Characteristic of Expert System

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Materials

- History of ES
- General concept
- Basic Types
- General stages
- Characteristic
- The advantages and limitations
- ES categories and examples

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History of Expert System

- **Early 1960**
  - ➤ AI research was dominated by a believe that:
    - a few laws of reasoning + powerful computers = expert or even superhuman performance
  - ➤ General-purpose Problem Solver (GPS):
    - ▪ A procedure developed by Newell & Simon, includes:
      1. A set of operators
      2. Preconditions
      3. Postconditions
      4. Heuristic for operators to try first
    - ▪ Tries to work out the steps needed to change a certain initial situation into a desired goal
  - ➤ On this time, concentration is on problem-solving mechanism

History of Expert System (2)

- **Mid-1960s**
  - ➤ There were special types of AI program to successfully deal with complex problem in a narrow domain:
    - ❑ Dendral (E. Feigenbaum, Standford Univ.)
    - ❑ MYCIN

  - ➤ General purpose to special-purpose programs
  - ➤ Recognized that the <u>problem-solving mechanism is only a small part</u> of a complete intelligent computer system

History of Expert System (3)

- **Mid-1970s**
  - ➢ Several ES had begun to emerge
  - ➢ "Knowledge" become target of study
  - ➢ Development of knowledge representation theories
  - ➢ Key insight:
    - ❑ The power of an ES is derived from the <u>specific knowledge</u> it posses, not from the particular formalisms and inference schemes it employs

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History of Expert System (4)

- **Beginning of the 1980s**
    - ➢ Commercial applications were built, such as:
        - ❑ XCON & XSEL (at DEC)
        - ❑ CATS-1 (at General Electric)
    - ➢ Effort to develop tools for speeding up the construction of ES, such as:
        - ❑ EMYCIN
        - ❑ AGE

History of Expert System (5)

- ## 1983
  - ➢ Some tools become commercially available
  - ➢ Most of the early development tools required special hardware, e.g. LISP machine

- ## Late 1980s
  - ➢ Development software can run on regular computers including microcomputers

