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Kecerdasan Buatan (*Artificial Intelligence*)

Program Studi Informatika



Universitas
Siber Asia

Session 4: Knowledge Representation

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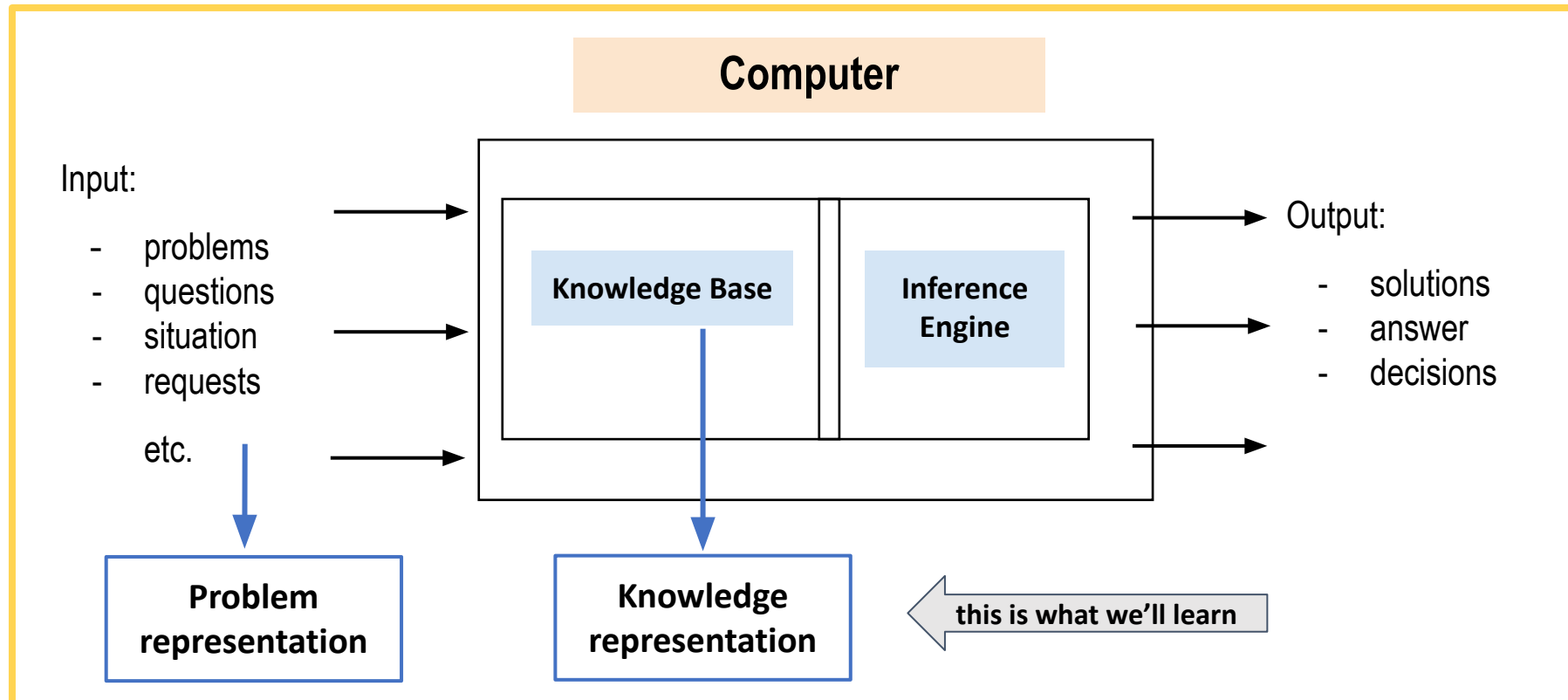
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Masih Ingat tentang Representasi Masalah?

Do you still remember about Problem Representation?

In session 2, we had seen the diagram of an AI-based computer. Where is the *knowledge*?



Session 4 - Knowledge Representation Part #1

Definisi Pengetahuan (*Knowledge Definition*)





Pengetahuan dalam Kecerdasan Buatan

Understanding “Knowledge”

Pengetahuan adalah..

