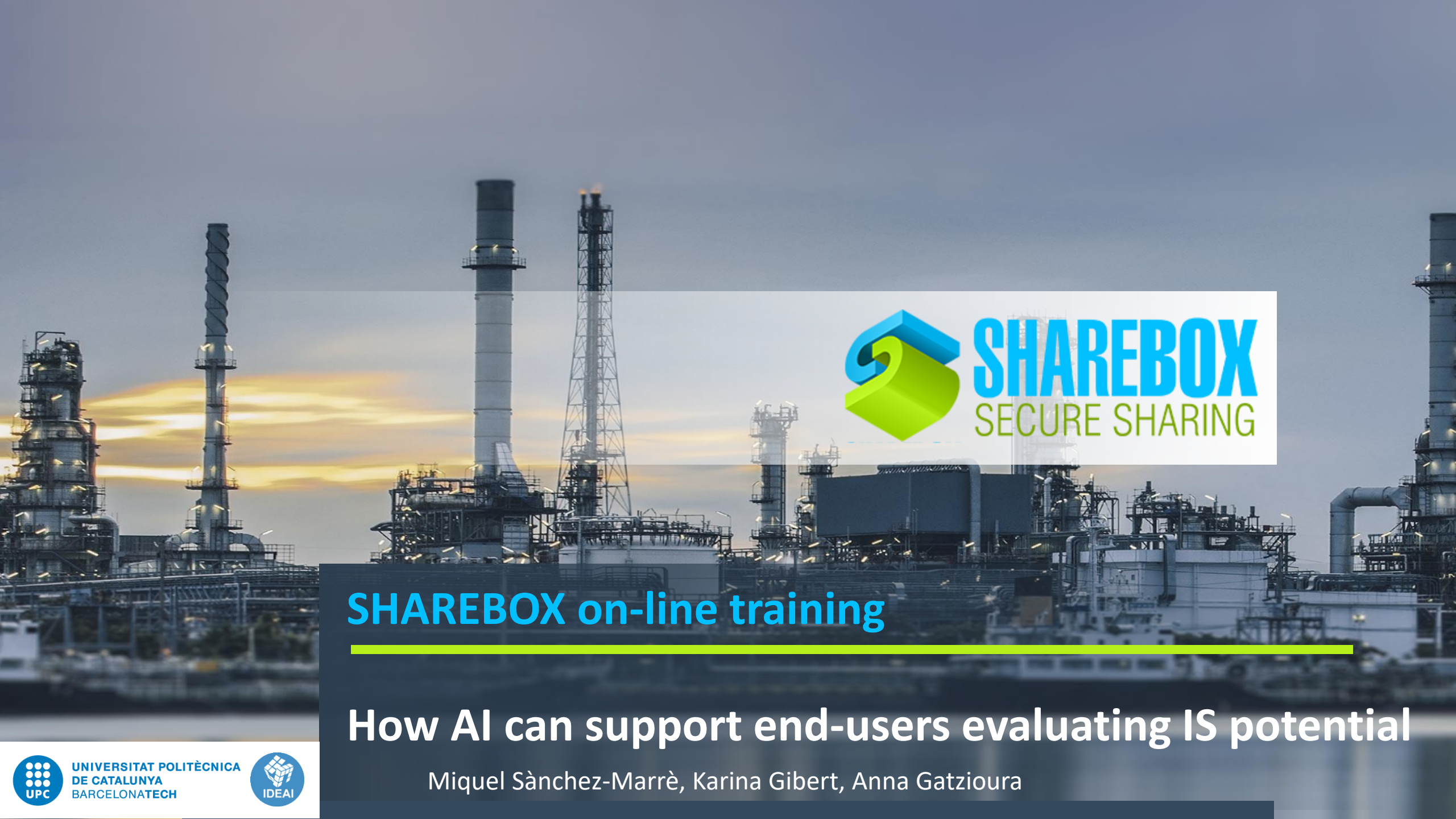


SHAREBOX
SECURE SHARING

SHAREBOX on-line training

How AI can support end-users evaluating IS potential

Miquel Sànchez-Marrè, Karina Gibert, Anna Gatzioura

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

UPC

IDEAI

Artificial Intelligence & Decision Support Tools

- ***Artificial Intelligence* (AI):** is the study of the possible or existing mechanisms – in human or other beings – providing such behaviour in them that can be considered as intelligence, and the simulation of these mechanisms, named as cognitive tasks, in a computer through the computer's programming.

