Context-Aware Case-Based Reasoning

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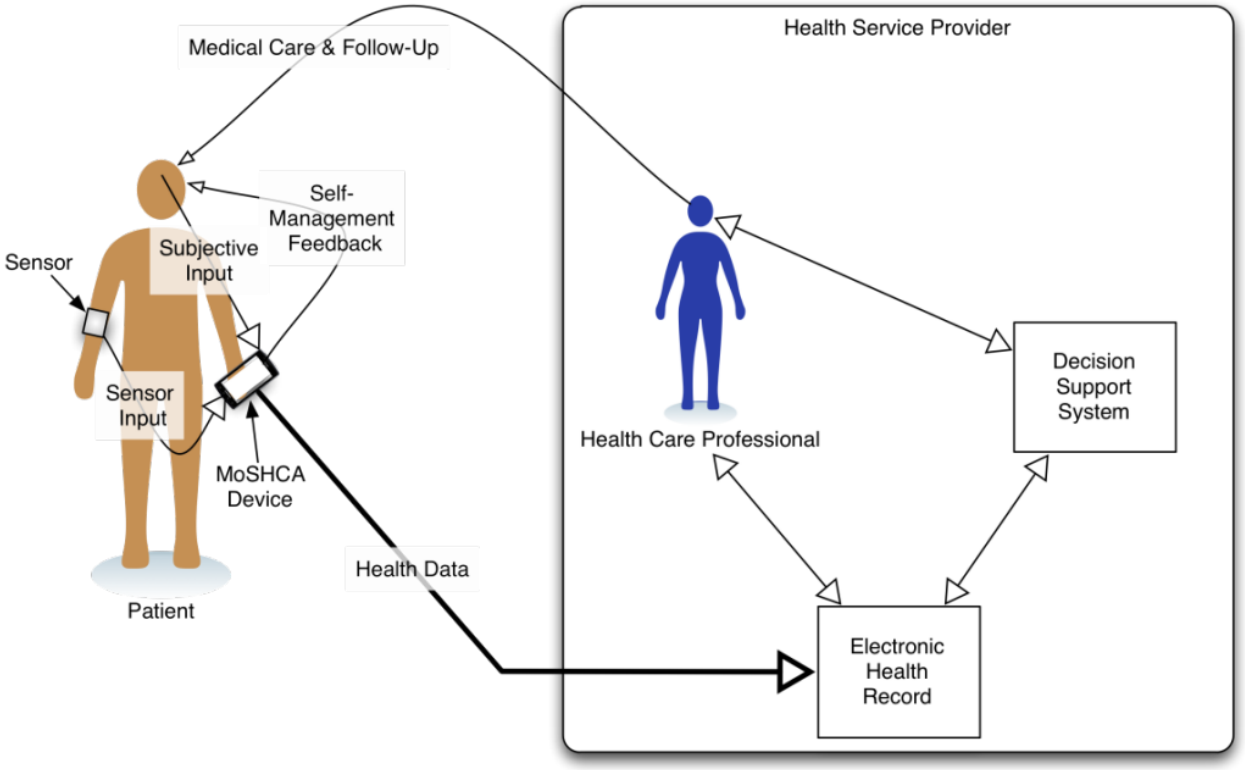
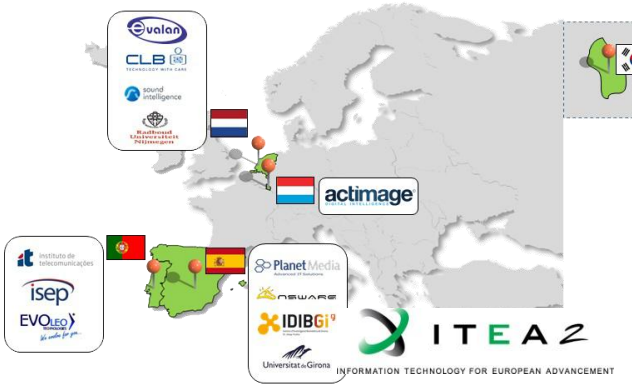
MoSHCA Project: My Mobile Smart Health Care Assistant

- Monitor & assist chronical disease patients



- COPD
- Diabetes
- Hypertension
- Epilepsy
- Premature-born babies
- Rehabilitation & Ageing