1. Hubungan di antara sekumpulan data yang mendeduksikan informasi, bersifat umum, dan mengandung informasi tentang model abstrak
2. Informasi yang digunakan sistem untuk mengambil keputusan dan berperilaku secara tepat serta cerdas

Knowledge is ...

1. *Relationship among a set of data that deduces information, is general in nature, and contains information about abstract models*
2. *Information that the system uses to make decisions and behave appropriately and intelligently*



Jenis-Jenis Pengetahuan (1)

Knowledge Types

Priori Knowledge	<p>Pengetahuan yang sudah ada sebelumnya, diperoleh tanpa bergantung pada pengalaman atau bukti, atau fakta yang dianggap benar secara universal</p> <p><i>the knowledge which comes before knowledge perceived from the senses OR facts that are considered true universally</i></p>
Posteriori Knowledge	<p>Pengetahuan yang bisa diverifikasi melalui indra, didapatkan melalui pengalaman atau kejadian, tidak selalu bisa diandalkan</p> <p><i>knowledge verifiable through the senses, gained by experience/evidence, not always be reliable</i></p>



Jenis-Jenis Pengetahuan (2)

Knowledge Types

Procedural Knowledge	Fokus pada bagaimana cara melakukan sesuatu, misalnya dokumen SOP <i>knowing how to do something, ex: user manual document</i>
Declarative Knowledge	Fakta atau informasi tentang sesuatu hal yang spesifik dan bisa diakses/dimanfaatkan <i>refers to the diverse knowledge about what something is, to be accessed and utilized</i>
Tacit Knowledge	Pengetahuan yang tidak secara mudah bisa diekspresikan melalui bahasa <i>knowledge not easily expressed by language</i>



Bentuk-Bentuk Pengetahuan

Knowledge Forms

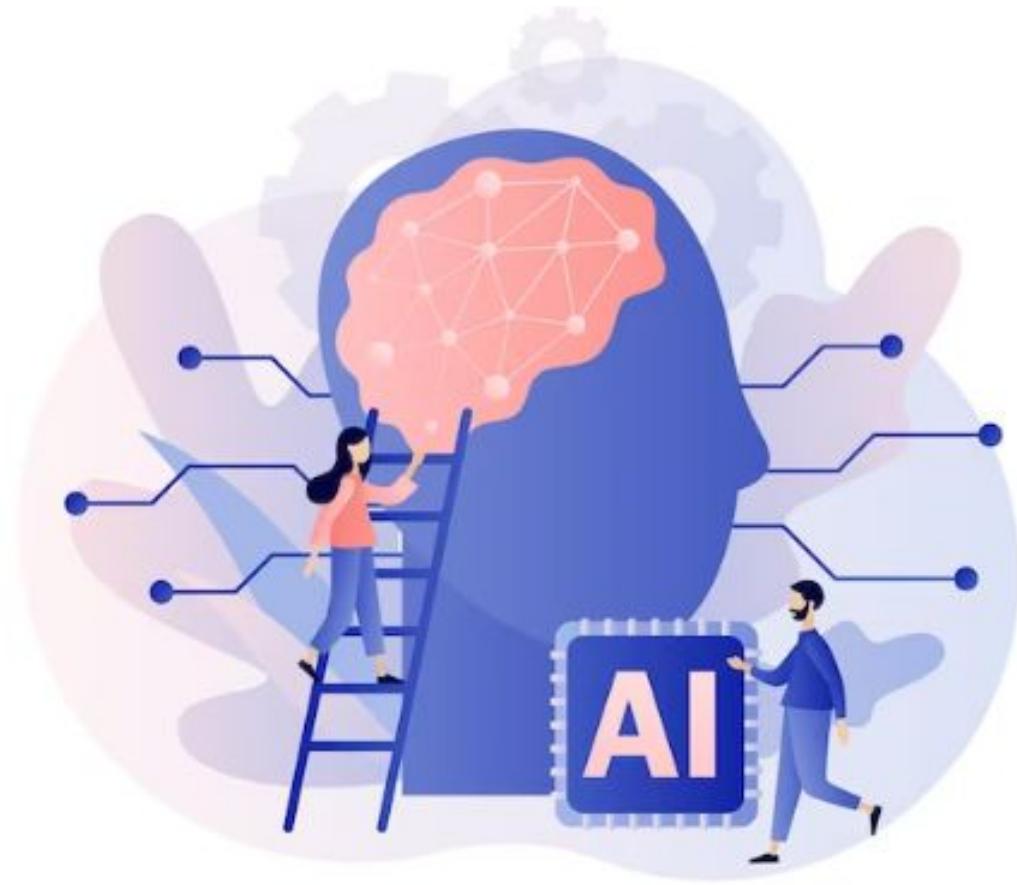
- Representasi pengetahuan pada dasarnya adalah untuk mengubah bentuk-bentuk pengetahuan sebagai berikut ke bahasa pemrograman:
 - **Object:** informasi terkait hal-hal (fisik) yang ada di dunia
 - **Event:** kejadian-kejadian dalam dunia nyata dan hubungannya
 - **Performance:** pemahaman bagaimana seseorang bersikap atau melakukan suatu tugas tertentu
 - **Fact:** hal-hal faktual tentang dunia kita, kebenarannya bisa diverifikasi
 - **Meta knowledge:** pengetahuan tentang pengetahuan yang direpresentasikan
 - **Knowledge base:** koleksi besar tentang pengetahuan yang disimpan dan disusun sehingga sistem bisa mengakses dan menggunakannya