- ***Intelligent Decision Support Systems* (IDSS),** is an AI application field oriented to give support to an end-user which is a decision-maker coping with complex decisions in a concrete domain

- ***Recommender Systems* (RS)** are a special case of IDSS, where decisions are always on which *items* are the optimal to be consumed (music, films, books, etc.) or used (waste material, resources, etc.) or taken/followed (medical treatment, nutritional plan, etc.) by the end-user

Issues on the use of AI in Industrial Symbiosis (IS)

- Improvement of recommendations and/or strategies for IS decisions
- Reducing economic costs
- Reducing raw material consumption
- Reducing waste products' disposal
- Increase the reuse of wasting materials
- Improve the circular economy
- Discovering new waste resources to be used as input to a production process
- Dynamic learning from past performed synergies

Decision Support in Industrial Symbiosis

- **Companies:**
  - Work based on predefined relationships and methods
  - Have difficulties for the simultaneous evaluation of:
    - Numerous current alternatives
    - Cost (environmental, economic etc.) reduction possibilities
    - Optimization options
  - Resource and process related information overload

- **Need for Intelligent Decision Support Systems**
  - Filter existing information
  - Identify suitable alternatives
  - Present Top-N candidates
  - Suggest unexpected possibilities

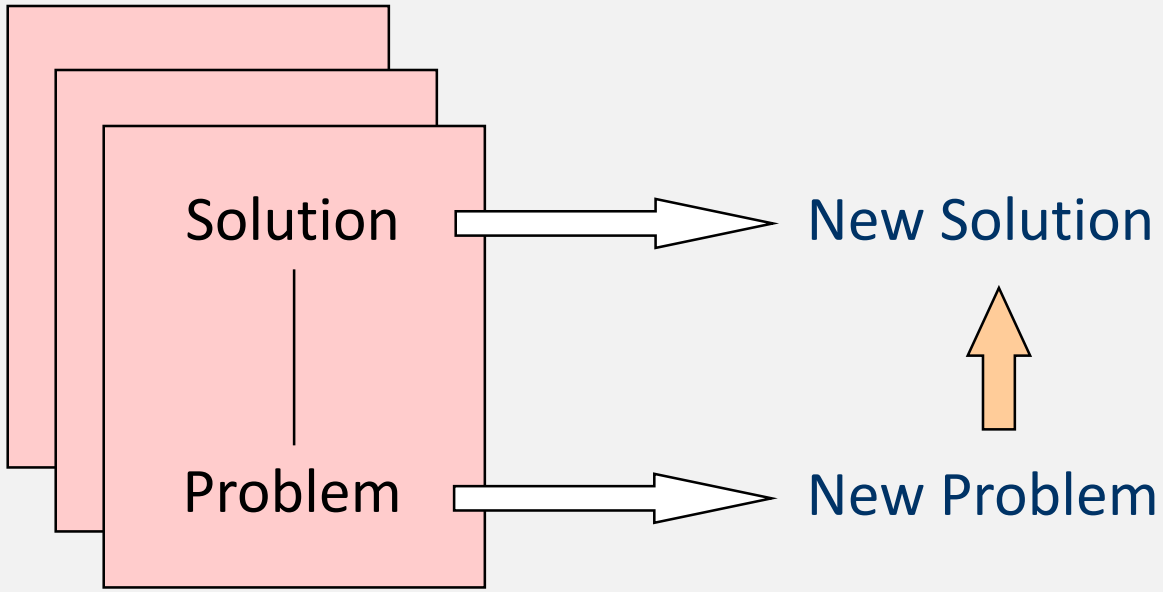
- **Recommender Systems**

Recommender Systems

- **Software tools & techniques for information retrieval and filtering**
  - Handle the existing information overload
  - Provide meaningful suggestions to users
    - Set of top – N items
    - Predict if an item will be of interest
  - Main Hypothesis:
    - Users' behavior & preferences remain stable
    - Similar users have similar behavior
  - Utility function, $v: U \times I \rightarrow R$
    - The utility that a user from U gets from an item (or action) from I.
    - Recommend the item(s) $i' \in I$ that maximize user's utility under certain circumstances: $\forall u' \in U, i' = argmax\ v(u', i)$

Case-Based Reasoning (CBR) paradigm

- "*Transferring knowledge from past problem solving episodes to new problems that share significant aspects with corresponding past experience and using the transferred knowledge to construct solutions to new problems*." (Carbonell, 1986)
- **CBR**: A methodology of solving new problems by adapting the solutions of previous similar problems



A computational metaphore of *Reasoning by Analogy*

- It uses **cases** as an episodic memory (**Case Library**).

