Artificial Intelligence Knowledge Base System

CONTENTS

- Knowledge representation
- Knowledge organization
- Acquisition of knowledge

KNOWLEDGE REPRESENTATION

- AI agents deal with knowledge (data)
  - Facts (believe & observe knowledge)
  - Procedures (how to knowledge)
  - Meaning (relate & define knowledge)
- Right representation is crucial
  - Early realisation in AI
  - Wrong choice can lead to project failure
  - Active research area

Some General Representations

1. Logical Representations
2. Production Rules
3. Semantic Networks
4. Frame Representation.

Propositional Logic

- Known as statement logic
- Propositional logic studies the ways of joining or modifying entire statement or sentences.
- It is defined as a declarative sentence that is either true or false, but not both.
- Example: the sun rises in the east.

Predicate Logic

- Predicate logic is a proposition whose truth depends on the value of one or more variables.
- **Predicates** allow us to talk about objects
  - Properties: is_wet(today)
  - Relations: likes(john, apples)
  - True or false
- Example: n is perfect square.

Syntax and Semantics

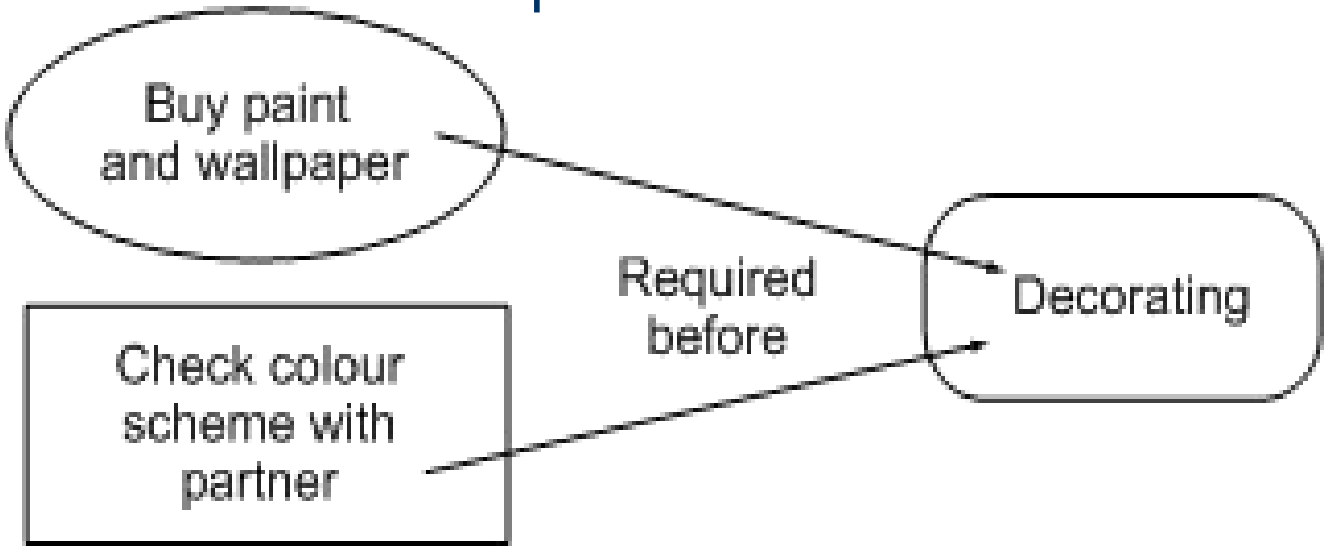
- Syntax
  - Rules for constructing legal sentences in the logic
  - Which symbols we can use (English: letters, punctuation)
  - How we are allowed to combine symbols
  - Example : I am going to Delhi.
- Semantic
  - How we interpret (read) sentences in the logic
  - Assigns a meaning to each sentence
- Example: “All lecturers are seven foot tall”

Production Rule

- Rule set of <condition , action>
  - “if condition then action”
- IF (at bus stop AND bus arrives) THEN action(get on the bus)
- conditions and actions must be clearly defined
  - can easily be expressed in first order logic

Graphical Representation

- Graphs easy to store in a computer.
- Humans draw diagrams all the time, e.g.
  - Causal relationships



