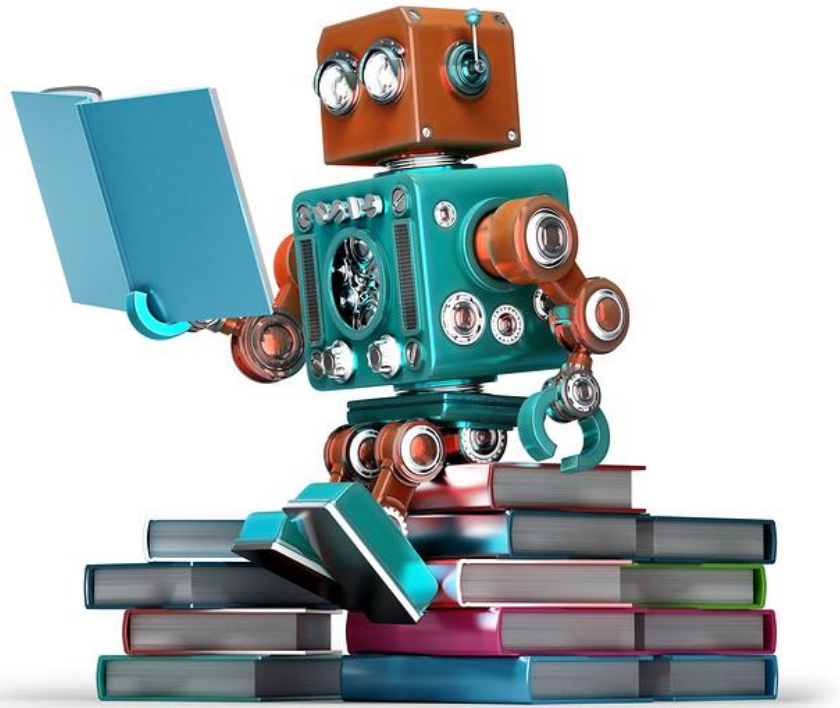
MACHINE REASONING
DAY 1



https://robohub.org/wp-content/uploads/2016/11/bigstock-Retro-Robot-Reading-A-Book-Is-110707406.jpg

DAY 1 AGENDA

1.1 Machine Reasoning Overview

1.2 Reasoning Types

1.3 Reasoning System Architectures

1.4 Rule/Process Reasoning System **Workshop**

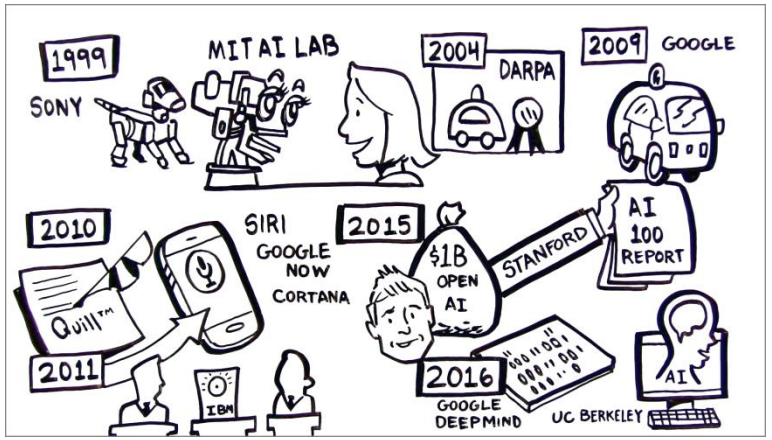
DAY 1 TIMETABLE

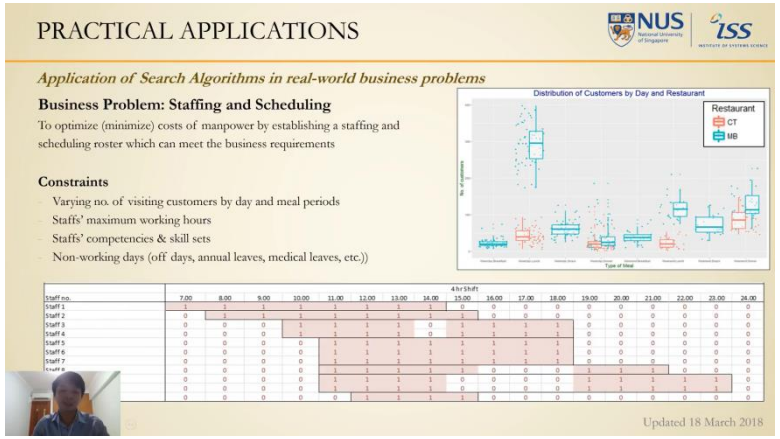
No	Time	Topic	By Whom	Where
1	9 am	Welcome and Introduction	GU Zhan (Sam)	Class
2	9.30 am	1.1 Machine Reasoning Overview	GU Zhan (Sam)	Class
3	10.10 am	Morning Break		
4	10.30 am	1.2 Reasoning Types	GU Zhan (Sam)	Class
5	12.10 pm	Lunch Break		
6	1.30 pm	1.3 Reasoning System Architectures	GU Zhan (Sam)	Class
7	2 pm	1.4 Rule/Process Reasoning System Workshop Tutorial	GU Zhan (Sam) All	Class
8	3.10 pm	Afternoon Break		
9	3.30 pm	1.4 Rule/Process Reasoning System Workshop	All	Class
10	4.50 pm	Summary and Review	All	Class
11	5 pm	End		

1.1
MACHINE REASONING OVERVIEW

1.1 REASONING SYSTEMS OVERVIEW

- **AI is a grand reasoning system.**





1.1 MACHINE REASONING OVERVIEW

- Reasoning
- Thinking
- Learning
- Cognition
- Artificial Intelligence

1.1 MACHINE REASONING OVERVIEW

- **Reasoning** **Forward Chaining Inference**

  is the capacity for consciously making sense of things, establishing and verifying facts, applying logic, and changing or justifying practices, institutions, and beliefs based on new or existing information.

- **Examples?**
  - Does this course look difficult to me?
  - Is the lecturer knowledgeable and competent?
  - Do my classmates appear to be smarter than I?
  - Am I likely to pass the course assessment?

1.1 MACHINE REASONING OVERVIEW

- **Thinking** **Backward Chaining Inference**

  encompasses a "goal oriented flow of ideas and associations that leads to a reality-oriented conclusion."

- **Examples?**
  - I'd like to pass the course assessment…
  - What actions can I take to pass the course assessment?
  - I'd like to get NUS master degree…
  - What legitimate "optimization" can I do?

1.1 MACHINE REASONING OVERVIEW

- **Learning** **Knowledge Acquisition & Representation; Rule Extraction**

  is the process of acquiring new, or modifying existing, knowledge, behaviours, skills, values, or preferences.

- **Examples?**
  - Tell me, I shall hear.
  - Show me, I shall see.
  - But involve me, I shall learn.
  - Lecture, workshop, and further self study can enable me to build intelligent software to create business impact.

1.1 MACHINE REASONING OVERVIEW

- **Cognition** **used by human to solve problem in fuzzy real world**

  is the set of all mental abilities and processes related to knowledge, attention, memory, judgment and evaluation, reasoning and "computation", problem solving and decision making, comprehension and production of language.

- **Examples?**
  - Survival phase : How can we eat?
  - Inquiry phase : Why do we eat?
  - Sophistication phase : Where shall we have lunch?