Context-Aware Case-Based Reasoning

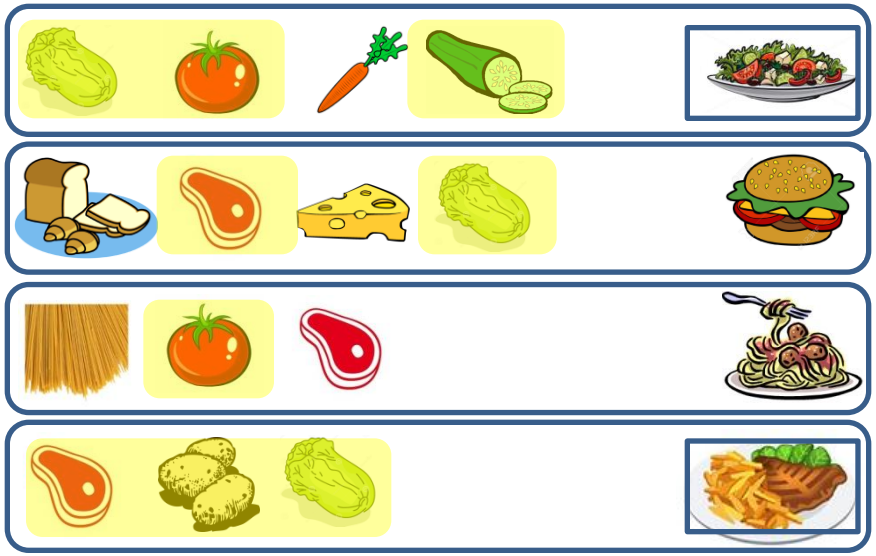
- Case-Based Reasoning

- Context-awareness / Ubiquitous computing

Case-based reasoning

- Imitate human problem solving

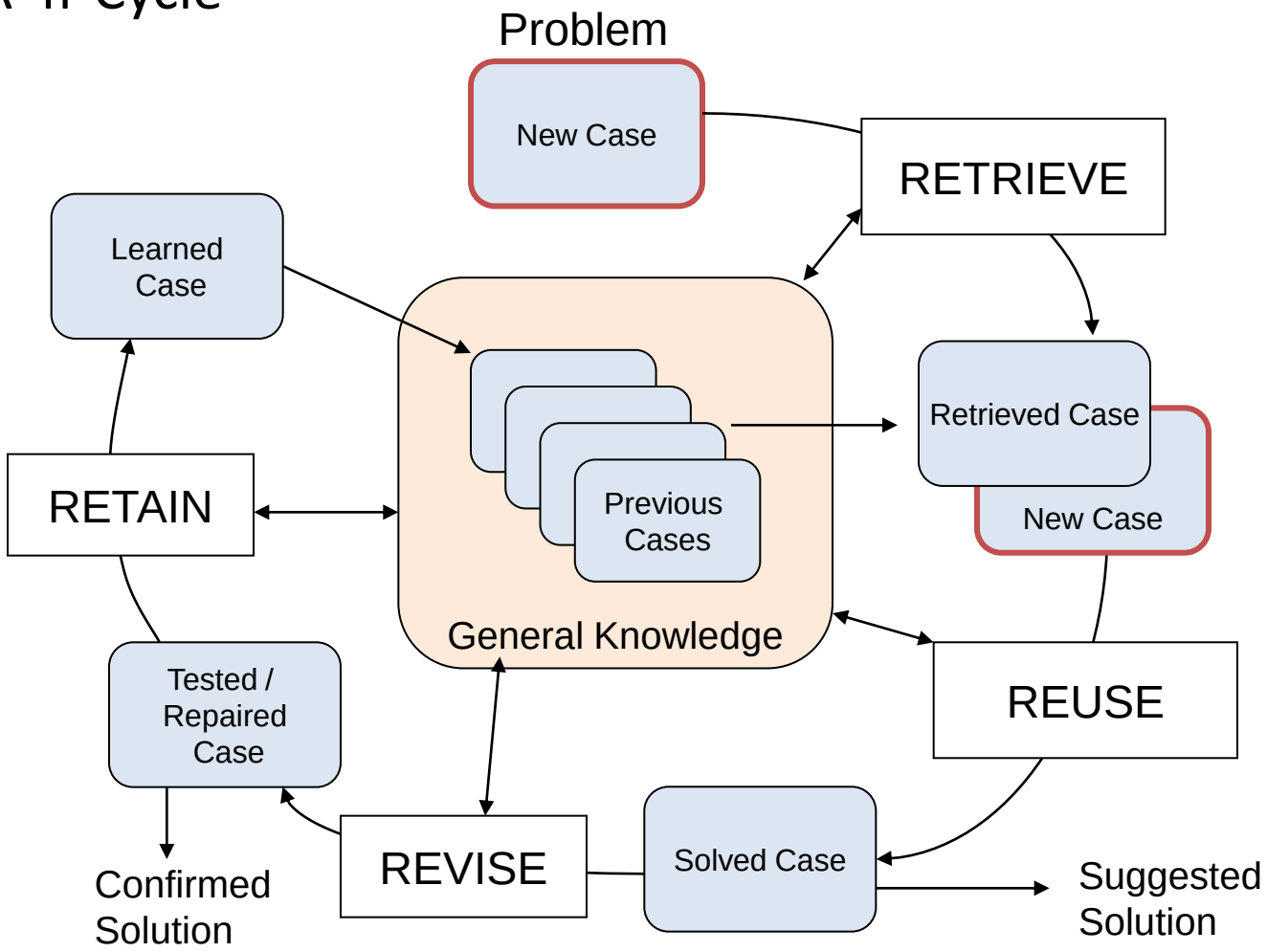
Remember (Retreive)