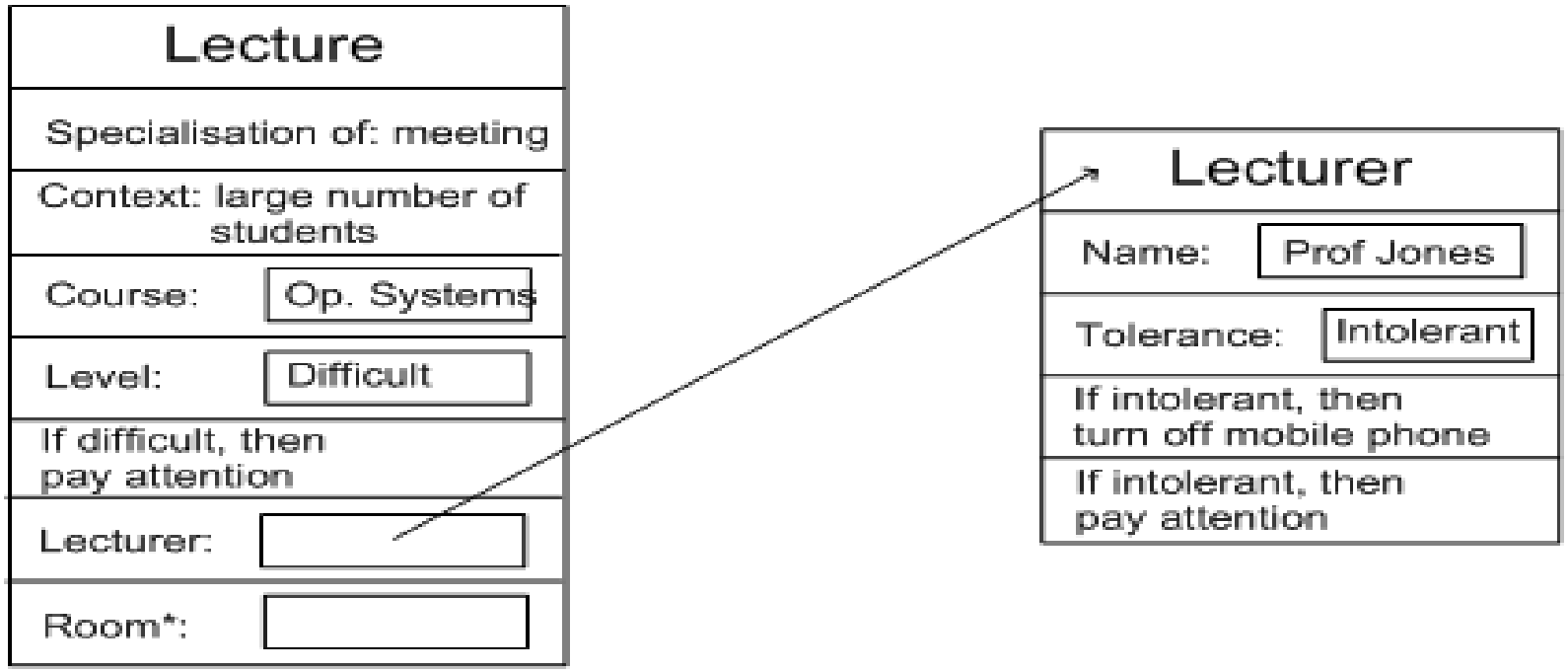
Semantic Networks

- Graphical representation (a graph)
  - Links indicate subset, member, relation, ...
- Equivalent to logical statements (usually FOL)
  - Easier to understand than FOL
  - Specialised SN reasoning algorithms can be faster
- Example: natural language understanding
  - Sentences with same meaning have same graphs

Frame Representations

- Semantic networks where nodes have structure
  - Frame with a number of slots and filler
  - Each slot stores specific item of information
  - Filler have the attributes of objects.

Example: Frame Representation



KNOWLEDGE ORGANIZATION

- Organization of knowledge in memory is key to efficient processing.
- Knowledge based system may require thousand of facts and rules to perform their intended tasks.
- It is essential then that the appropiate facts and rules be easy to locate and retrieve.

- Knowledge can be organized in memory for easy access by method known as indexing.
- **Indexing** is a way to optimize the performance of a database by minimizing the number of disk accesses required when a query is processed.
- It is a data structure technique which is used to quickly locate and access the data in a database.