Douglas Adams < The Restaurant at the End of the Universe >

1.1 MACHINE REASONING OVERVIEW

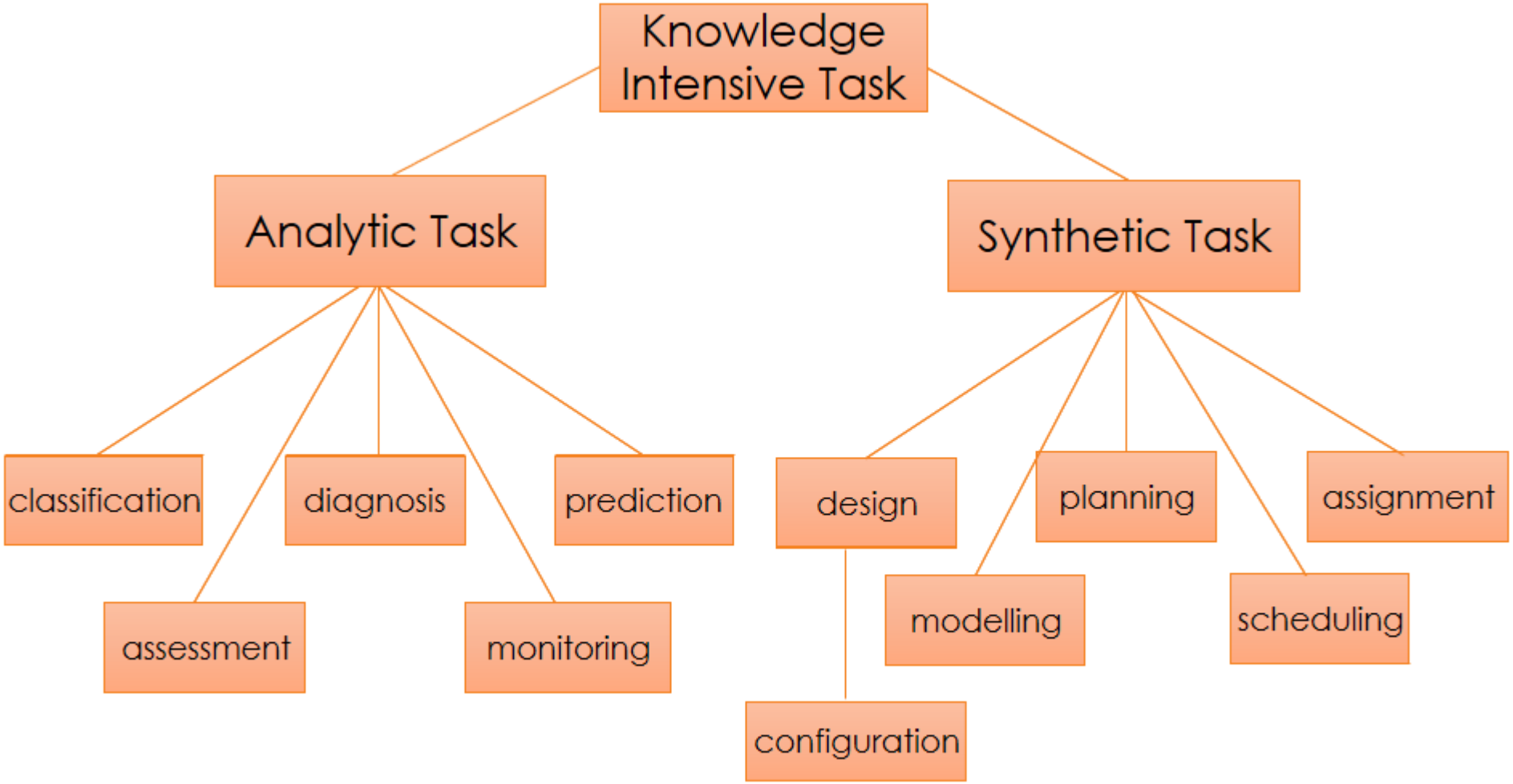
- **Artificial Intelligence** **used by machine to solve problem in fuzzy real world**

  is intelligence demonstrated by machines, which mimics "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving".

- **Examples?**
  - Automated Cheque Recognition & Clearing
  - Algorithmic Trading System
  - High Frequency Trading System
  - DOTA2 Game Playing AI

1.1 MACHINE REASONING OVERVIEW

Problem Solving Task Hierarchy



1.1 MACHINE REASONING OVERVIEW

Problem Solving Task Types

- **Analytic Tasks**
  - System to be analysed pre-exists, but usually not completely "known".
  - Input: some data to trigger the system (e.g. patient symptoms)
  - Output: some characterization or behaviours about the system (e.g. cause of illness)
- **Synthetic Tasks**
  - System does not yet exist.
  - Input: requirements about system to be constructed
  - Output: constructed system description

1.1 MACHINE REASONING OVERVIEW

Problem Solving of Analytic Tasks

- **Analytic Tasks**

  Identification, Classification, Prediction, Clustering/Grouping, …

- **Techniques (S-MR Machine Reasoning)**

  Heuristic Business Rules

  Decision Trees

  Case Based Reasoning

  Fuzzy Logic

  Rule Induction

  Machine Learning

  …

1.1 MACHINE REASONING OVERVIEW

Problem Solving of Synthetic Tasks

- **Synthetic Tasks**

  Planning, Scheduling, Optimisation, Design, …

- **Techniques (S-RS Reasoning Systems)**

  Uninformed (brute force / blind) Search

  Informed (heuristic) Search

  Simulations

  Genetic Algorithms

  Reinforcement Learning

  Data Mining

  …

1.2
REASONING TYPES

1.2 REASONING TYPES

- Deductive Reasoning
- Inductive Reasoning
- Analogical Reasoning
- Abductive Reasoning
- Fuzzy Reasoning

1.2 REASONING TYPES

Deductive Reasoning

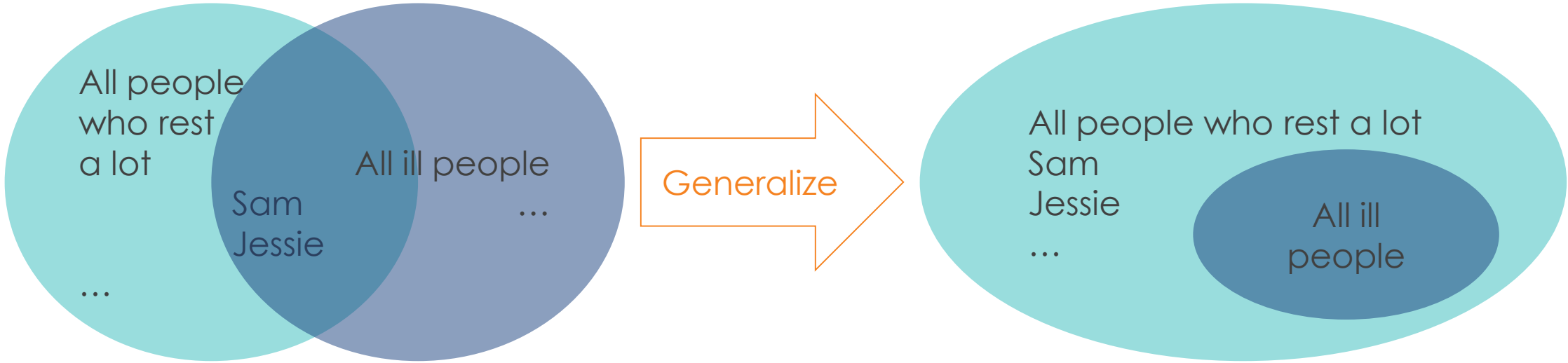
- **Knowledge/Rule : All ill people need rest a lot.**
- **Individual 1 : Sam is ill, therefore he need rest a lot.**
- **Individual 2 : Jessie is ill, therefore she need rest a lot.**
- **Individual …**

☺ Reasoning Rationality: Universal → Individual

1.2 REASONING TYPES

Inductive Reasoning

- **Individual 1** : When Sam is ill, he rests a lot.
- **Individual 2** : When Jessie is ill, she rests a lot.
- **Generalised Rule** : All people who rest a lot, they are ill.

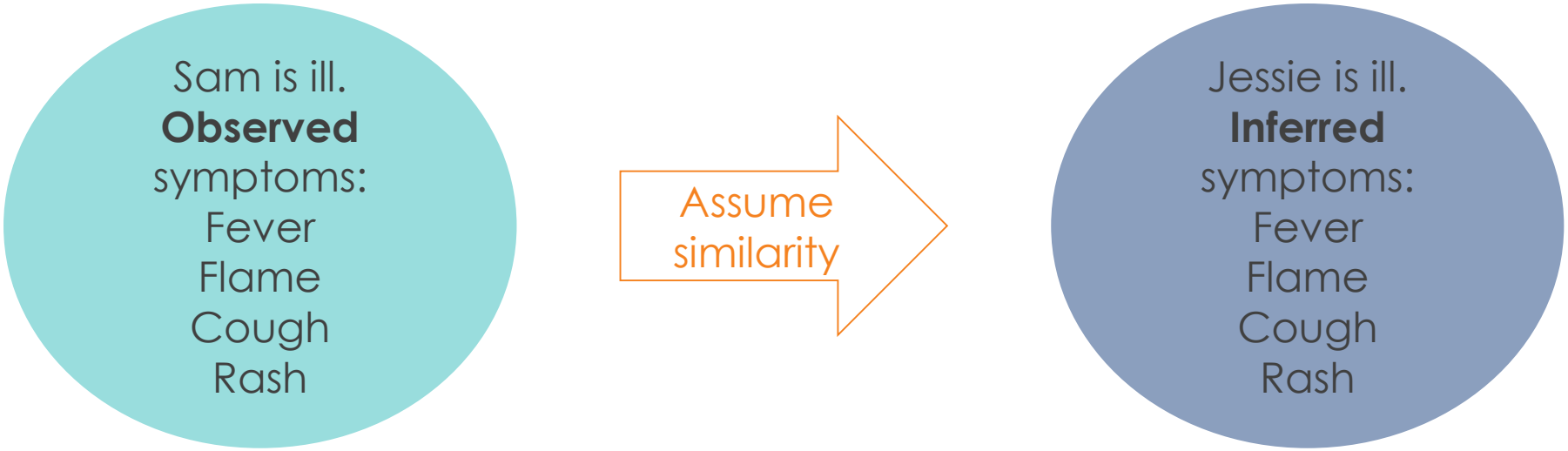


☺ **Reasoning Rationality: Individual → Universal** (Machine Learning)

