

An Ontological Framework for Decision Support



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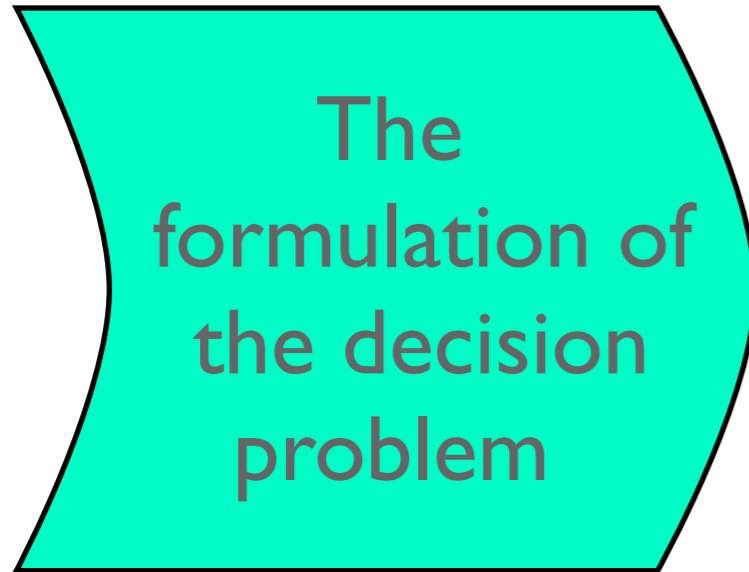
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Decision Making

- The decision making process of a **Decision Support System (DSS)** typically consists of three phases:

Decision Making

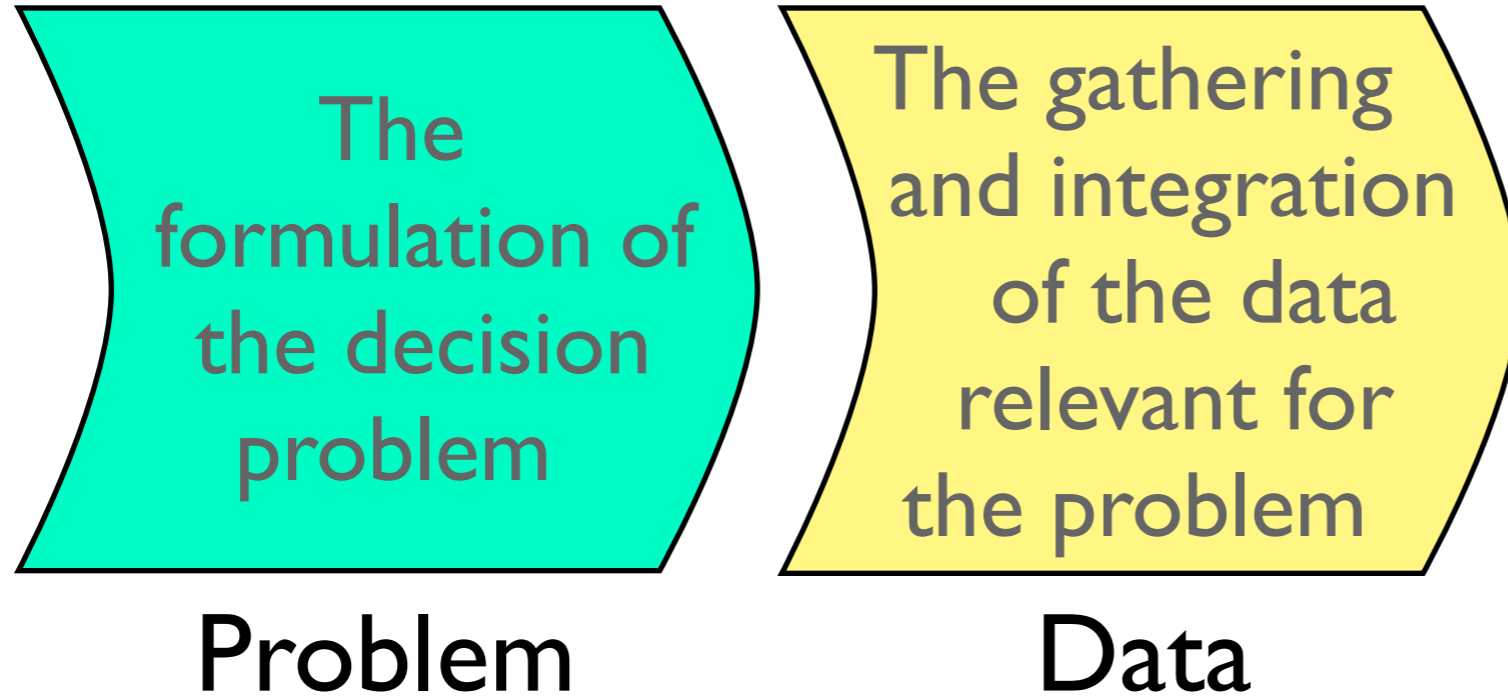
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Problem