Knowledge Forms (english)

- ❖ Knowledge representation is basically to convert the following forms of knowledge into programming languages:
 - **Object:** information related to things in the world,
 - **Event:** events in the real world and their relationships
 - **Performance:** understanding how someone behaves or performs a certain task, it includes the goals and objectives of the task
 - **Fact:** factual things about our world, the proportions of which we can verify true or false
 - **Meta knowledge:** knowledge about represented knowledge, or things what we already know
 - **Knowledge base:** a big library, collection of knowledge that is stored and organized so that the system can access and use it

Session 4 - Knowledge Representation Part #2

Tentang Representasi (*About Representation*)





Tujuan Representasi Pengetahuan (RP)

Why should we represent the knowledge (KP)?

RP memungkinkan AI untuk:

- menerjemahkan pengalaman manusia ke dalam bahasa yang dimengerti komputer
- menggunakannya untuk penalaran sehingga bisa bertindak secara tepat sesuai kepakaran manusia
- membuat inferensi: menghasilkan kesimpulan atau membuat prediksi
- mampu merencanakan aksi berikutnya dan menyelesaikan permasalahan yang kompleks

KP allows AI to:

- *translate human experiences into language that computers understand*
- *use it for reasoning that it can act appropriately according to human expertise*
- *make an inference: yield a conclusion or create a prediction*
- *able to plan next actions and solve complex problems*



Teknik-Teknik Representasi Pengetahuan (1)

Knowledge Representation Techniques (1)

- ❖ ***Logic-based representation***: using formal logic
 - ex: first-order predicate logic, PROLOG
- ❖ ***Procedural representation***: show procedure as a collection of instruction, usually using IF THEN schema
 - ex: rules, production system
- ❖ ***Network representation***: draw a problem as graph and tree
 - ex: semantic network, conceptual graph
- ❖ ***Structural representation***: extends the concept of Network Representation by making its nodes into complex data structures
 - ex: scripts, object, frame

(Mylopoulos and Levesque)



Teknik-Teknik Representasi Pengetahuan (2)

Knowledge Representation Techniques (2)