1.2 REASONING TYPES

Analogical Reasoning

- **Known case** : **Sam is ill with his symptoms: fever, flame, cough, and rash.**
- **Inferred case** : **Jessie is ill too, therefore she would have same symptoms as Sam: fever, flame, cough, and rash.**

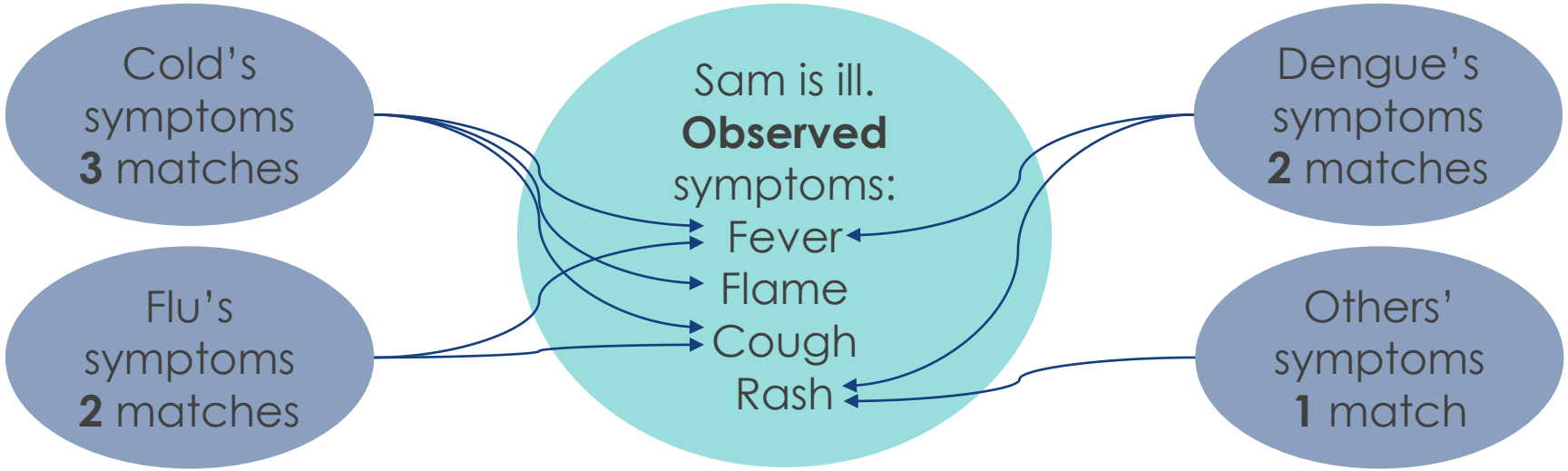


☺ **Reasoning Rationality: Known case → Inferred case**

1.2 REASONING TYPES

Abductive Reasoning

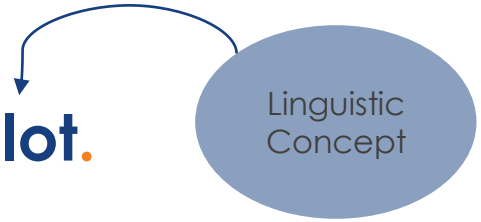
- **Known observations** : Sam is ill with his symptoms: fever, flame, cough, and rash.
- **Inferred root cause** : **Cold? Flu? Dengue? Others?**



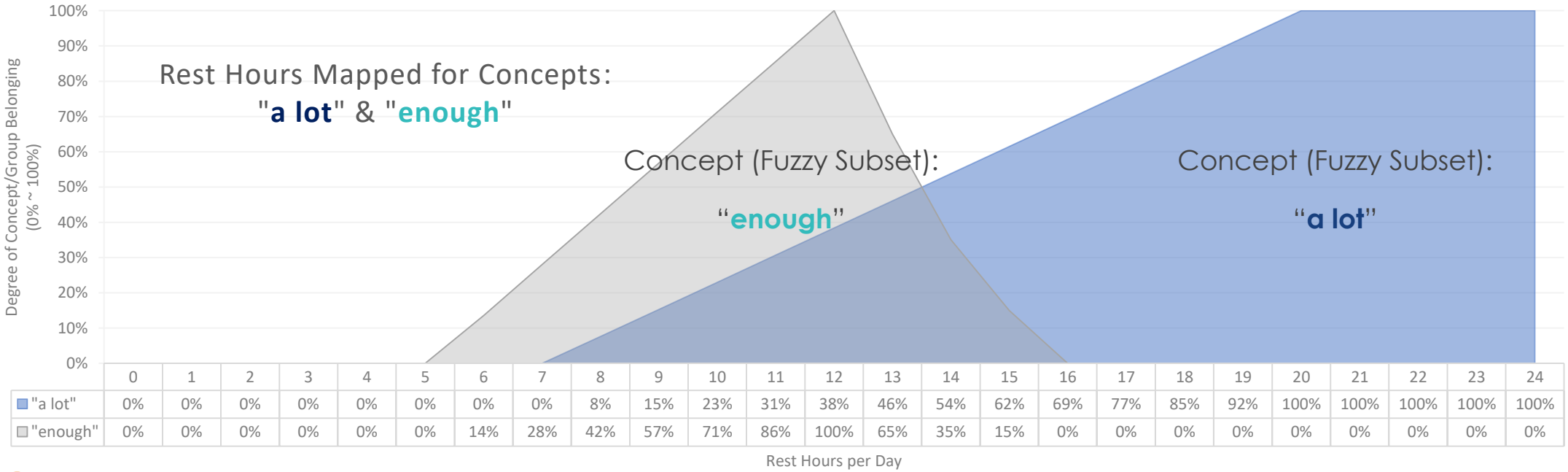
☺ **Reasoning Rationality: Observations → Causes likelihood**

1.2 REASONING TYPES

Fuzzy Reasoning



- **Imprecise Knowledge** : All ill people need rests **a lot.**
- **Precise measurement** : How many hours/minutes per day is considered as "**a lot**"?



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
"a lot"	0%	0%	0%	0%	0%	0%	0%	0%	8%	15%	23%	31%	38%	46%	54%	62%	69%	77%	85%	92%	100%	100%	100%	100%	100%
"enough"	0%	0%	0%	0%	0%	0%	14%	28%	42%	57%	71%	86%	100%	65%	35%	15%	0%	0%	0%	0%	0%	0%	0%	0%	0%

☺ **Reasoning Rationality: Imprecise → Precise** (measures/actions)

1.2 REASONING TYPES

Exercise 1.2

- **What's the reasoning type of below two tasks?**

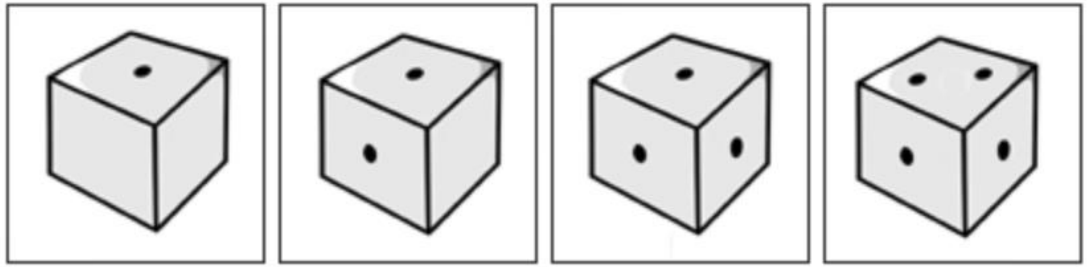
Statement Knowledge:

1) All hamburgers are meals
2) Some cows are hamburgers

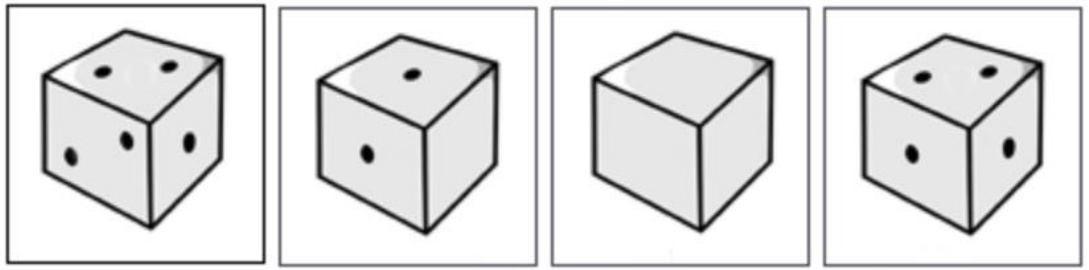
Candidate answers:

a) All meals are cows
b) At least some meals are cows
c) No cows are meals
d) Some cows are no meal