Local Resource Recommender for Industrial Symbiosis

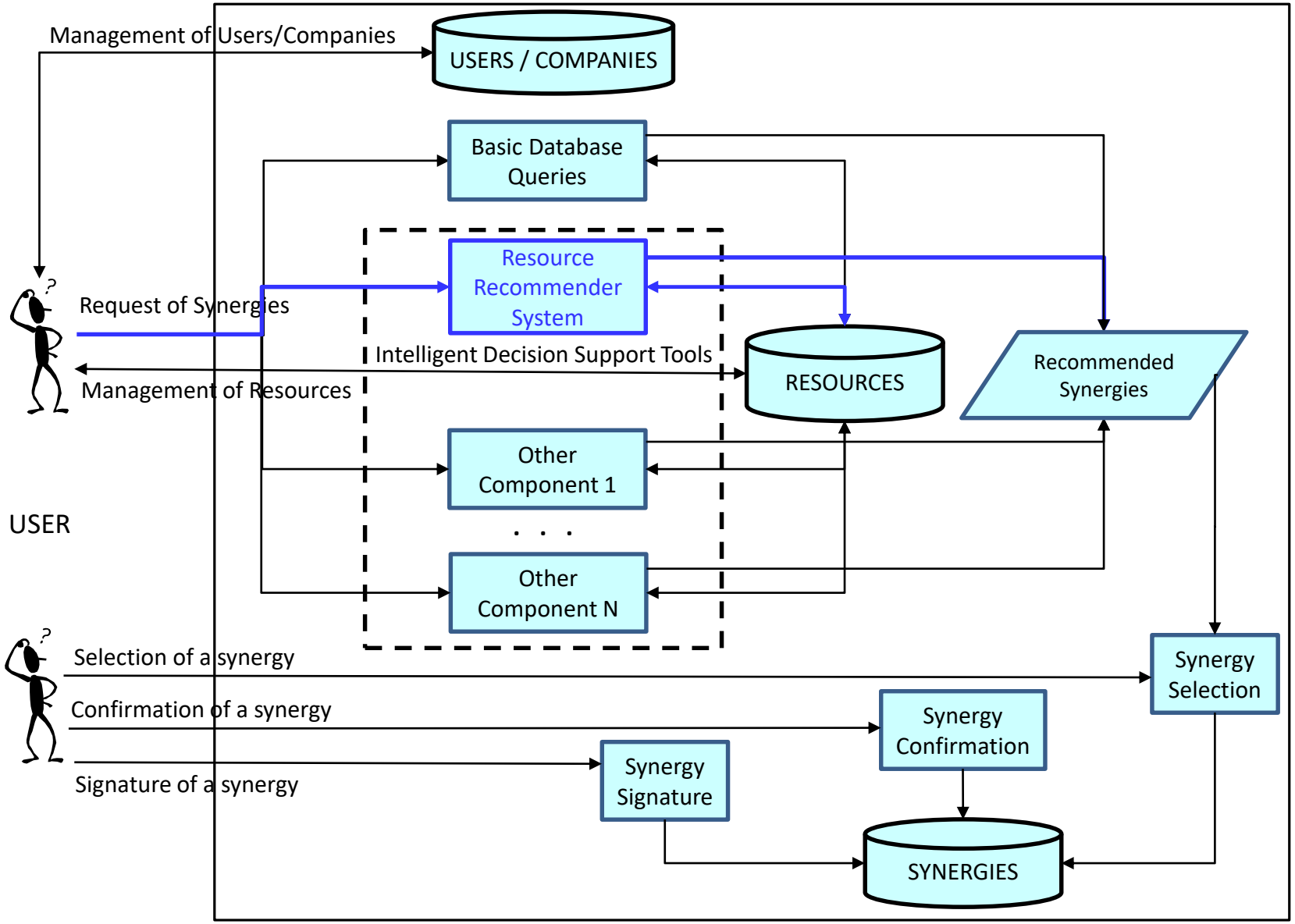
Objectives:

- Improvement of recommendations and/or strategies for Industrial Symbiosis (IS) decisions

How:

- Apply a hybrid recommender system using CBR and Ontological knowledge from EWCs to improve strategies for resource selection and starting of synergies
- Search for resources which are similar to the one specified in the user query
- Filter or rank the candidate resources
  - Filtering: only the same EWCs pass the filter
  - Ranking: the resources are ranked according to a hybrid semantic similarity function, which takes into account: keywords, EWCs, site distance, etc.
- The user finally selects the resource to start a possible synergy