- ## Now
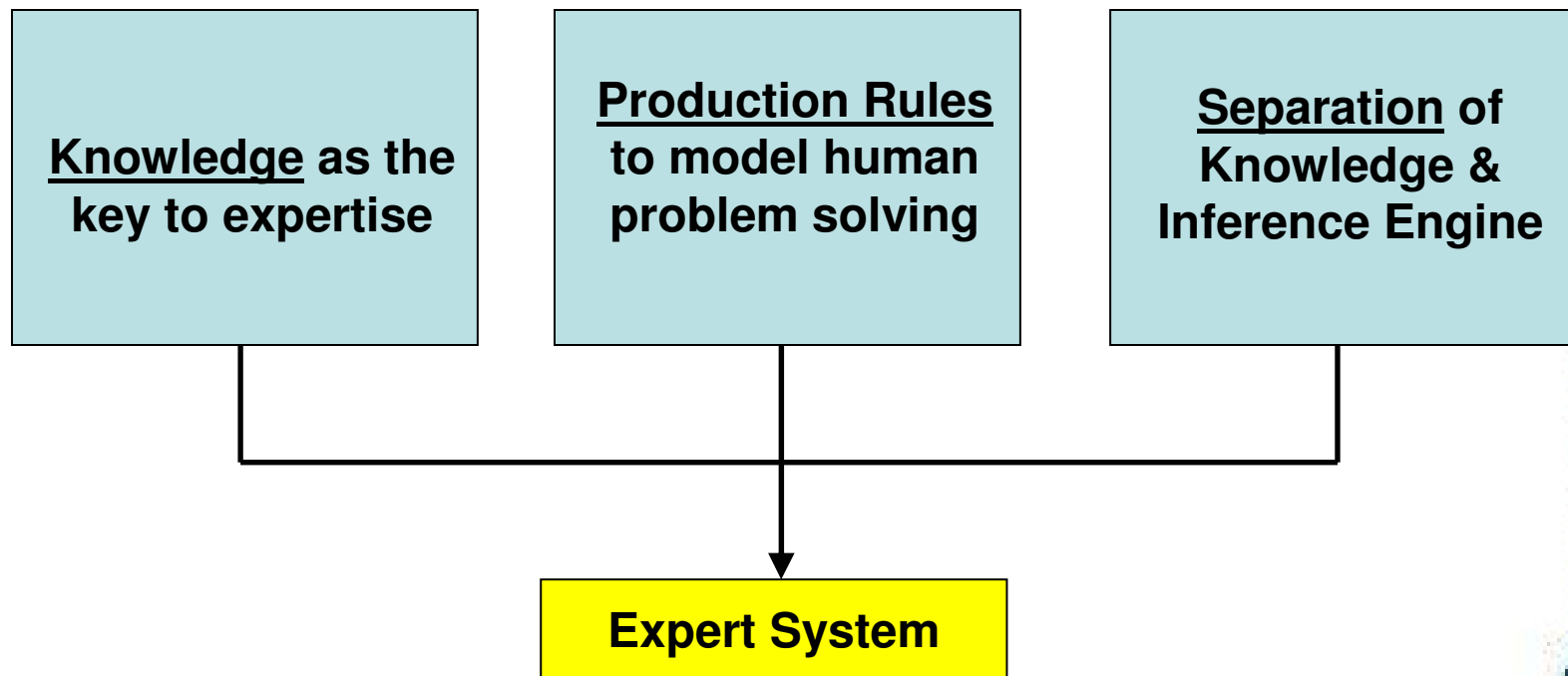 - ➢ ES is used in many fields

Expert System

- **1st developed :**
  - contain human expert knowledge exclusively

- **NOW :**
  - Any system that uses ES technology
  - The knowledge:
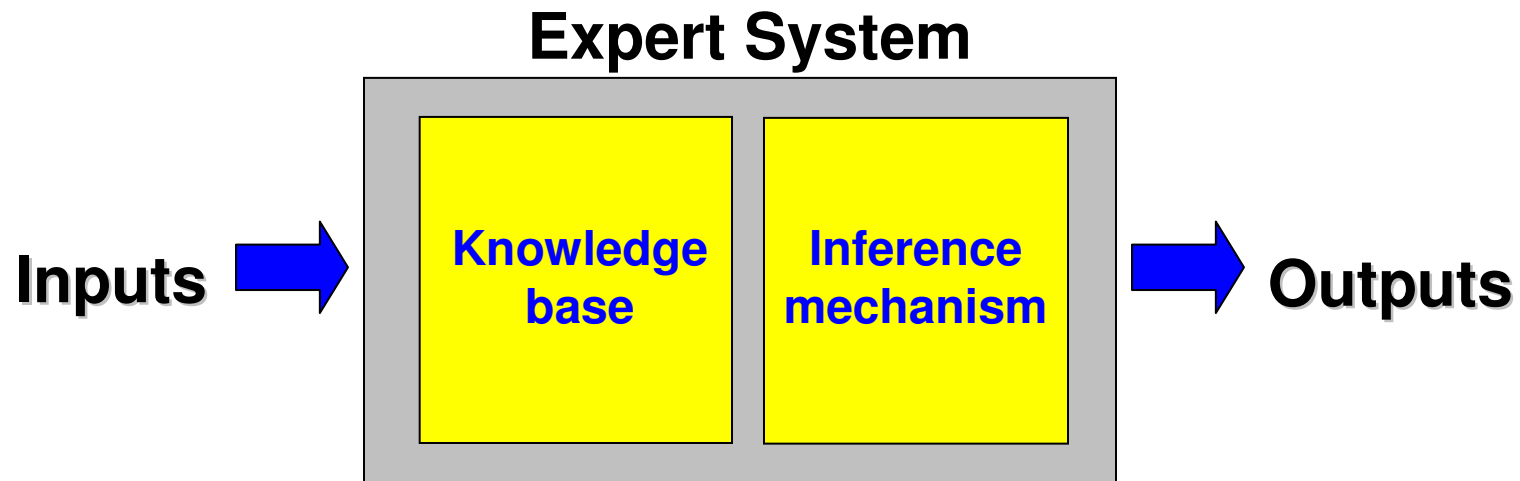   Expertise's + available knowledge generally

General Concept of ES

- The modern ES is a convergence of 3 important factors:

Knowledge as the key to expertise	**Production Rules** to model human problem solving	**Separation** of Knowledge & Inference Engine