Sequence Knowledge:



Candidate next steps:



https://www.fibonicci.com/logical-reasoning/

1.3
REASONING SYSTEM ARCHITECTURES

1.3 REASONING SYSTEM ARCHITECTURES

Static Reasoning

- Logic programs
- Deductive classifier
- Rule based systems
- Fuzzy systems
- Case-based reasoning systems

Dynamic Reasoning

- Search systems
- Simulation systems
- Optimization systems
- Recommendation systems
- Knowledge Discovery systems (Data Mining, Machine Learning)
- Hybrid systems

Cognitive Reasoning

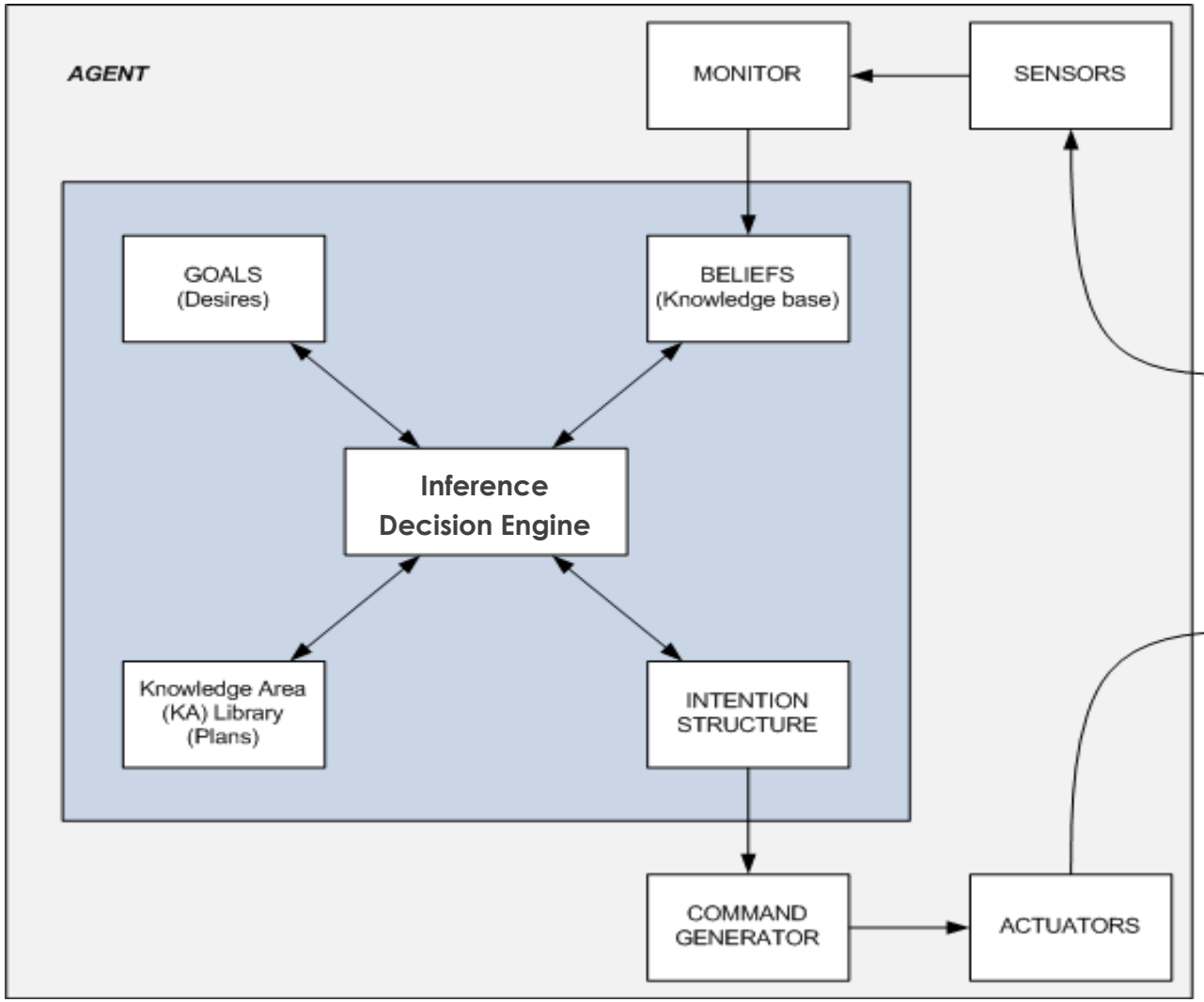
- Semantic systems (knowledge graph)
- Natural language systems
- Question Answering systems
- Negotiation & Debate systems
- Multi Agent systems (Swarm Intelligence)
- Chat-bot systems

1.3 REASONING SYSTEM ARCHITECTURES

- **Proactive Reasoning Systems (Goal Driven)**
  - Autonomous Software System (Sales Chabot, Robotic Process Automation)
  - Multi Agent Cooperative System (Warehouse Robotic Swarm, Coordinated Robotic Cleaners)
  - Constrain Solver (Global Travel Planner)
- **Reactive Reasoning Systems (Data Driven)**
  - Business Rule Management System (BRMS)
  - Business Process Management System (BPMS)
  - Constrain Solver (Delivery Vehicles Scheduler)

1.3 REASONING SYSTEM ARCHITECTURES

Goal Driven Systems



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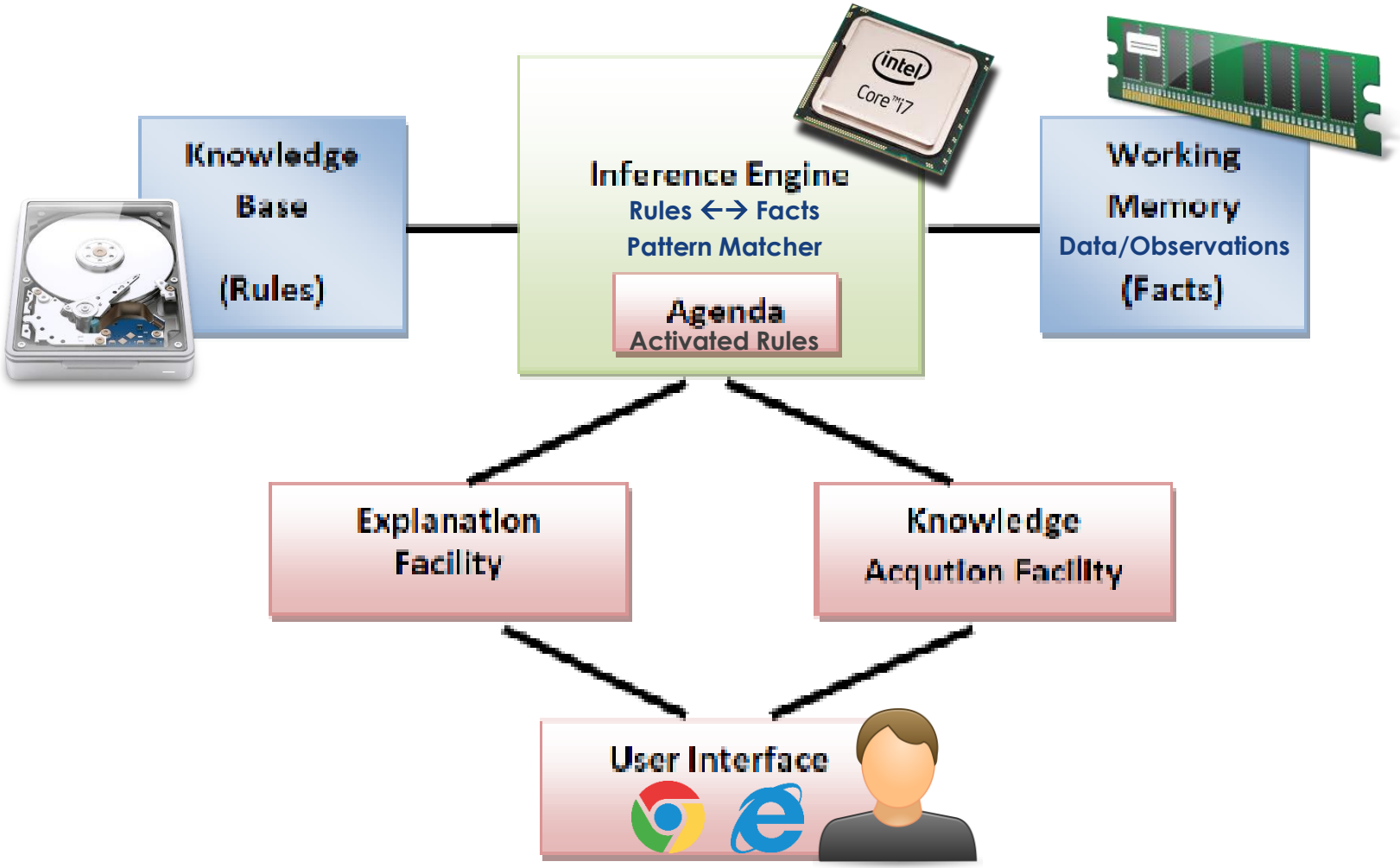
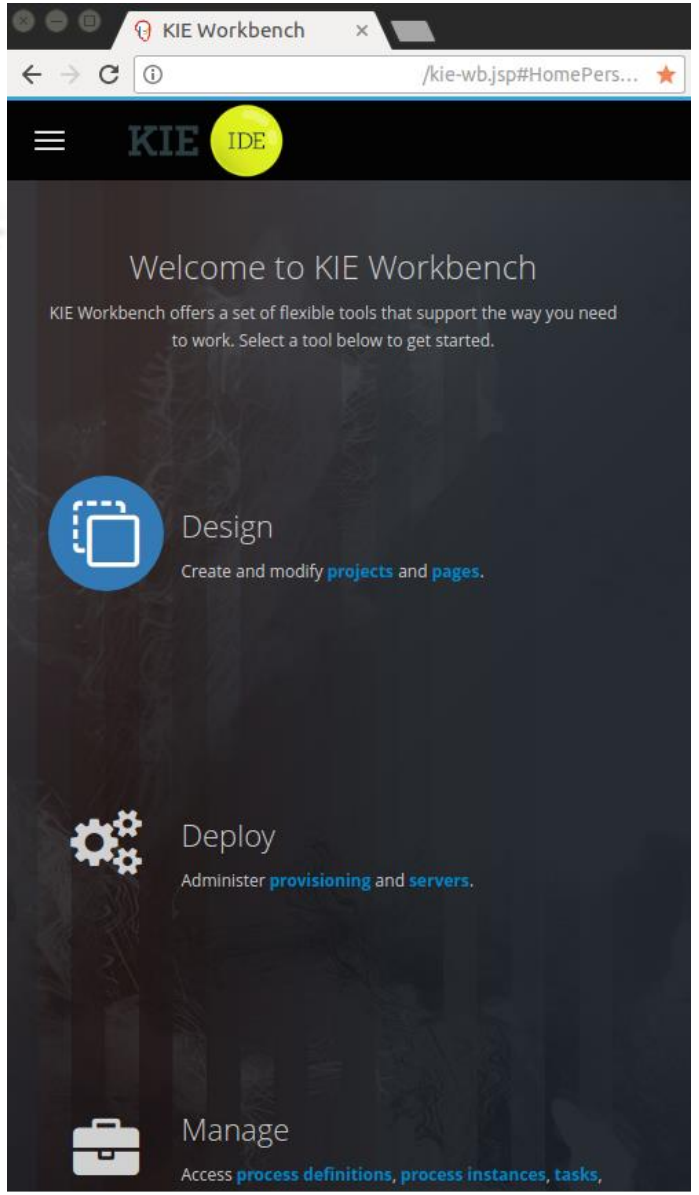
1.3 REASONING SYSTEM ARCHITECTURES