Adapt (Reuse)

Case-based reasoning

- CBR 4r Cycle



Context-awareness

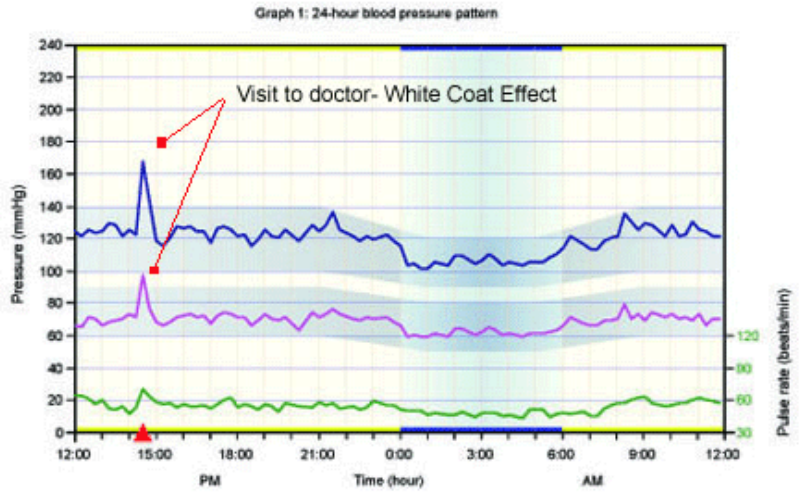
- Ability to change the behavior of a computing system depending on the context where it is being executed

- Information can have different meanings depending on the context it is placed

Context-awareness

- An example: The white coat effect

Clinical environment: high preassure



Other environment: normal preassure

Context: Who & Where

Context-awarenes

- Heart rate frequency

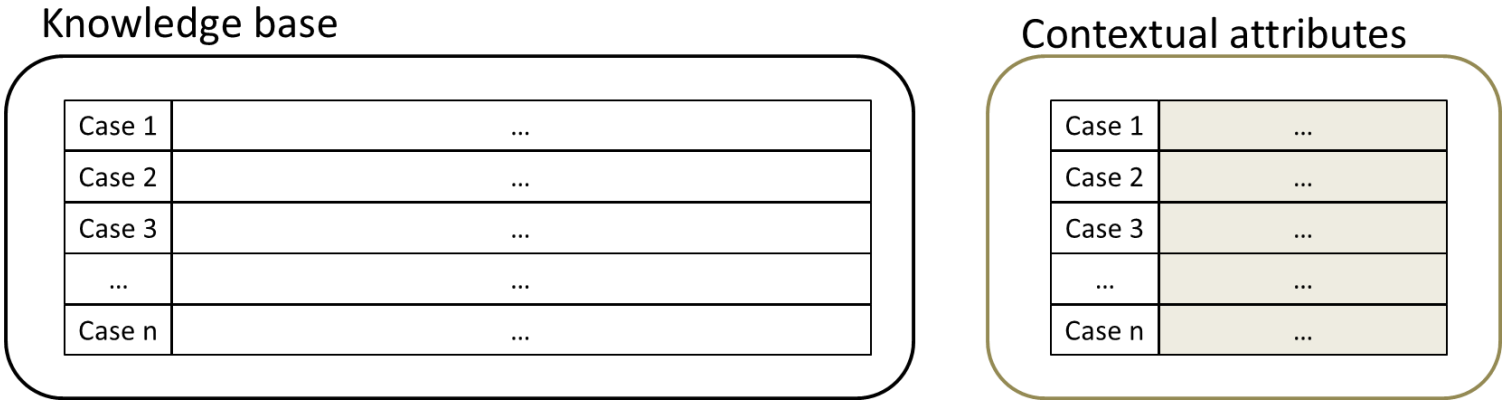
\+ High HRF = Normal Situation

\+ High HRF = Problem?