Expert System

General Concept of ES (2)

Expert System

Inputs →
| Knowledge base | Inference mechanism |
→ **Outputs**

- Notes:
  - The process is mimic human expert when they solve a specific problem

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General Concept of ES (3)

- **Knowledge base:**
  - There are some knowledge representation
  - But the common method of representing knowledge are _IF - THEN type rules_ and _frame_

- **Inference Engine :**
  - There are a lot of algorithm can be used in AI
  - But ES is using algorithm that mimic human thinking which are _forward chaining_ and _backward chaining_

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Conventional System vs Expert System

Conventional System	Expert System
Information and its processing are usually combined in one sequential program	Knowledge base is clearly separated form the processing (inference) mechanism
Program doesn't make mistakes	Program may make mistake
Explanation is not a part of most conventional system	Explanation is part of most ES
The system operates only when it's completed	The system can operate with only a few rules (as the first prototype)

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Conventional System vs ES (2)

Conventional System	Expert System
Execution is done on a step by step (algorithmic)	Execution is done by using heuristic and logic
Need complete information to operate	Can operate with incomplete or uncertain information
Effective manipulation of large database	Effective manipulation of large knowledge bases
Representation and use of data	Representation and use of knowledge
Efficiency is a major goal	Effectiveness is a major goal

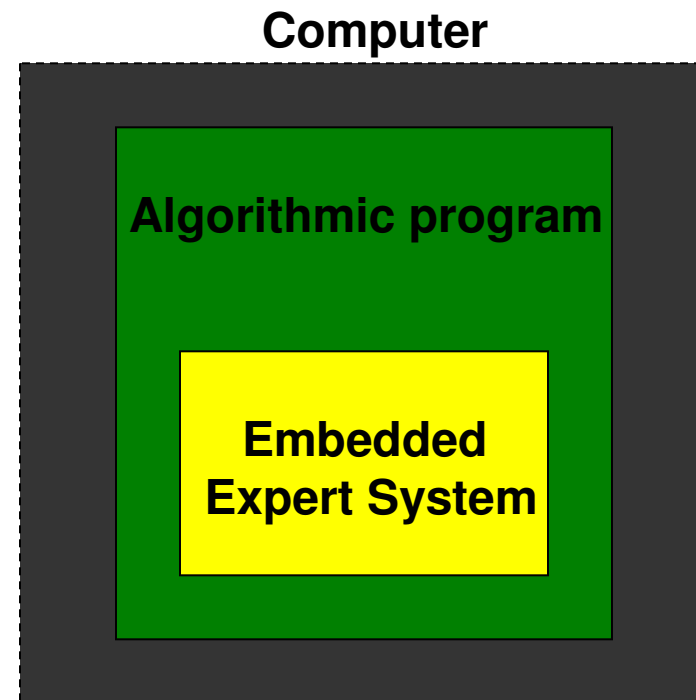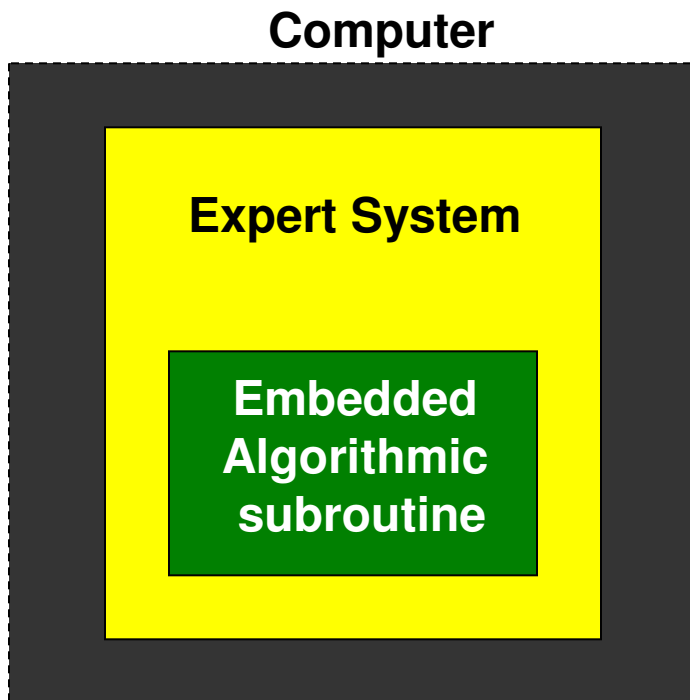joko purwadi