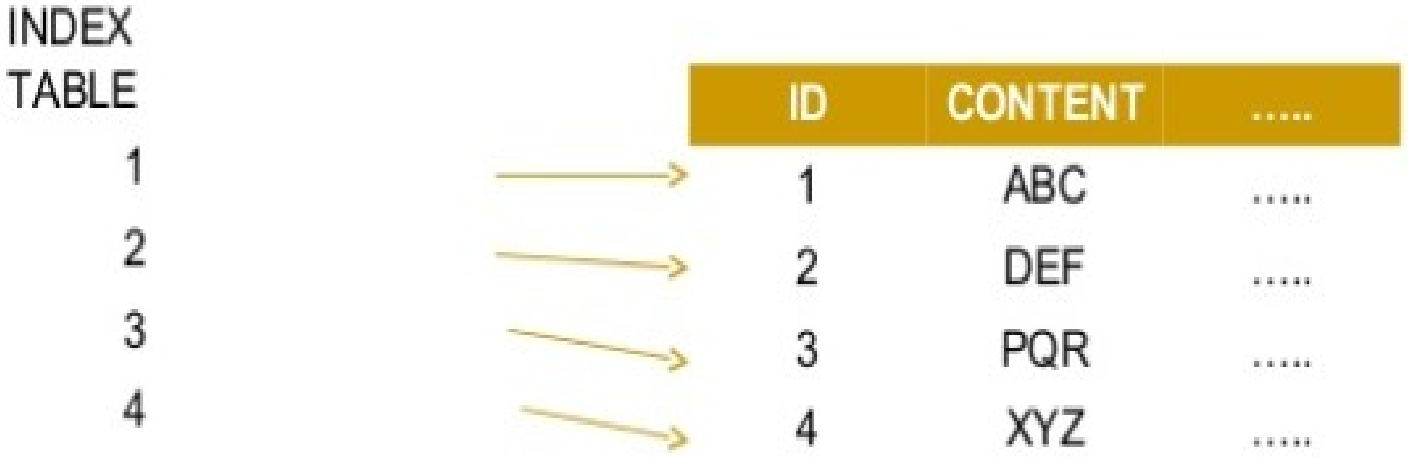
Creating index

- Syntax:

```
CREATE INDEX <index-name>
ON <table-name>
(<column-name> [ASC|DESC],
 <column-name> [ASC|DESC]…);
```

Create index on id column

```
CREATE INDEX testid_index ON test1
(id ASC);
```



Types of indexing techniques

- Ordered indexing
- Hashed indexing

ORDERED INDEX:

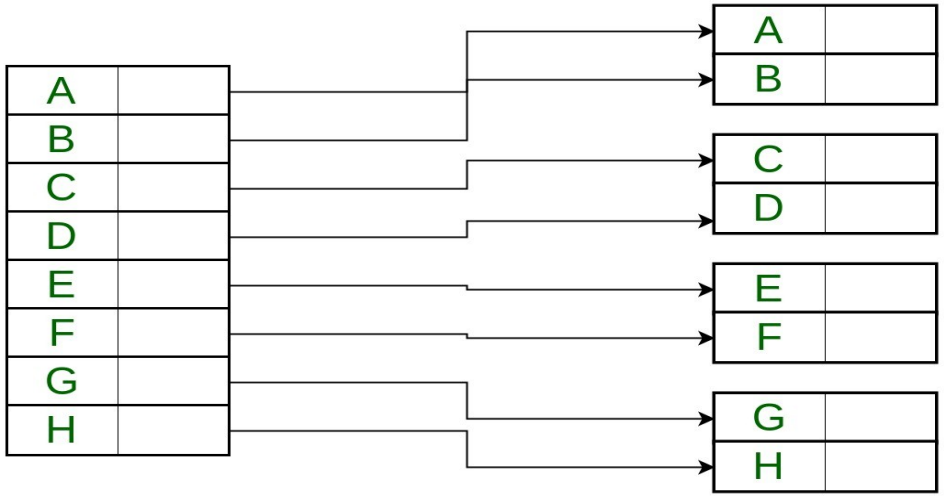
- Used to access the data sorted by order of values.
- Binary search can be used to access the data.