LOGIC-BASED
REPRESENTATION

**Logical
Representation**

**Semantic Network
Representation**

NETWORK
REPRESENTATION

PROCEDURAL
REPRESENTATION

**Production
Rules**

**Frame
Representation**

STRUCTURAL
REPRESENTATION

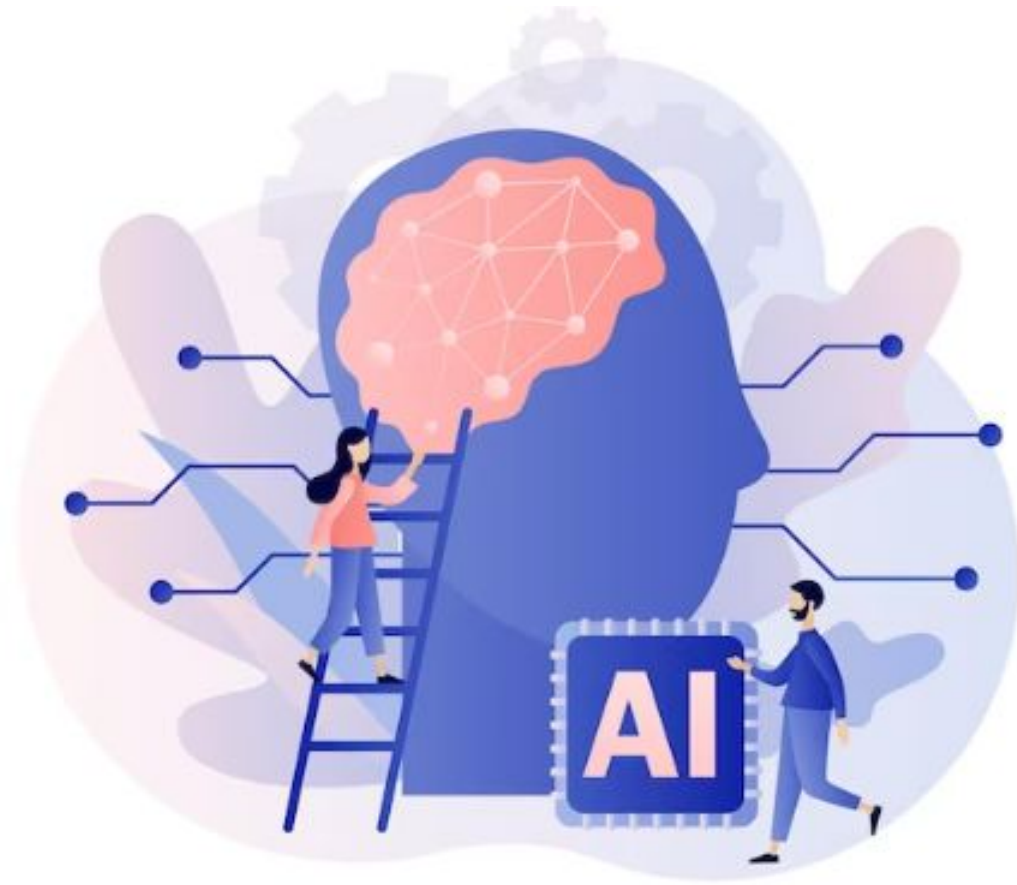
**KR
Techniques**



ThinkPalm

Session 4 - Knowledge Representation Part #2

Metode Representasi Pengetahuan (*Knowledge Representation Method*)





(1) Representasi Logik

(1) *Logical Representation*

1

Logics: Example

“finding the culprit”

- ▶ Jack owns a dog. Every dog owner is an animal lover. No animal lover kills an animal. Either Jack or Curiosity killed the cat, which is named Tuna. Did Curiosity kill the cat?
- ▶ Hints (for predicates):
 - ▶ Owns(x,y): x has y
 - ▶ Animal(x): x is an animal
 - ▶ Cat(x): x is a cat
 - ▶ Dog(x): x is a dog
 - ▶ AnimalLover(x): x is an animal lover
 - ▶ Kills(x,y): x kills y

source: STEI-ITB IF3054 AI lecture notes



(1) Representasi Logik

(1) *Logical Representation*

2

Logics: Example (2)