Basic Types of ES

1. ## Stand-alone

   ➢ When the computer is running a program, it is totally dedicated to it

2. ## Embedded

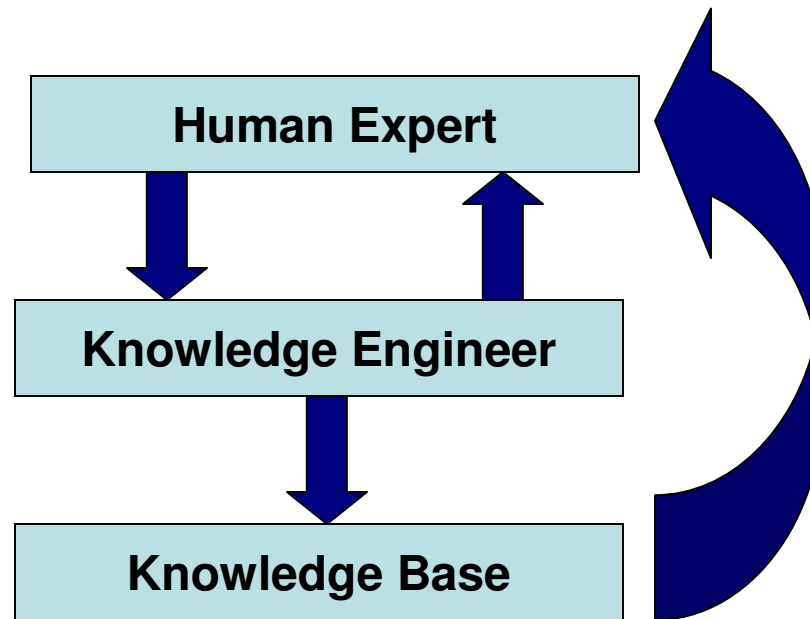   ➢ The ES is just a portion of another larger program

Basic Types of ES (2)

- Type of embedded expert system:

Computer

Expert System

> **Embedded Algorithmic subroutine**

Computer

Algorithmic program

> **Embedded Expert System**

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General Stages of ES Development

- General Stages in the development of an Expert System

```
+---------------------+
|    Human Expert     |  <---+
+---------------------+      |
      |          ^           |
      v          |           |
+---------------------+      |
| Knowledge Engineer  |      |
+---------------------+      |
      |                      |
      v                      |
+---------------------+      |
|   Knowledge Base    | ----+
+---------------------+
```

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Characteristic

1. High performance
  - The response at a level of competency equal to or better than an expert

2. Adequate response time
  - Perform in a reasonable time, comparable to or better than HE's time

3. Good reliability
  - Must be reliable and not prone to crashes or else it will not be used

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Characteristic (2)

4. Understandable

- ➢ Have an explanation capability
  - a. Sanity check
  - b. Accuracy validation of the knowledge

5. Flexibility

- ➢ Important to have an efficient mechanism for adding, changing, and deleting knowledge

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Advantages of Expert System

1. ## Increased availability
   - ➢ Expertise is available on any suitable computer hardware

2. ## Reduced cost
   - ➢ The cost of providing expertise per user is greatly lowered

3. ## Reduced danger
   - ➢ Can be used in environments that might to hazards for a human

4. ## Permanence
   - ➢ The knowledge will last indefinitely

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Advantages (2)

5. **Multiple expertise**
   - ➤ The knowledge of multiple expert can be made available to work simultaneously & continuously on a problem at any time of day or night
   - ➤ The level of expertise may exceed that of a single human expert (HE)

6. **Increased reliability**
   - ➤ Increase confidence by providing a 2nd opinion
   - ➤ When HE is tired or under stress she will make mistake

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Advantages (3)

7. ## Explanation
   - ➢ Can explain in detail the reasoning that lead to a conclusion
   - ➢ A human may be too tired, unwilling, or unable to do this all the time

8. ## Fast response
   - ➢ May response faster and be more available than HE
   - ➢ Real-time ES : emergency situations