Data (Fact/Rule/Process) Driven Systems



https://www.researchgate.net/profile/Bhavani_Panda/publication/232707515/figure/fig2/AS:339607343386657@1457980108974/Fig2-Structure-of-a-rule-based-expert-system.png



1.4 WORKSHOP

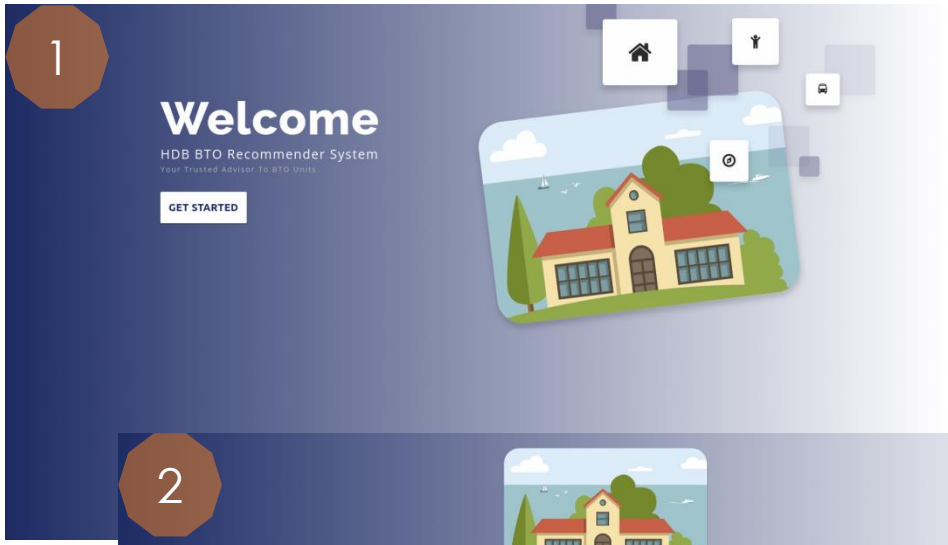
RULE/PROCESS REASONING SYSTEM

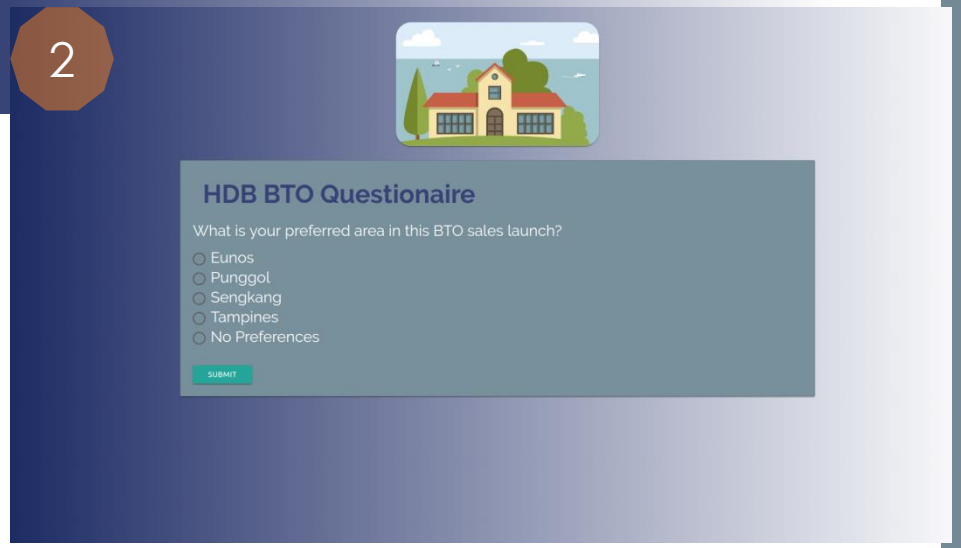
1.4 WORKSHOP RULE/PROCESS REASONING SYSTEM

- **Case Study of HDB BTO Recommender**
  - Use case demo
  - System analysis & exploration
- **KIE Development Suite Tutorial**
  - Access KIE "**Knowledge Is Everything**"
  - KIE components: KIE Workbench, Rule Engine, and Server
  - KIE Workbench development functions
  - Reasoning system development using KIE Workbench
- **KIE Development – Individual Work**
  - Example KIE reasoning systems

1.4 WORKSHOP RULE/PROCESS REASONING SYSTEM

Case Study of HDB BTO Recommender





Project	Address	Block	Level	Unit	Price	Room Type	Direction	Floor Area	Completion Date
FERNVALE GLADES	SENGKANG WEST WAY	460A	14	77	$402,000	5-room	N-S	113 Sqm	30-Apr-21
FERNVALE GLADES	SENGKANG WEST WAY	460B	14	103	$402,000	5-room	N-S	113 Sqm	30-Apr-21
FERNVALE GLADES	SENGKANG WEST WAY	461B	14	133	$402,000	5-room	N-S	113 Sqm	30-Jun-21

Alternatives which may interest you (based on top result)
5-room Units for Block 460A in Project FERNVALE GLADES:
Available Booked