Context: What & Where

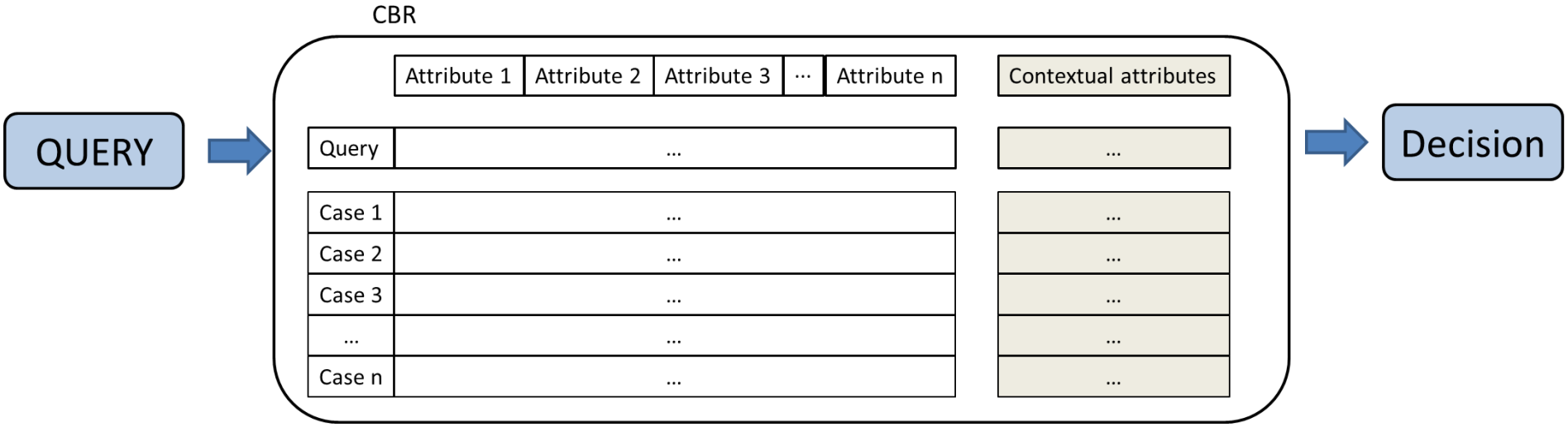
Context-aware CBR

- How can CBR be improved with context-awareness?



- 4 Methods
  - **Plain context CBR**
  - **Case-base filtering**
  - Attribute filtering
  - **Context stacking**

Plain Context CBR

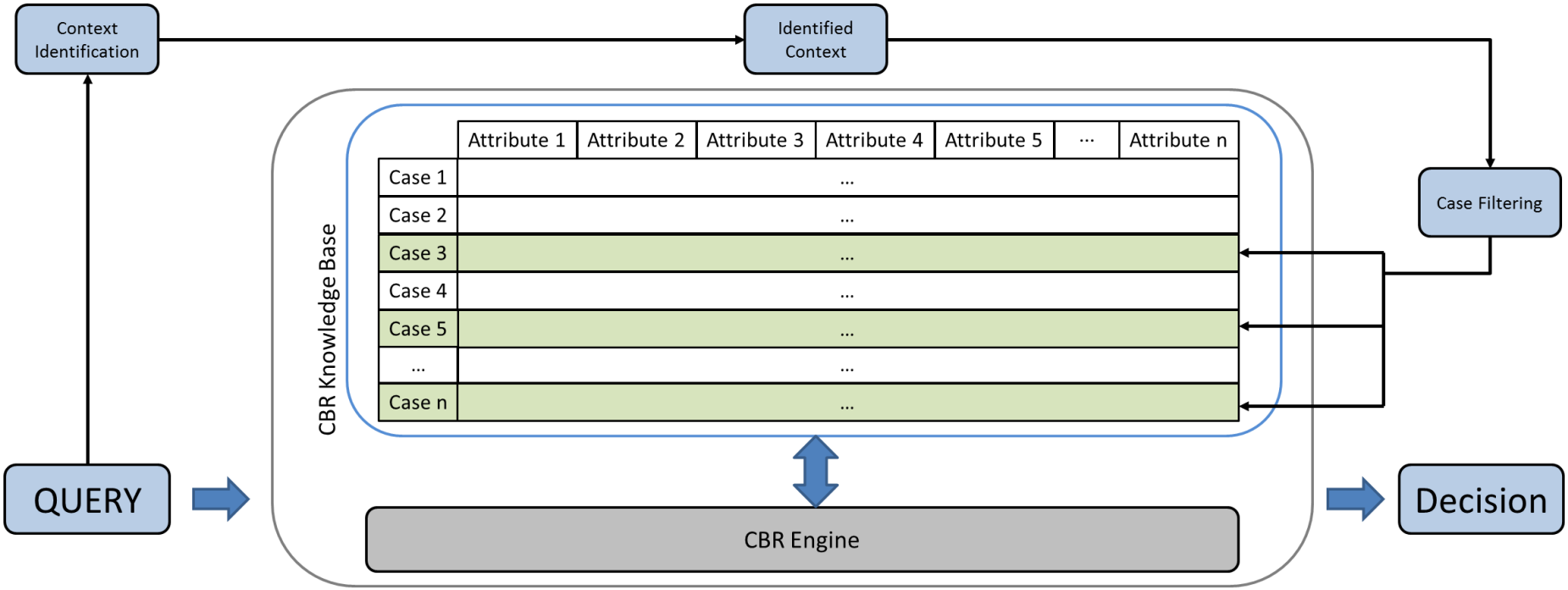


1. Context representation

$$\begin{aligned} &\text{attributes:} && \langle at_1, \ldots, at_n \rangle \\ &\text{context:} && \langle c_1, \ldots, c_n \rangle \\ &\text{case:} && \langle at_1, \ldots, at_n, c_1, \ldots, c_n \rangle \end{aligned}$$