Types of ordered index

Dense indexing:

- For every search key value in the data file, there is an index record.
- This record contains the search key and also a reference to the first data record with that search key value.

Dense Index



Data File

Index Record

For every search value in a Data File,

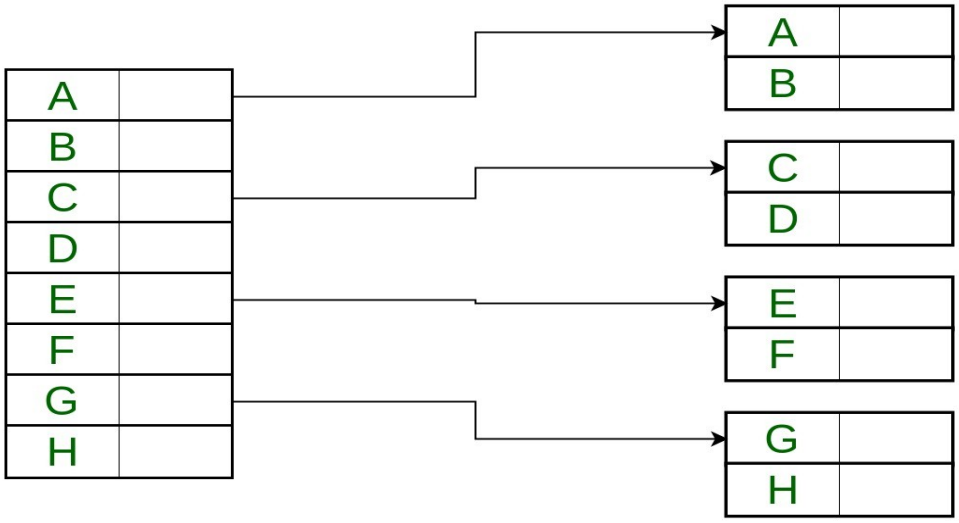
There is an Index Record.

Hence the name **Dense Index**.

Sparse Index:

- The index record appears only for a few items in the data file. Each item points to a block
- To locate a record, we find the index record with the largest search key value less than or equal to the search key value we are looking for.

Sparse Index



For very few search value in a Data File,

There is an Index Record.

Hence the name **Sparse Index**.

HASHING:

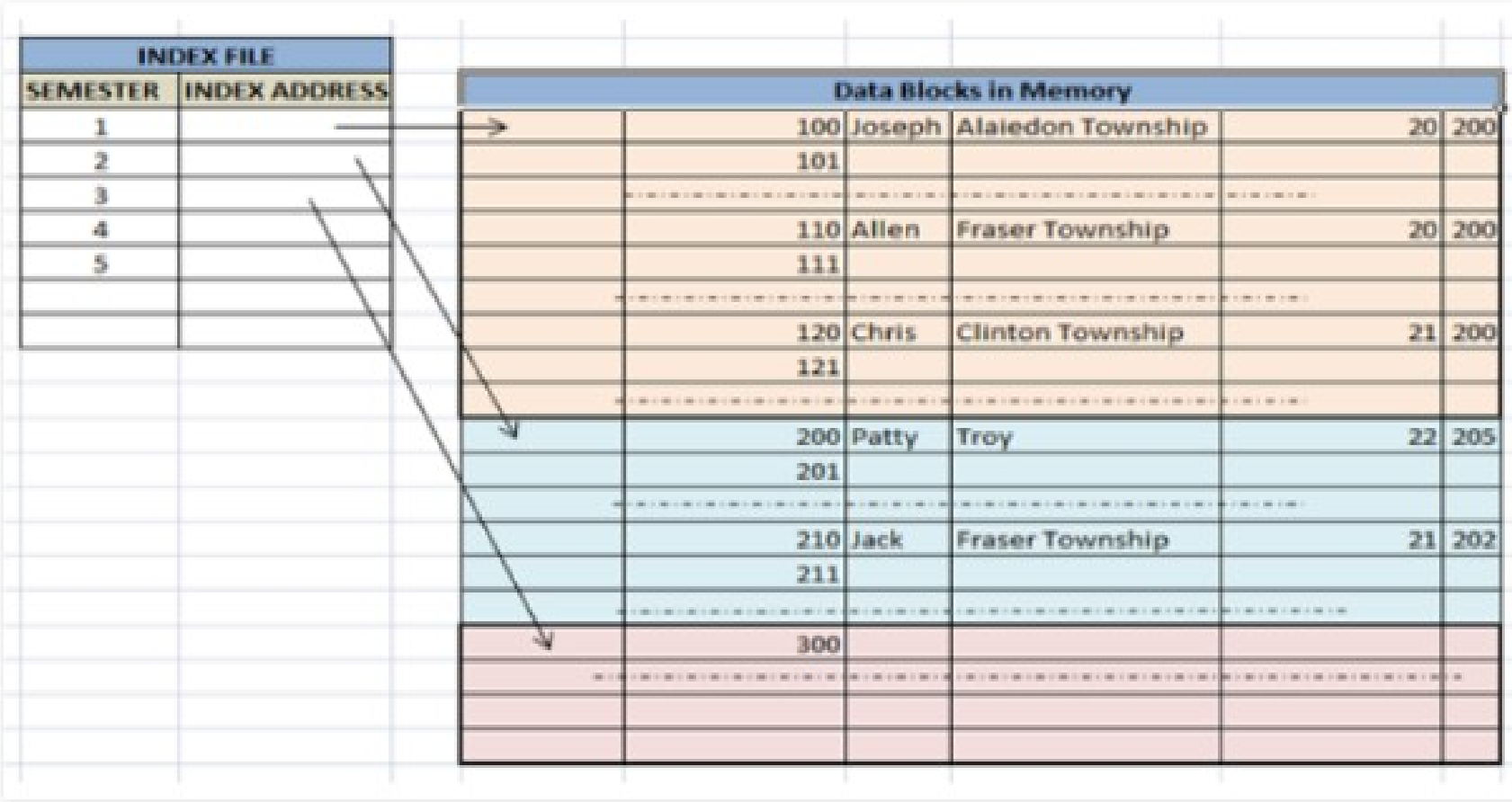
- Indices are based on the values being distributed uniformly across a range of buckets.
- The buckets to which a value is assigned is determined by a function called a hash function.

three methods of indexing:

- Clustered Indexing
- Non-Clustered or Secondary Indexing
- Multilevel Indexing

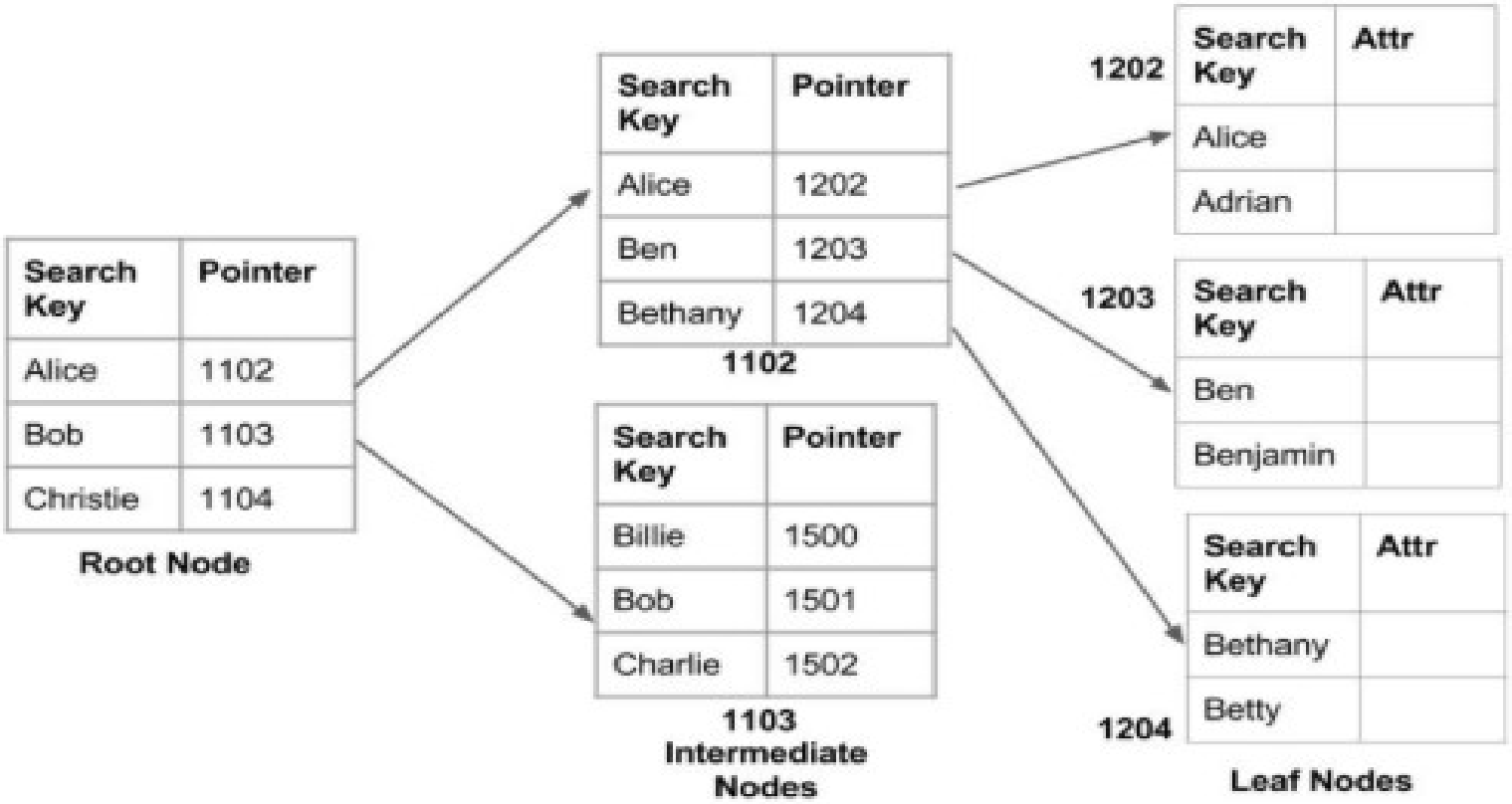
Clustered Indexing

- When more than two records are stored in the same file these types of storing known as cluster indexing.
- cluster indexing has an entry for each distinct value of clustering field.
- There can be only one clustered index per table.


INDEX FILE
SEMESTER
INDEX ADDRESS
1
2
3
4
5
Data Blocks in Memory
100 Joseph Alaiedon Township 20 200
101
110 Allen Fraser Township 20 200
111
120 Chris Clinton Township 21 200
121
200 Patty Troy 22 205
201
210 Jack Fraser Township 21 202
211
300