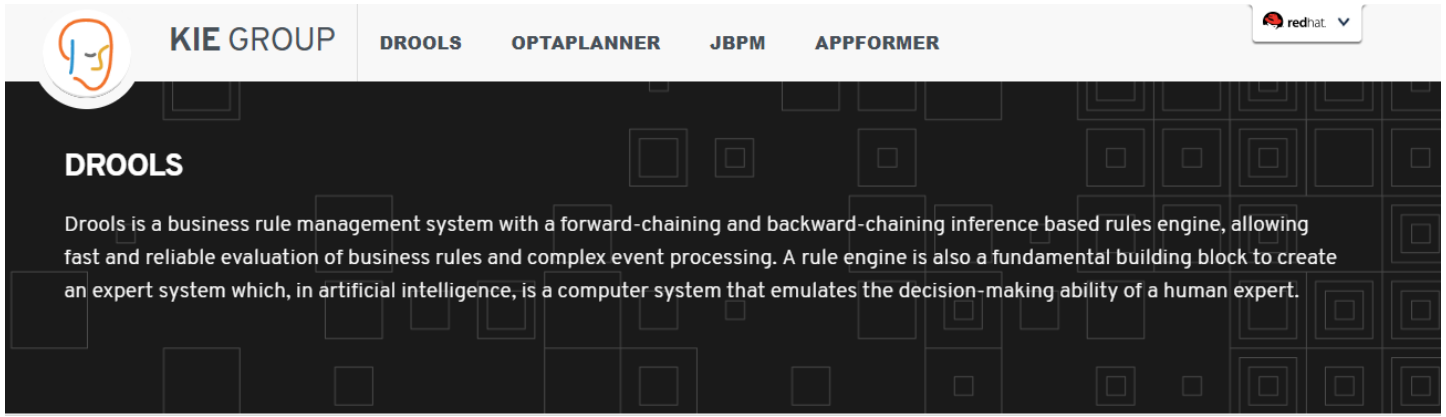
Level / Unit	77	79	87	89
14	$402,000	$402,000	$402,000	$402,000
13	$396,500	$396,500	$396,500	$396,500
12	$391,000	$391,000	$391,000	$391,000
11	$385,500	$385,500	$385,500	$385,500
10	$380,000	$380,000	$380,000	$380,000
9	$374,500	$374,500	$374,500	$374,500
8	$369,000	$369,000	$369,000	$369,000
7	$363,500	$363,500	$363,500	$363,500
6	$358,000	$358,000	$358,000	$358,000
5	$352,500	$352,500	$352,500	$352,500
4	$347,000	$347,000	$347,000	$347,000
3	$341,500	$341,500	$341,500	$341,500
2	$336,000	$336,000	$336,000	$336,000

Demo System : http://www.bit.ly/iss-vm

Source Code : https://github.com/telescopeuser/bto-recommender-system

1.4 WORKSHOP RULE/PROCESS REASONING SYSTEM

KIE Development Suite Tutorial



DROOLS

Drools is a business rule management system with a forward-chaining and backward-chaining inference based rules engine, allowing fast and reliable evaluation of business rules and complex event processing.

Read more →

OPTAPLANNER

OptaPlanner is a constraint solver that optimizes use cases such as employee rostering, vehicle routing, task assignment and cloud optimization.

Read more →

JBPM

jBPM is a flexible Business Process Management suite allowing you to model your business goals by describing the steps that need to be executed to achieve those goals.

Read more →

APPFORMER

AppFormer is a low code platform to develop modern applications. It's a powerful tool for developers that can easily build applications by mashing up components and connect them to other Red Hat modules and software.

We make building apps looks easy.