2. Context CBR

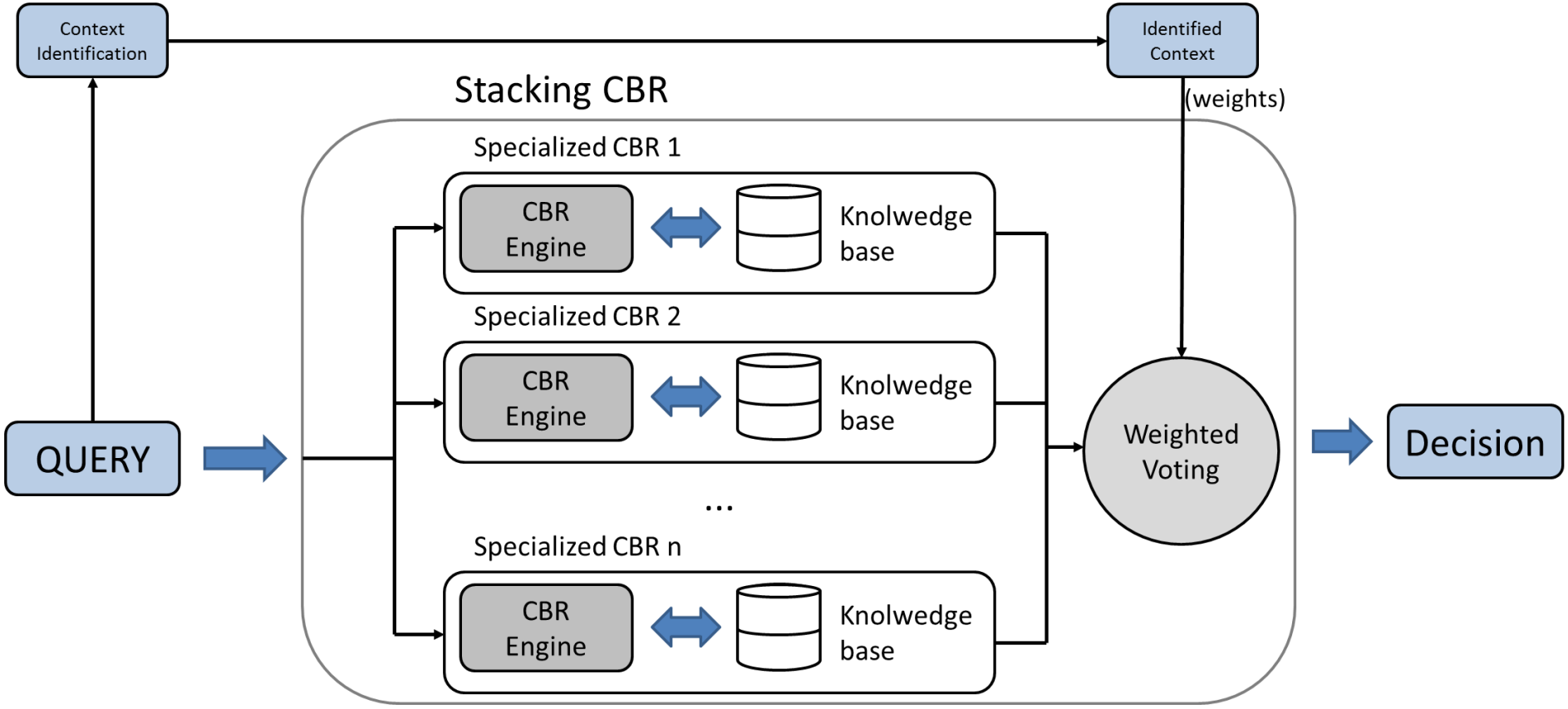
Case-base Filtering



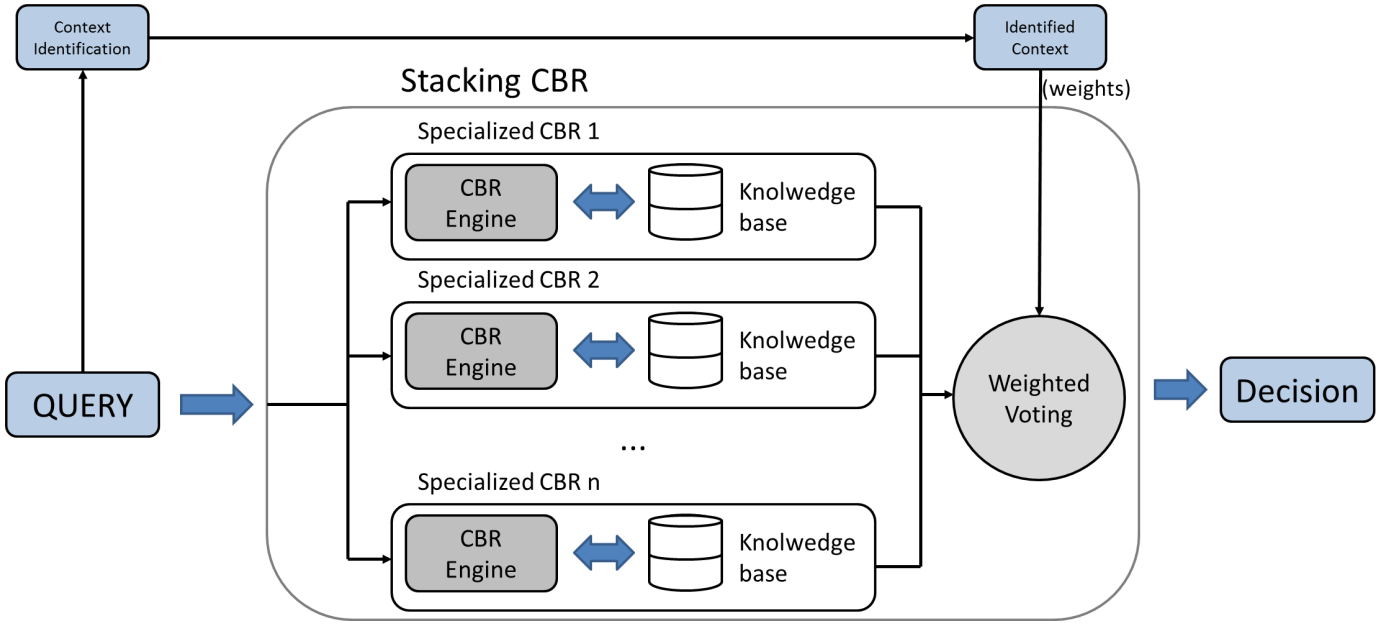
1. Context representation: identifing & labeling the KB
2. Query case representation identifing & labeling the query case
3. Context CBR only Consider cases with the same labels

$$sim(c, i_j) = \begin{cases} f(c, i_j) & \text{if } l_c = l_{i_j} \\ 0 & \text{otherwise} \end{cases}$$