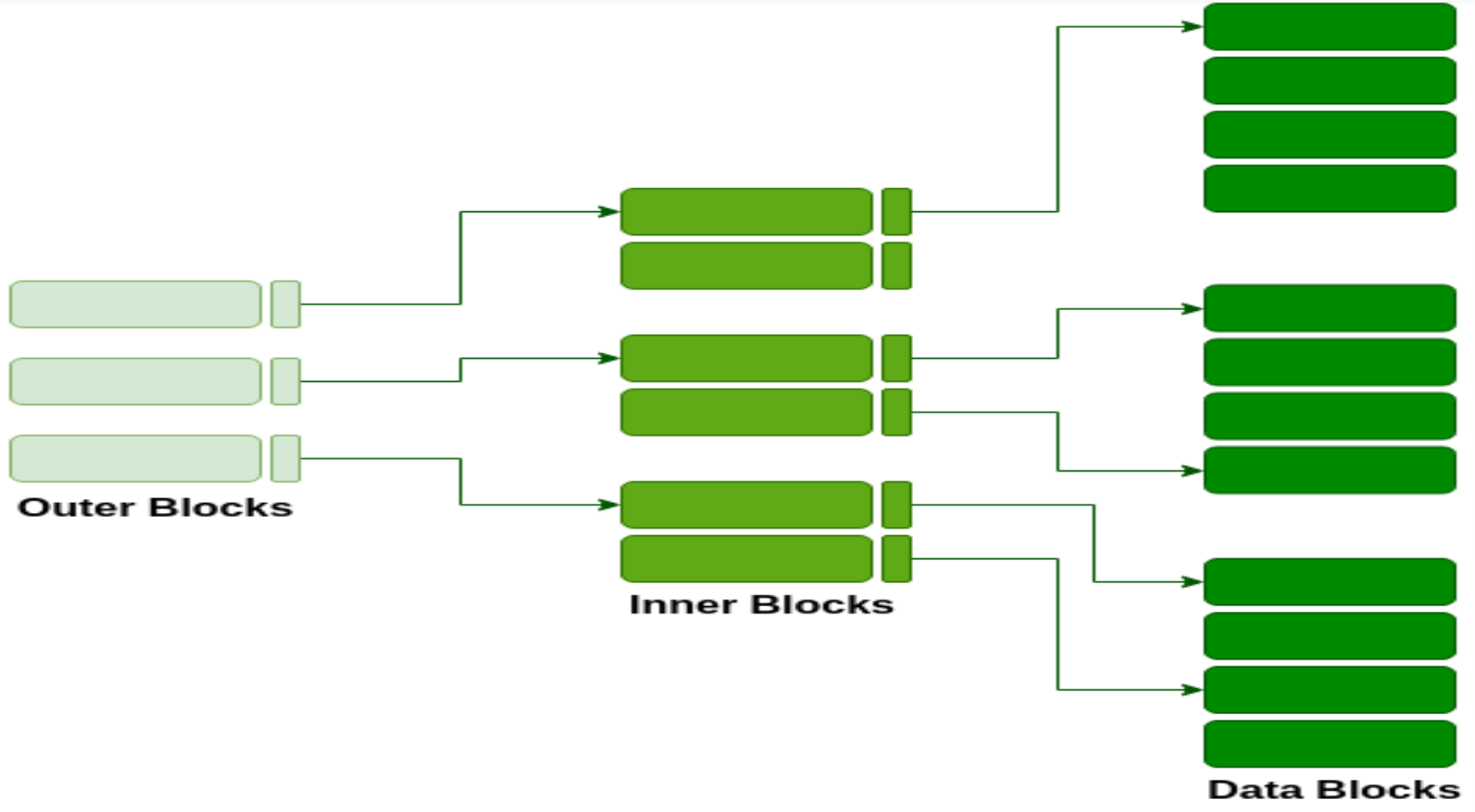
Non-clustered indexing

- A non clustered index just tells us where the data lies.
- it gives us a list of virtual pointers or references to the location where the data is actually stored.


Search Key
Pointer
Alice
1102
Bob
1103
Christie
1104
Root Node
Search Key
Pointer
Alice
1202
Ben
1203
Bethany
1204
1102
Search Key
Pointer
Billie
1500
Bob
1501
Charlie
1502
1103
Intermediate Nodes
1202
Search Key
Attr
Alice
Adrian
1203
Search Key
Attr
Ben
Benjamin
1204
Search Key
Attr
Bethany
Betty
Leaf Nodes