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Advantages (4)

9. **Steady, unemotional, and complete response at all times**
   - ➢ May be very important in real-time and emergency situations
   - ➢ HE may not operate at peak efficiency because of stress or fatigue

10. **Intelligent tutor**
    - ➢ Letting the student run sample programs & explaining the system's reasoning

Advantages (5)

11. Intelligent database

- ➢ Can be used to access a database in an intelligent manner
- ➢ Ex.: data mining

12. Indirect benefit

- ➢ Knowledge is explicitly known instead of being implicit in the expert's mind

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Limitations of Expert System

1. Not easy to do *rule induction* (system creates rules from data)
   - ➢ Especially when the knowledge has never been explored
   - ➢ Inconsistencies, ambiguities, duplication, etc.

2. HE should know the extent of their knowledge & qualify their advice as the problem reaches their 'limits of ignorance'

3. Lack of causal knowledge
   - ➢ ES do not really have an understanding of the underlying causes & effects in a system
   - ➢ Using *shallow knowledge*, than *deep knowledge*

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Limitations (2)

4. ES expertise is limited to the knowledge domain contained in the system

5. ES cannot generalize their knowledge by using *analogy* to reason about new situations the way people can

6. Knowledge acquisition bottleneck
   - ➢ Repeating the cycle of interviewing the expert, constructing a prototype, testing, interviewing, and so on
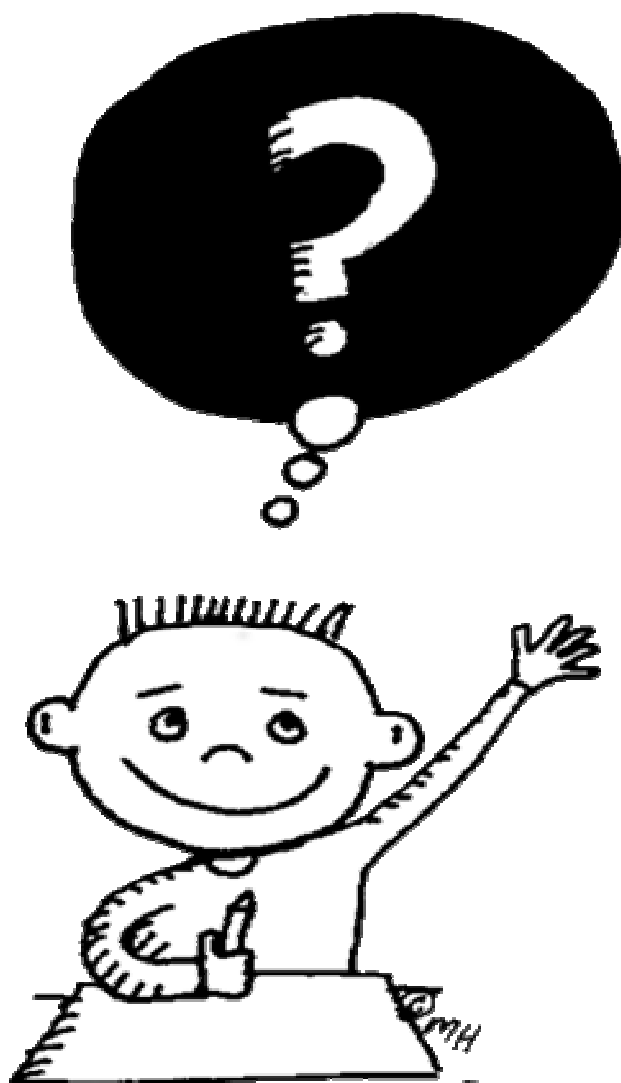   - ➢ Very time-consuming and labor intensive task

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Notes for + and – of ES

✓ Important point:
- aware of + and – of any technologies
- It can be appropriately utilized

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Categories of ES

- **Generic ES categories:**
  - **Interpretation** : clarification of situations
  - **Design** : developing products to specification
  - **Planning** : developing goal-oriented schemes
  - **Prediction** : intelligent guessing of outcomes
  - **Diagnosis** : estimate defects
  - **Repair** : automatic diagnosis, debugging, planning and fixing
  - **Control** : intelligent automation
  - **Instruction** : optimized computer instruction

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