Context stacking



Context stacking

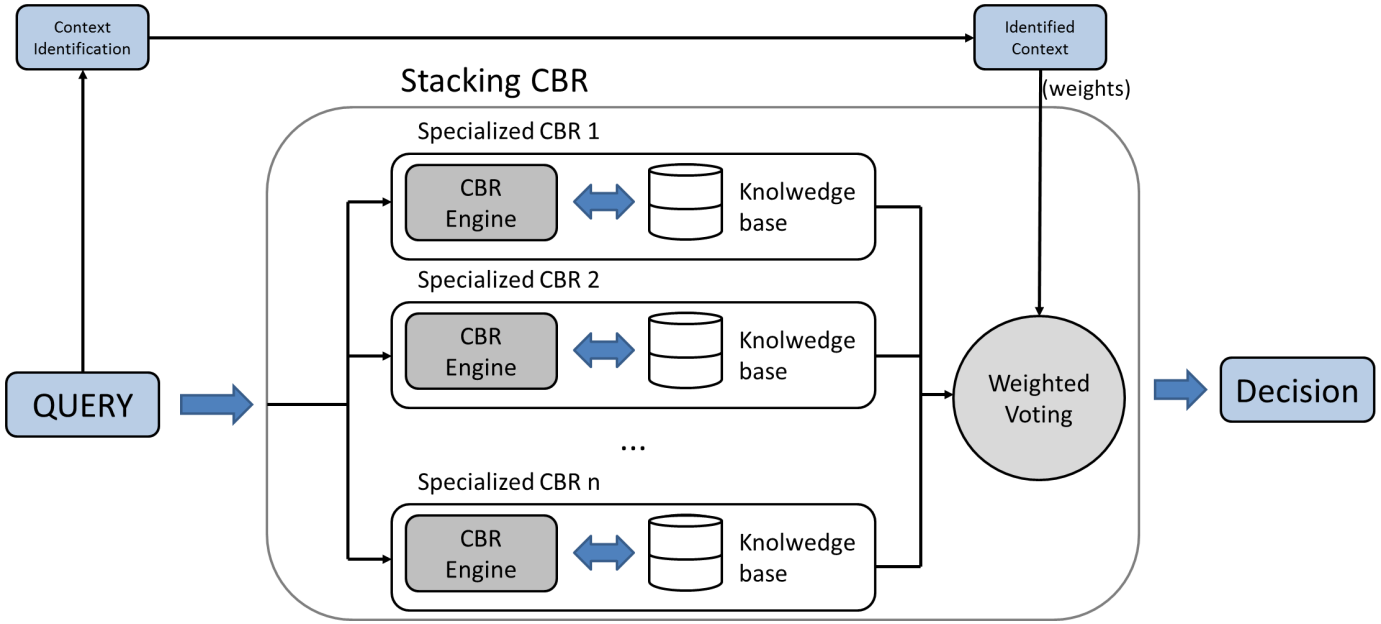


1. Context representation — Identify & label the KB
2. Stacking CBR weighting — Learn the weights for each CBR (depending on the type of context)

$$WS^{l_m} = \left\langle ws_1^{l_m}, \ldots, ws_k^{l_m} \right\rangle$$

3. Query case representation — identifing & labeling the query case

Context stacking



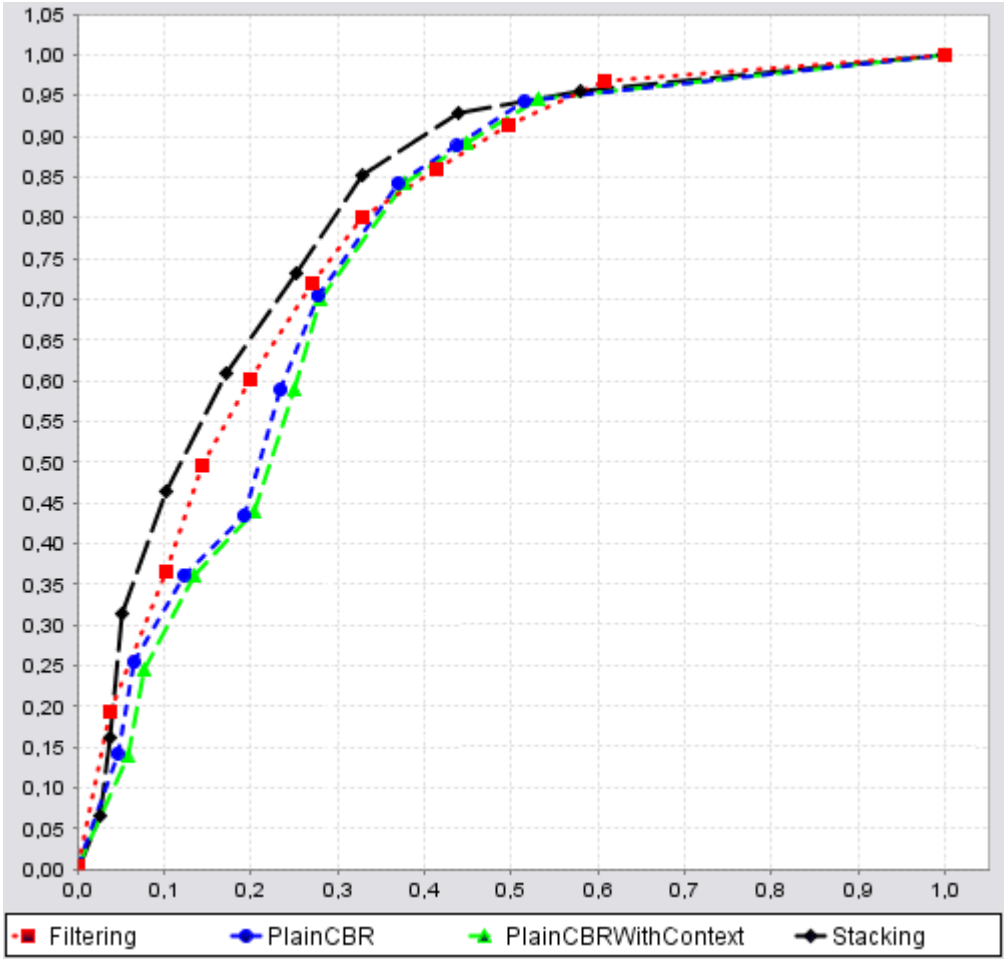
4. Context Stacking:
   - Deliver the case to each existing CBR
   - Select the appropriate set of weights
   - Aggregate the CBR outputs using a MCDM

$$r^c = mcdm(S, WS^{l_m})$$

Experimentation

- Breast cancer data-base (Catalan Institute of Oncology, ICO)
  - 502 cases (270 with cancer)
  - 1197 attributes (37 geographical & environmental context)
  - 3 different contexts identified:
    - Context A: Big city, Mediterranean climate, Metropolitan area
    - Context B: Small cities, Cold climate, Mountain area
    - Context C: Small cities, Dry continental climate, Rural area

Results



Method*	AUC
Simple CBR (Baseline)	0.774
Plain Context CBR	0.771
Case-base Filtering	0.795
Context Stacking	0.818

* All methods use the same retrieve & reuse configuration

Conclusions

- Case-based Reasoning + Pervasive computing = Context-aware Case-based Reasoning
- 3 approaches:
  - Plain context CBR (natural handling of context)
  - Case-base filtering
  - Context stacking
- Tested with a breast-cancer database
- Contextual information can improve the outputs of case-based reasoning.