- A. $(\exists x) \text{Dog}(x) \wedge \text{Owns}(\text{Jack}, x)$
- B. $(\forall x) ((\exists y) \text{Dog}(y) \wedge \text{Owns}(x, y)) \Rightarrow \text{AnimalLover}(x)$
- C. $(\forall x) \text{AnimalLover}(x) \Rightarrow ((\forall y) \text{Animal}(y) \Rightarrow \sim \text{Kills}(x, y))$
- D. $\text{Kills}(\text{Jack}, \text{Tuna}) \vee \text{Kills}(\text{Curiosity}, \text{Tuna})$
- E. $\text{Cat}(\text{Tuna})$
- F. $(\forall x) \text{Cat}(x) \Rightarrow \text{Animal}(x)$

source: STEI-ITB IF3054 AI lecture notes



(1) Representasi Logik

(1) *Logical Representation*

3

Logics: Example (2)

2. Answer:

1. Dog(spike)
2. Owns(Jack,spike)
3. $\sim \text{Dog}(y) \vee \sim \text{Owns}(x, y) \vee \text{AnimalLover}(x)$
4. $\sim \text{AnimalLover}(x1) \vee \sim \text{Animal}(y1) \vee \sim \text{Kills}(x1,y1)$
5. $\text{Kills}(\text{Jack}, \text{Tuna}) \vee \text{Kills}(\text{Curiosity}, \text{Tuna})$
6. Cat(Tuna)
7. $\sim \text{Cat}(x2) \vee \text{Animal}(x2)$

source: STEI-ITB IF3054 AI lecture notes



(1) Representasi Logik

(1) *Logical Representation*

4

Logics: Example (3)

1. Dog(spike)
2. Owns(Jack,spike)
3. $\sim \text{Dog}(y) \vee \sim \text{Owns}(x, y) \vee \text{AnimalLover}(x)$
4. $\sim \text{AnimalLover}(x1) \vee \sim \text{Animal}(y1) \vee \sim \text{Kills}(x1,y1)$
5. $\text{Kills}(\text{Jack}, \text{Tuna}) \vee \text{Kills}(\text{Curiosity}, \text{Tuna})$
6. Cat(Tuna)
7. $\sim \text{Cat}(x2) \vee \text{Animal}(x2)$
8. $\sim \text{Kills}(\text{Curiosity}, \text{Tuna}) \rightarrow$ negated goal
9. $\text{Kills}(\text{Jack}, \text{Tuna})$ 5,8
10. $\sim \text{AnimalLover}(\text{Jack}) \vee \sim \text{Animal}(\text{Tuna})$ 9,4 x1/Jack,y1/Tuna
11. $\sim \text{Dog}(y) \vee \sim \text{Owns}(\text{Jack}, y) \vee \sim \text{Animal}(\text{Tuna})$ 10,3 x/Jack
12. $\sim \text{Owns}(\text{Jack}, \text{spike}) \vee \sim \text{Animal}(\text{Tuna})$ 11,1
13. $\sim \text{Animal}(\text{Tuna})$ 12,2
14. $\sim \text{Cat}(\text{Tuna})$ 13,7 x2/Tuna
15. False 14,6

source: STEI-ITB IF3054 AI lecture notes



(1) *Logical Representation*

PLUS MINUS

Advantages of logical representation:

1. Enables us to do logical reasoning
2. Logical representation is the basis for the programming languages

Disadvantages of logical representation:

1. Have some restrictions and are challenging to work with
2. May not be very natural, and inference may not be so efficient

javapoint.com



(2) Procedural Representation → Rules

Rules

in “turning on a car” case

**IF the battery is good
THEN there is electricity**

**IF there is electricity AND good spark plugs
THEN the spark plugs will fire**

**IF the spark plugs fire AND
there is gas
THEN the engine will run**

**IF the engine runs AND
there are good tires
THEN the car can move**

source: STEI-ITB IF3054 AI lecture notes



(2) Procedural Representation → Rules

PLUS MINUS

Advantages of production rules:

- The production rules are expressed in natural language
- Highly modular, so we can easily remove, add or modify an individual rule

Disadvantages of production rules:

- Production rule system does not exhibit any learning capabilities, as it does not store the result of the problem for the future uses
- During the execution of the program, many rules may be active hence rule-based production systems are inefficient

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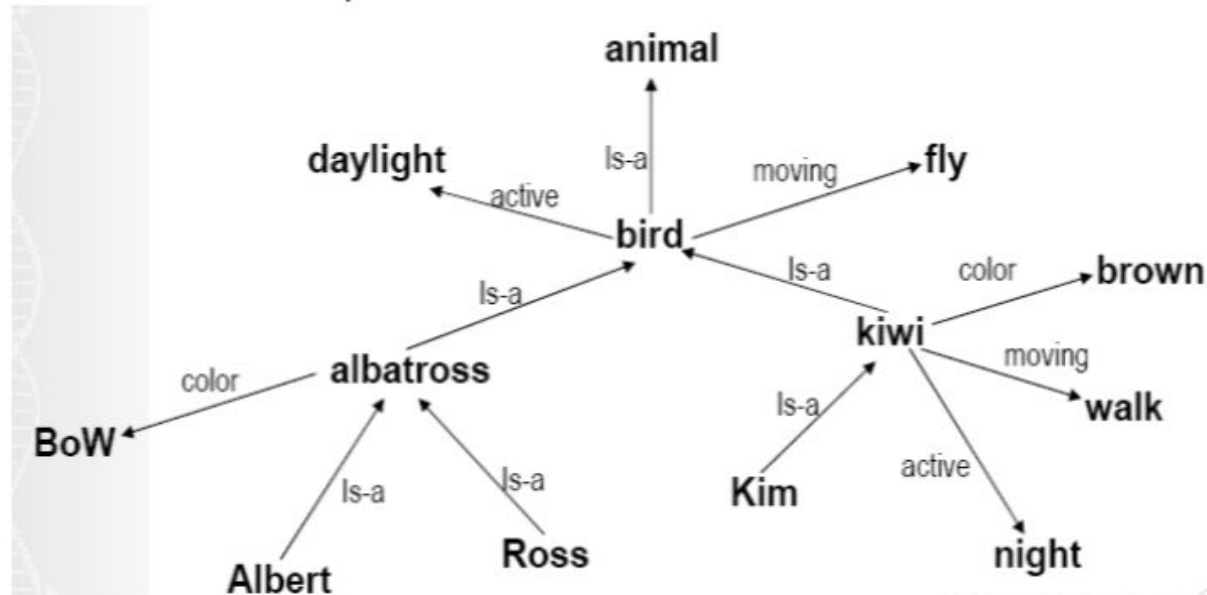


(3) *Network Representation* → *Semantic Network*

Semantic Network

“finding the culprit”

- ▶ **A bird is a kind of animal**
- ▶ **Flying is the normal moving method of birds**
- ▶ **An albatross is a bird**
- ▶ **Albert is an albatross, and so is Ross**



source: STEI-ITB IF3054 AI lecture notes



(3) *Network Representation* → *Semantic Network* *PLUS MINUS*

Advantages of semantic networks

- Formal definitions of semantic networks have been developed
- Related knowledge is easily clustered
- Efficient in space requirements
- Objects represented only once
- Relationships handled by pointers