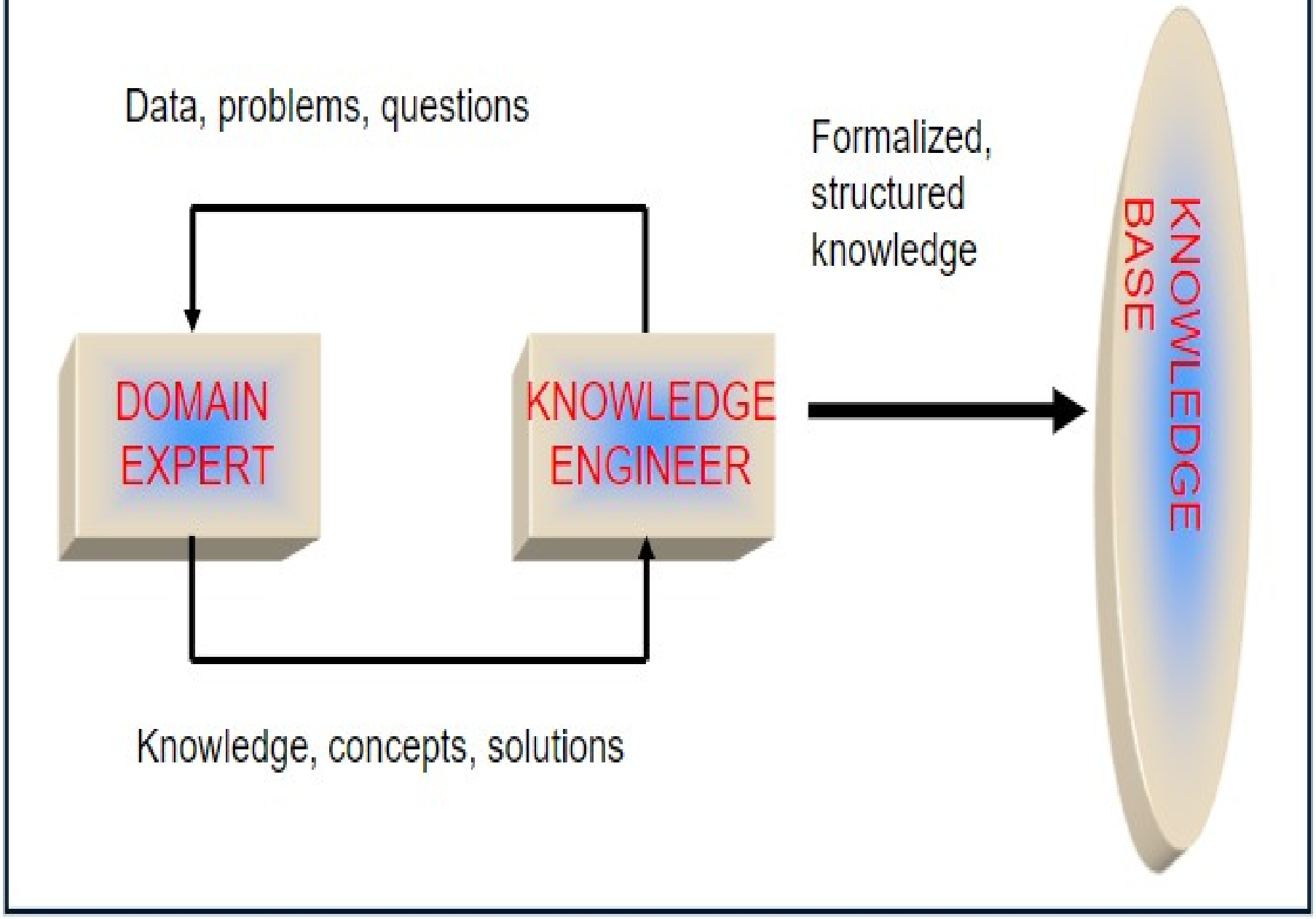
Multilevel Indexing

- single-level index might become too large a size to store with multiple disk accesses.
- The multilevel indexing segregates the main block into various smaller blocks so that the same can stored in a single block.


Outer Blocks
Inner Blocks
Data Blocks

KNOWLEDGE ACQUISITION

- It is the extraction of knowledge from sources of expertise, and transfer to the knowledge base.
- It also include acquiring knowledge from other sources such as books, drawings etc.
- Another term is knowledge elicitation.


Data, problems, questions
DOMAIN EXPERT
KNOWLEDGE ENGINEER
Knowledge, concepts, solutions
Formalized, structured knowledge
KNOWLEDGE BASE

Knowledge acquisition techniques

- The development of an expert system is entirely dependent upon the knowledge provided by the chosen expert.
- Introspection
- Observation
- Induction
- Protocol analysis
- Prototyping
- interviewing

Interviewing: types of question

Types	Purpose:	Form
Direct	Obtain specific information on some known issue	• What does … mean? • Is … true ? • What is the value of … ?
Indirect	Obtain general information on concepts and problem solving strategies	• What issues are considered for …? • How do you determine … ? • What do you look for when .. ?
Probes	Probe deeper into an establish issue	• Can you explain … ? • Can you discuss … ?
Prompt	Direct interview into a new area	• Can you discuss … ? • Can you return to … ?

introspection

- This is where the expert acts as expert and knowledge engineer.
- By examining his own thought processes the Expert builds a system which he believes effectively replicates the thinking processes.

Prototyping

- An extension of the interviewing technique.
- Here the expert works with the knowledge engineer in building a system.
- Both parties contributes to the system design.
- The expert uses the system to test the knowledge to be included.

Observation

- The most obvious, straightforward approach to knowledge acquisition.
- The expert is closely observed.
- Involves the use of video recordings for subsequent analysis.