Read more →

JBoss KIE

http://www.kiegroup.org/

JBoss KIE DROOLS

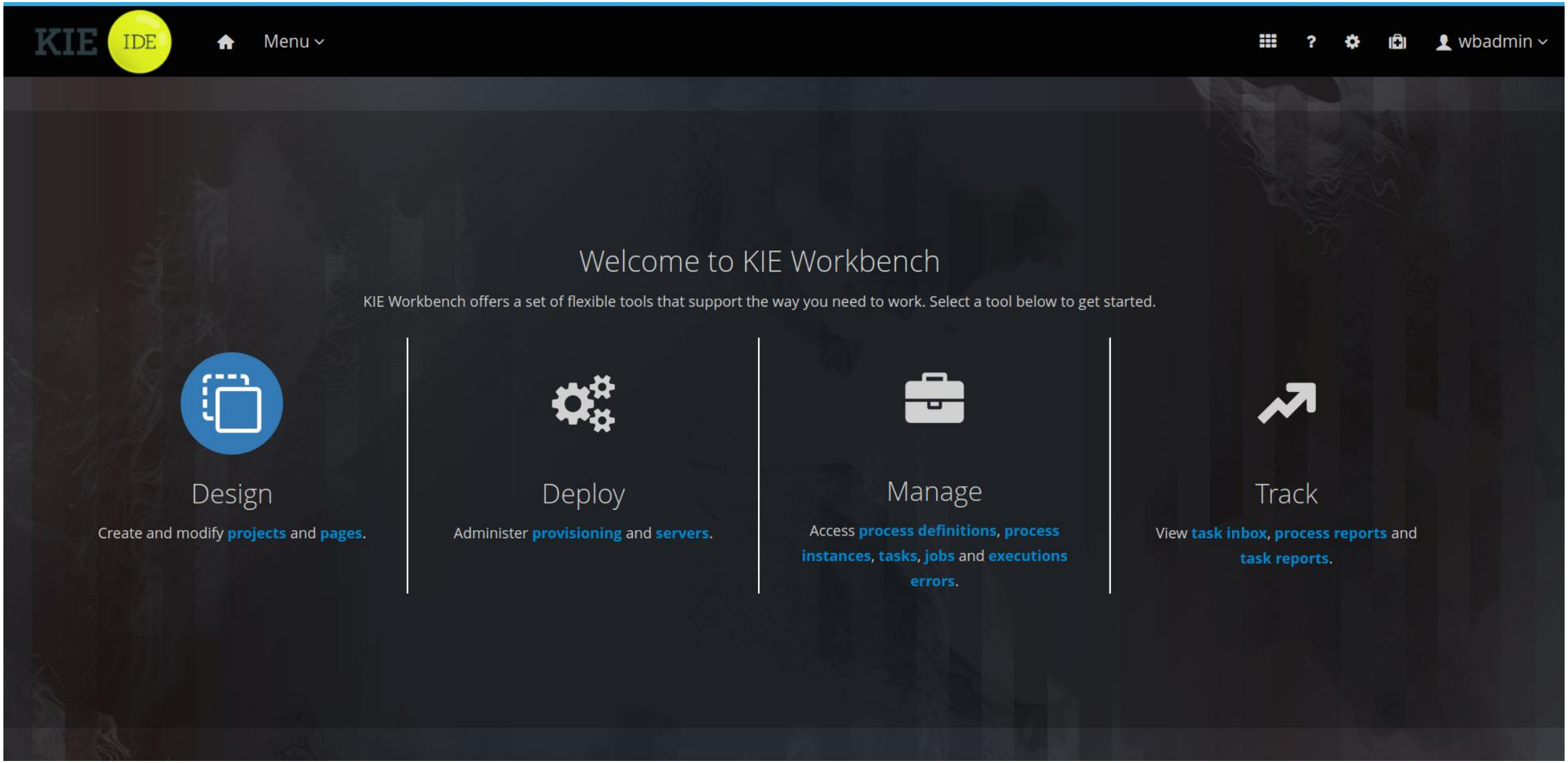
http://www.drools.org/

JBoss KIE JBPM

http://www.jbpm.org/

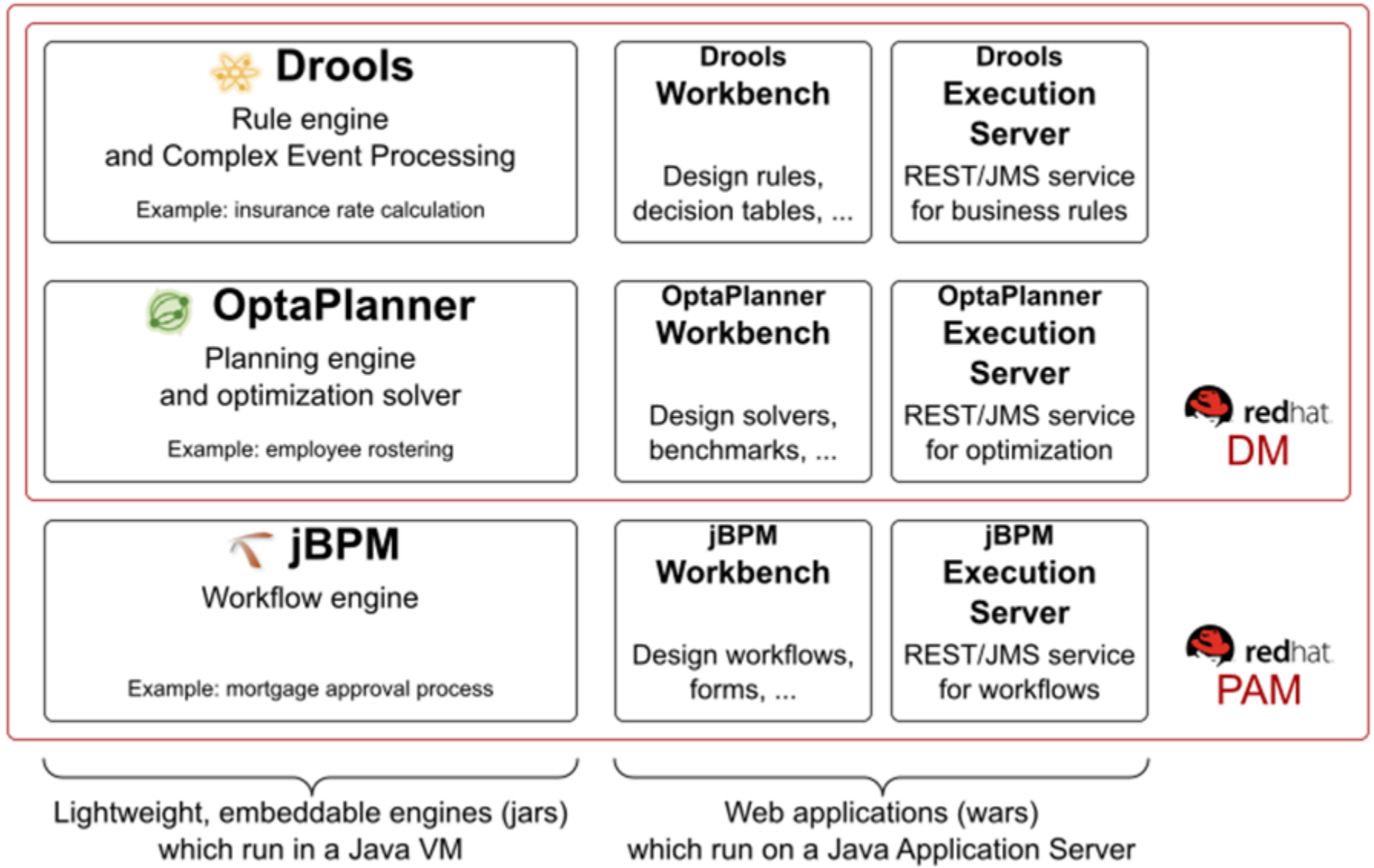
1.4 WORKSHOP RULE/PROCESS REASONING SYSTEM

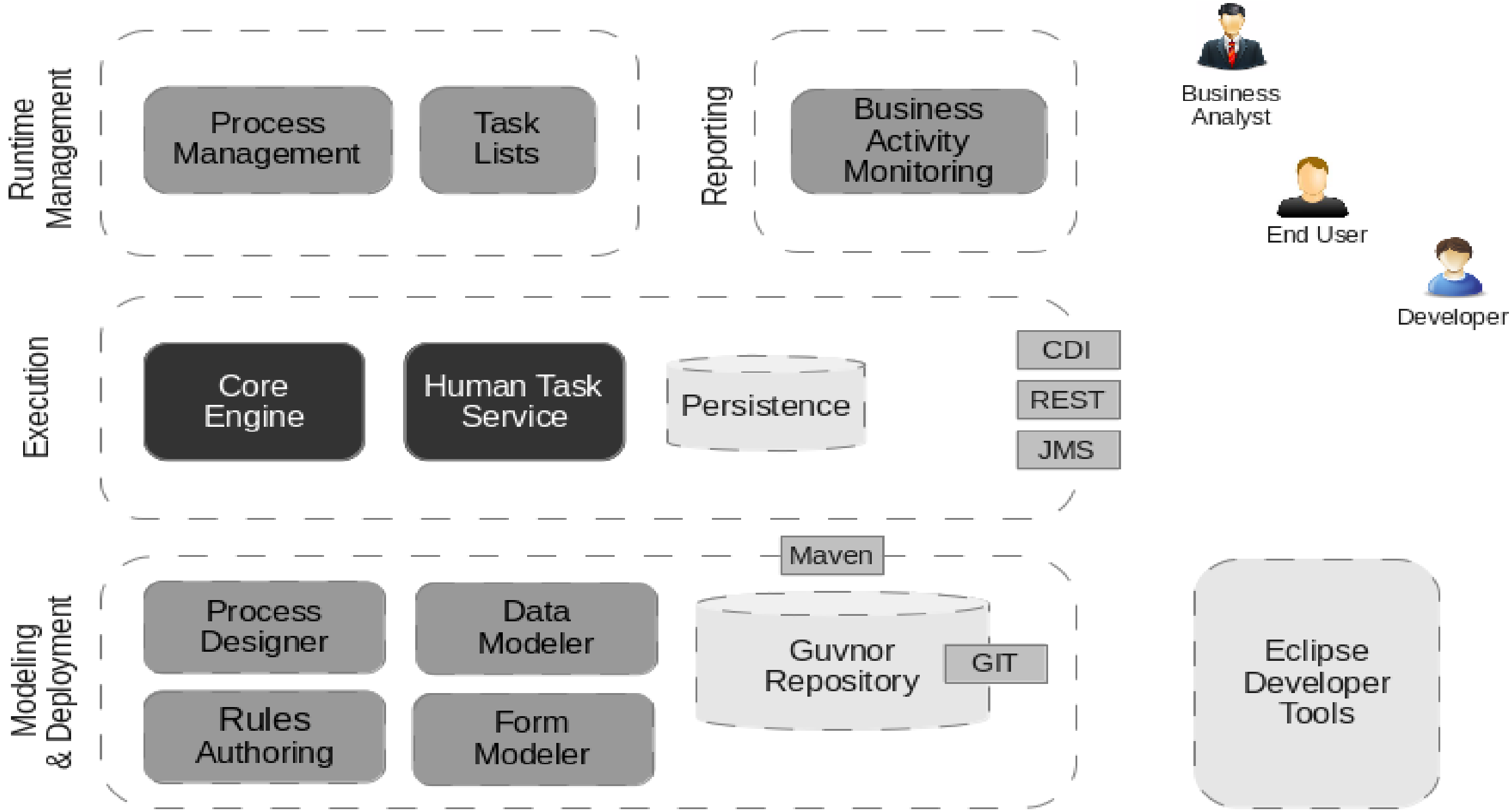
KIE Development – Individual Work



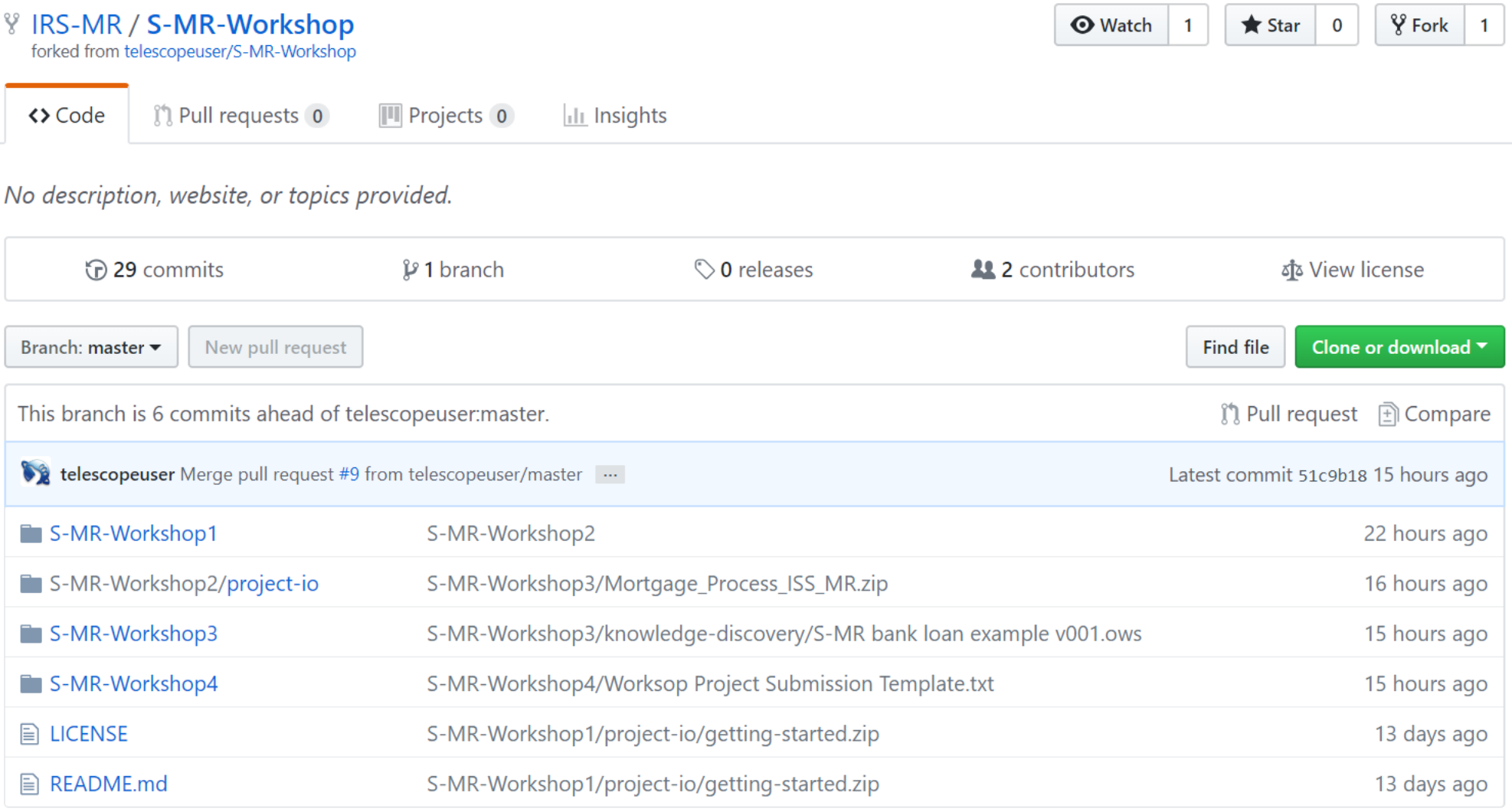
KIE functionality overview

What are the KIE projects?