Disadvantages of semantic networks

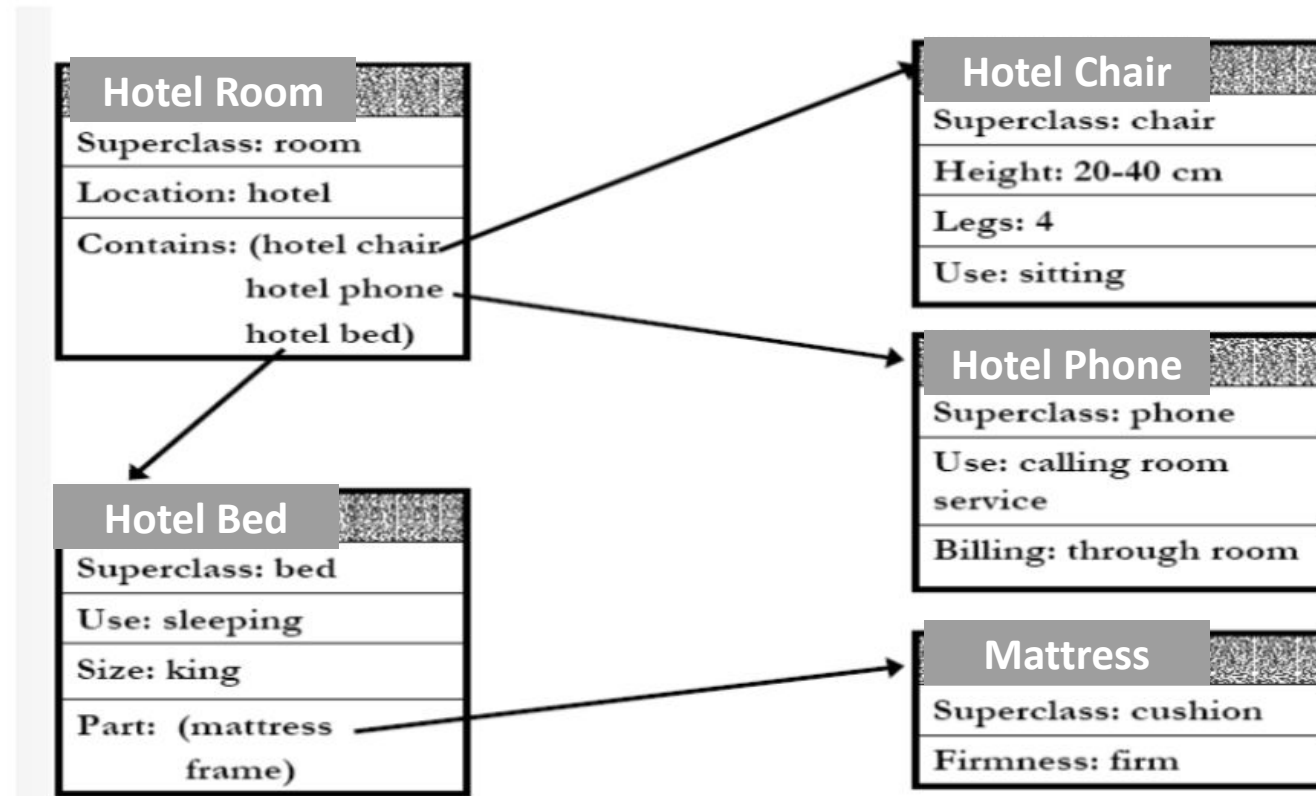
- Inheritance (particularly from multiple sources and when exceptions in inheritance are wanted) can cause problems
- Facts placed inappropriately cause problems
- No standards about node and arc values

uomustansiriyah.edu.id



(4) Structural Representation → Frames

Frames



source: STEI-ITB IF3054 AI lecture notes



(4) Structural Representation → Frames

PLUS MINUS

Advantages of frame representation:

1. Makes the programming easier by grouping the related data → OOP style
2. Comparably flexible and used by many applications in AI
3. It is very easy to add slots for new attribute and relations
4. It is easy to include default data and to search for missing values
5. Easy to understand and visualize.

Disadvantages of frame representation:

1. Inference mechanism cannot be smoothly proceeded by frame representation
2. Has a much generalized approach



More about Knowledge Representation

There are some other knowledge representations such as:

- ❖ *Decision table*
- ❖ *Decision tree*
- ❖ *Skeletal plan*
- ❖ *Constraints*
- ❖ *Probabilistic mode, ex: Bayesian Network*

Can you discover on how they represent the knowledge?

TERIMA KASIH

Sampai jumpa di sesi berikutnya!



Jangan lupa cek LMS untuk kuis dan berikan umpan balik 😊