Future work

- Attribute weighting & context management
- How to integrate context-awarenes in Revise & Retain cycles.
- Integrate the solution into a physical scenario
  (Integration to MoSHCA project)

QUESTIONS?

CONTEXT-AWARE CASE-BASED REASONING

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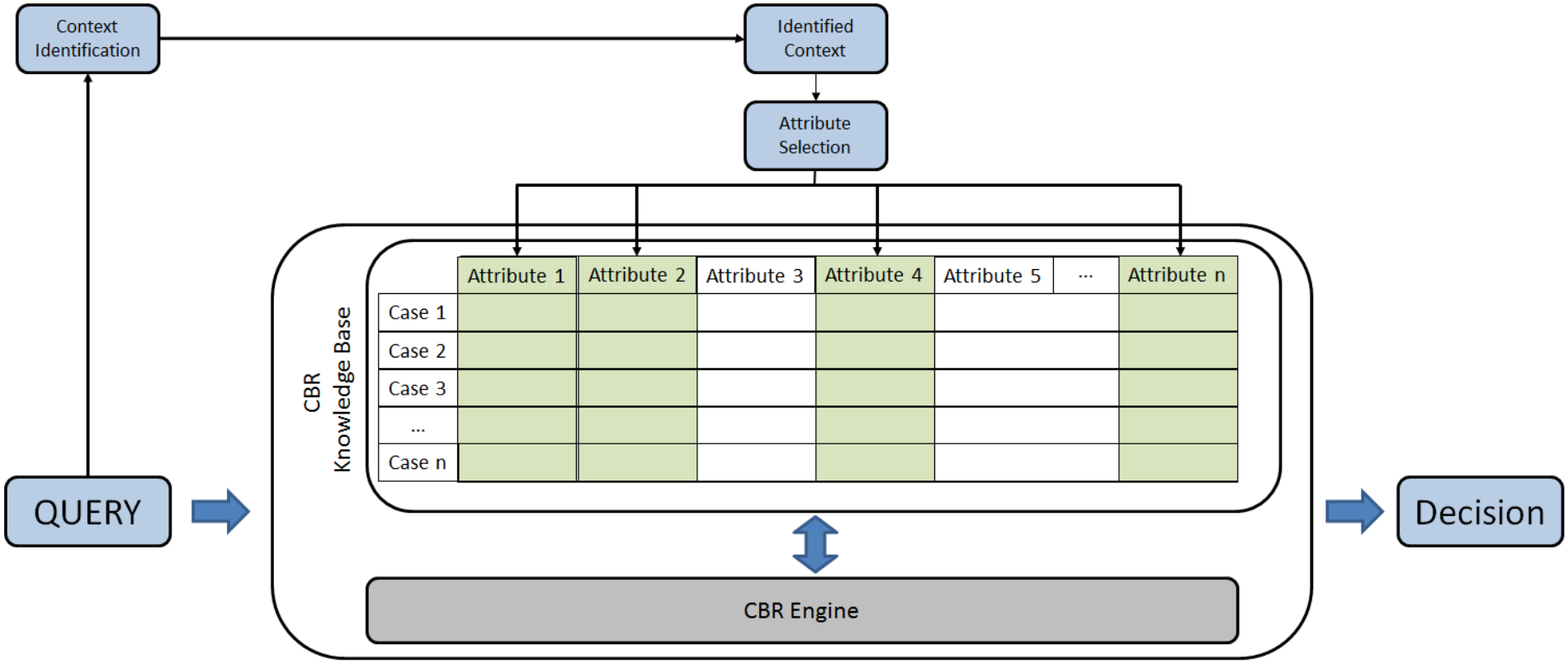
Attribute weighting



Types of Context

Sensor-related Context

- **What** recorded the data?
  - Precision of the sensor
  - Calibration of the sensor
- **Who** recorded the data?

…

Geo-temporal Context

- **Where** the data is recorded?
  - GPS coordinates
  - Home vs. Hospital

…

- **When** the data is recorded?

Environmental Context

- **How** is the environment of the patient?
  - Environmental conditions
  - Habits of their relatives
  - Stressful or peaceful environment

…