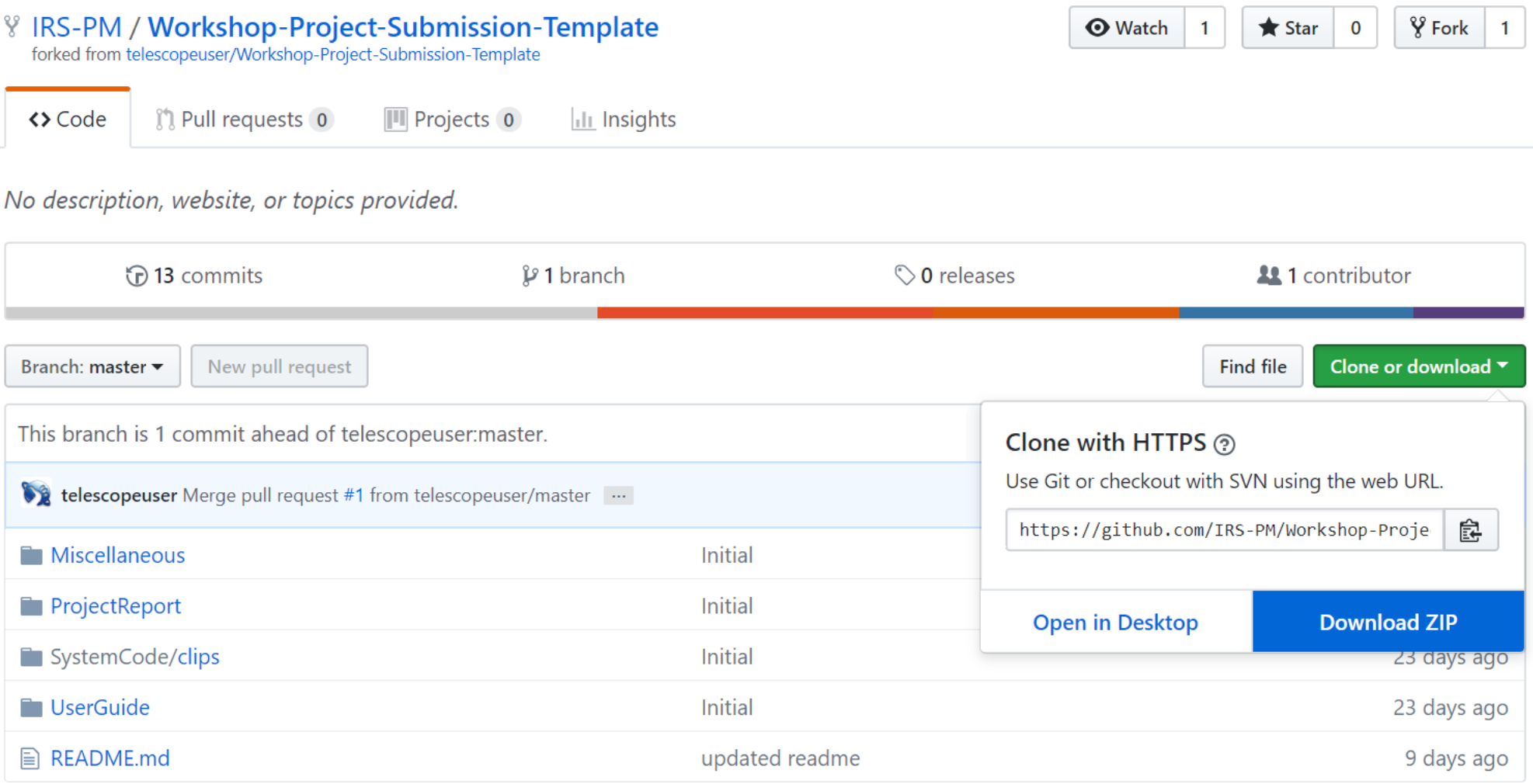

Runtime Management
Process Management
Task Lists
Reporting
Business Activity Monitoring
Business Analyst
End User
Developer
Execution
Core Engine
Human Task Service
Persistence
CDI
REST
JMS
Modeling & Deployment
Maven
Process Designer
Data Modeler
Guvnor Repository
GIT
Rules Authoring
Form Modeler
Eclipse Developer Tools

1.4 WORKSHOP RULE/PROCESS REASONING SYSTEM



LINK HTTPS://GITHUB.COM/IRS-MR/S-MR-WORKSHOP

1.4 WORKSHOP RULE/PROCESS REASONING SYSTEM



LINK HTTPS://GITHUB.COM/IRS-PM/WORKSHOP-PROJECT-SUBMISSION-TEMPLATE

1.4 WORKSHOP RULE/PROCESS REASONING SYSTEM

Github Help

https://help.github.com/

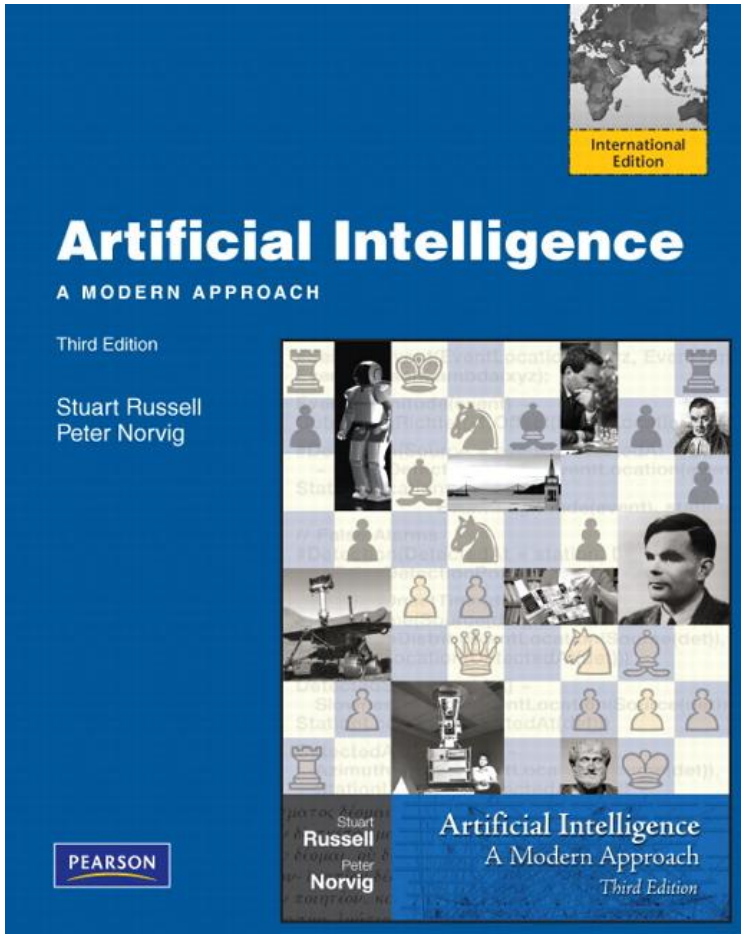
Git Cheat Sheets

https://services.github.com/on-demand/resources/cheatsheets/

Videos of Github Training & Guides

https://www.youtube.com/githubguides

DAY 1 REFERENCE



1. KIE Workbench Tutorial : Data Object, Form, Task and Process creation

   https://www.youtube.com/watch?v=xQqxhEcrFB0

   https://www.youtube.com/watch?v=US5tG4ZUPg0

2. KIE Drools Official Tutorial

   https://www.drools.org/learn/video.html

   https://www.drools.org/learn/slides.html

3. KIE Drools On Boarding Course (Java & Eclipse)

   https://nheron.gitbooks.io/droolsonboarding/content/

4. KIE Development Plugin for Eclipse IDE

   http://www.drools.org/download/download.html

Drools and jBPM tools	Eclipse plugins and support for Drools, jBPM and Guvnor functionality. Distribution zip contains binaries and sources.	Distribution ZIP