SHAREBOX Platform Architecture with the Resource Recommender



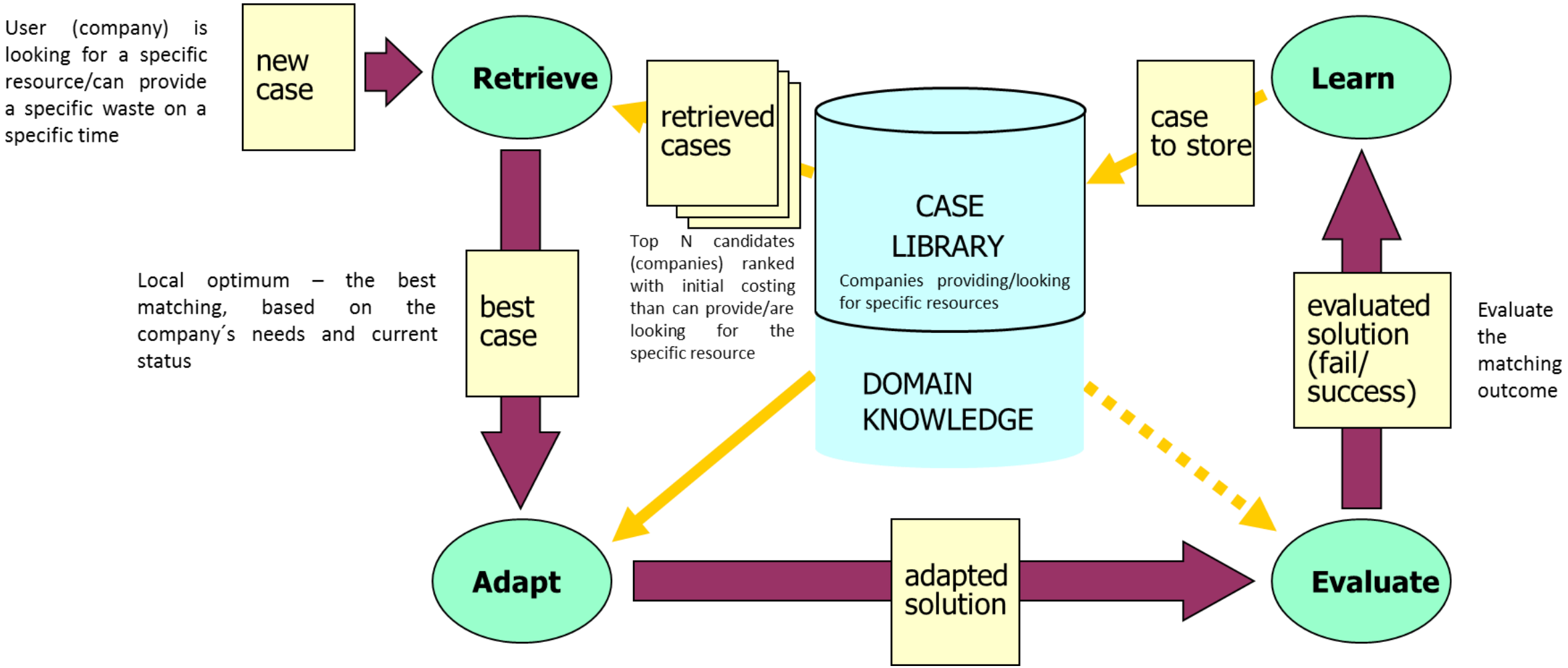
Resource/Waste product Feature Model

- **Resource Id**
- **Name**
- **Description:** basic information describing the resource
- **Waste code/s:** EWC(s) of the registered resource
- **Type:** Have/Want, indicating whether the resource is offered or needed by the company site
- **Quantity:**
  - A specific number or in some cases it is possible to have theoretically unlimited availability (no limitations)
- **Measurement unit:** depending on the type of resource
- **Frequency or date:** when it is generated or requested
- **Site:**
  - Geo-location of the resource, not the company
  - Longitude and latitude

User Query

- **Keywords:** One or more keywords describing the resource requested
- **Resource direction:** type of resource: a needed (want) or an offered (have) resource
- **EWC code:** the waste code of the requested resource
  - In the three hierarchical levels: chapter, subchapter, code
  - Search method: Filter/Rank
- **Category:** same as the EWC in the case that resource category descriptions are used
  - In three levels
  - Search method: same as in the case of the EWC
- **Site:** the geo-location of the site where the resource is located
  - does not refer to the company
  - longitude and latitude

CBR application in Resource Recommendation



An Example of the Resource Recommender

- **User query:**
  - Want “steel”
  - With EWC 08 01 99
  - At longitude -127.9248046875 and latitude 54.13669645687003
- **From past data:**
  - 16 resource candidates for keyword “steel”
- **If Results filtered:**
  - 6 resource candidates for keyword “steel” and EWC 08 01 99
- **If Results ranked:**
  - 3 EWC candidates (similarity > 0.5)
    - 08 01 99 , 06 13 99 , 06 04 99
  - 71 another resource candidates

An intelligent system for improving the usage of the SHAREBOX platform / A synergy hybrid recommender

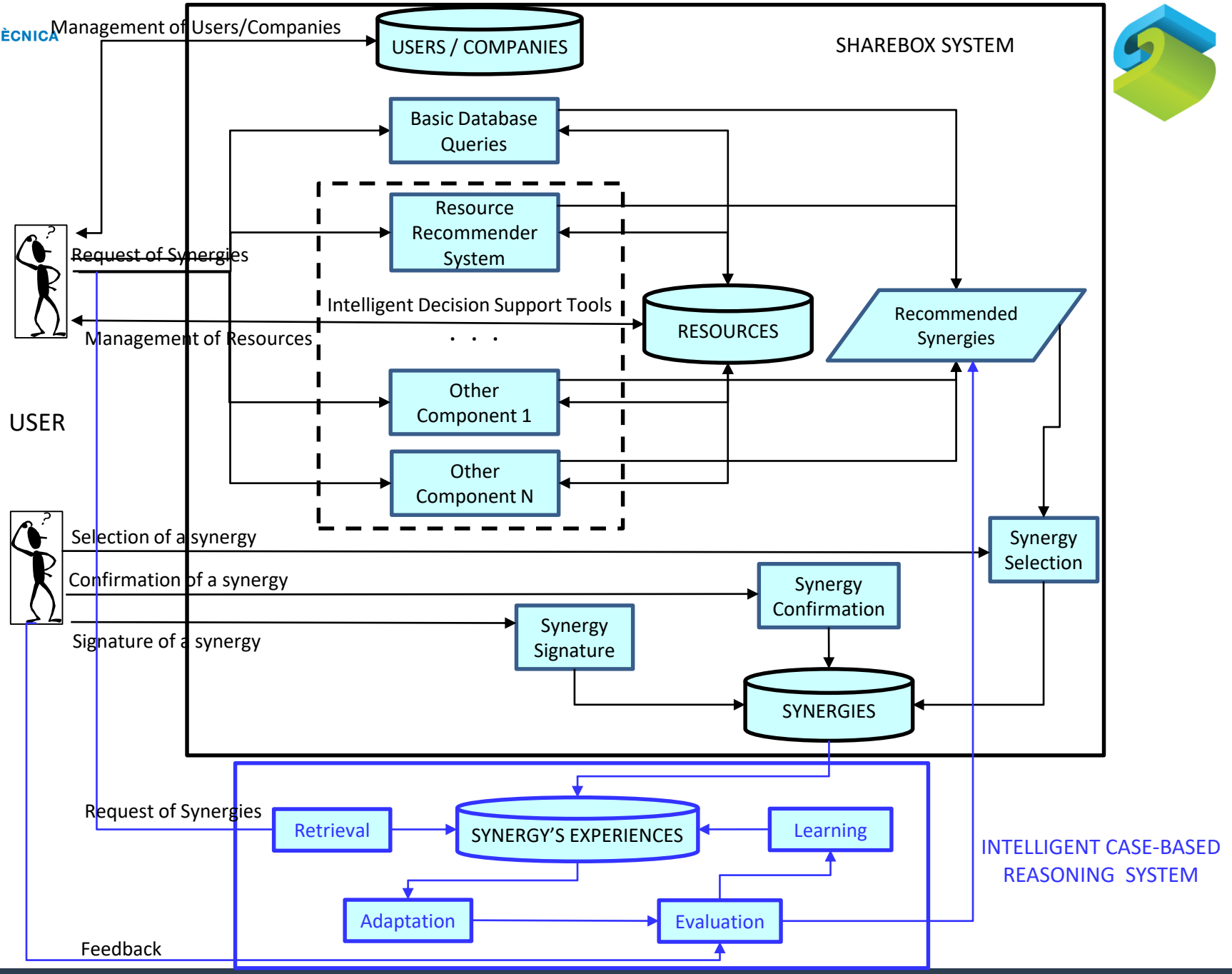
Objectives:

- SHAREBOX system's day-to-day usage and performance improvement
- Symbiotic synergies optimization

How:

- Design and develop an intelligent module
- Use data mining techniques to gather historic data
- Use a case-based reasoning to analyze daily operations and learn to solve operational problems
- Suggest recommendations in a more competent way based on successful past synergies
- Evaluate synergies' feedback

Global Synergy Recommender System intergrated in SHAREBOX platform



Synergy model

- **User**
  - Company
  - Category: industrial sector
  - Location site
- **Resource required**
  - EWCs
- **Synergy partner**
  - Company
  - Category: industrial sector
  - Location site
- **Resource obtained**
  - EWCs
- ***Synergy status:*** requested, scoping, negotiation, signed, ongoing, completed
- ***Synergy rating:*** synergies are automatically evaluated with a 5-star rating system

User Query

- **User**
  - Company
  - Category: industrial sector
  - Location site
  - Optionally:
    - Synergy status required
    - Synergy rating required
- **Resource required**
  - EWCs description

Retrieval Flexibility

- **Retrieved synergies according to different focus:**
  - Resource-based: only synergies with similar EWCs
  - User-based: only synergies initiated by users of the same category
  - Case description-based: only synergies initiated by users of the same category and on similar resources
  - Location-based: only synergies performed in close geographic locations to the user location
  - Status-based: only synergies having reached the same status are evaluated
  - Rating-based: only higher rated synergies are considered
  - Similarity-based: the whole case (synergy) similarity is considered (rating, status, location, user category, and resource)

An Example of the Synergy Recommender

- **User query**
  - Category: 15 (Waste Packaging)
  - Location site: Geolocation of Castelldefels (41° 16' 48.058" N 1° 58' 35.866" E)
  - Resource required: EWC = 15 01 02, plastic packaging
- **Retrieved synergies**
  - Similarity-based:
    - <15 01 02, plastic packaging, company-24, ongoing, 5 stars>,
    - <20 01 39, plastics from municipal waste, company-371, completed, 5 stars >,
    - <19 12 04, plastic and rubber wastes from mechanical treatment of waste, company-254, ongoing, 5 stars>
    - <15 01 01, cardboard packaging, company-89, negotiation, 3 stars>,
    - <15 01 03, wooden packaging, company-453, signed, 4 stars>,

Advantages of using Recommender Systems in IS

- They provide the SHAREBOX platform with:
  - A very *flexible recommendation* system for suggesting the most suitable resources or synergies, given a query of a user through *similarity-matching strategies.*
  - A *hybrid semantic measure* to compare EWCs and linguistic terms to suggest appropriate resources and synergies
  - ***Maximize* the possibility to *find the most useful resource*. This is a great advantage compared with usual Information Systems based on the *exact-matching approach* offered by a database querying system.**
  - A *resource discovering functionality*, with its hybrid recommendation strategy.
  - *Increase* of *reusing* of waste products
  - *Reductions* on *new raw material* for productive industrial processes
  - *Energy cost savings* derived on the established synergies
  - The ability to learn with the use of the platform and to improve the accuracy of the recommendations
  - *Analogical reasoning* techniques exploiting the knowledge from past resources and synergies

The project: SHAREBOX

SHAREBOX
SECURE SHARING

SHAREBOX
SECURE SHARING

www.sharebox-project.eu

Secure Management Platform for Sharing Process Resources

- Joint project funded by EU (Horizon 2020)
- 16 project partners from 8 countries
- EC funding (A): 5.416.544,75 €
- Private investment (B): 1.500.000 €
- Funding period: 2015-2019

Funded by the Horizon 2020 Framework Programme of the European Union

SPIRE
Sustainable Process Industry through Resource and Energy Efficiency

www.spire2030.eu

Authors of this presentation

Miquel Sànchez-Marrè[1], Karina Gibert[2], Anna Gatzioura[1]

Intelligent Data Science and Artificial Intelligence Research Centre (IDEAI-UPC)

Knowledge Engineering and Machine Learning Group (KEMLG-UPC)

[1]Computer Science Dept., [2]Statistics & Operations Research

Universitat Politècnica de Catalunya · Barcelona**Tech**

http://sharebox-project.eu/

Funded by the Horizon 2020 Framework Programme of the European Union

Sustainable Process Industry through Resource and Energy Efficiency

www.spire2030.eu