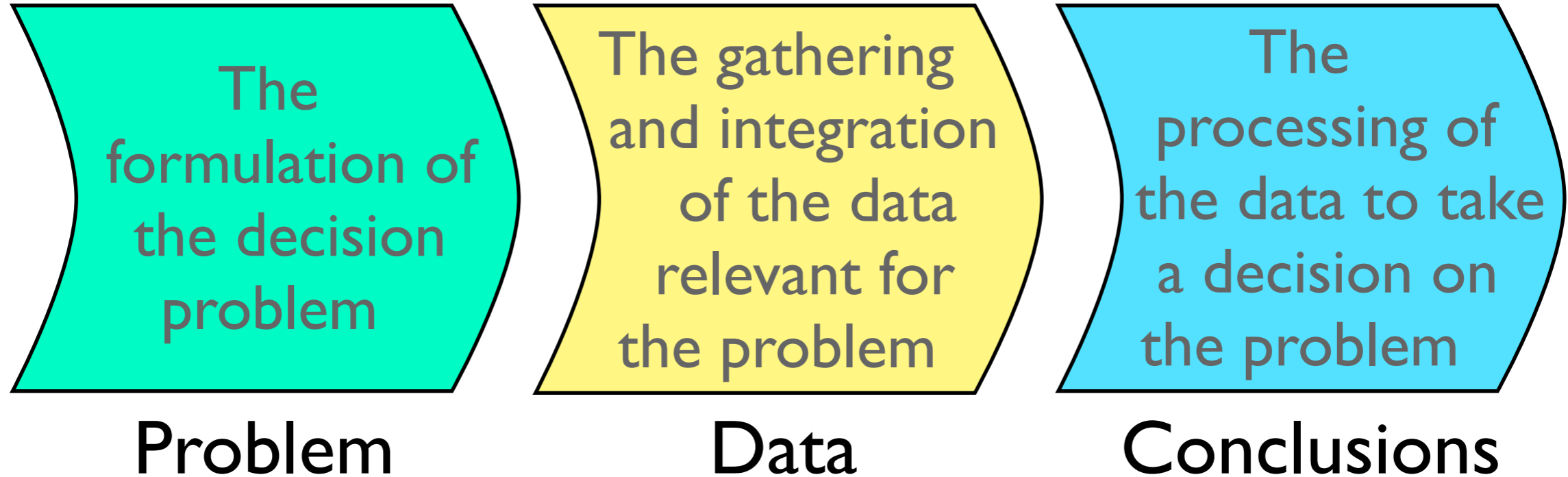
Decision Making

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Decision Making

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Our Contribution

- We propose to adopt an **ontology-based knowledge base** as the main (enhanced) **data structure** of a DSS:
 - **T-Box**: formally represents the content manipulated in the **three decision-making phases** (problem, data, conclusions)
 - **A-Box**: each **request** submitted to the system corresponds to a **single incrementally-built A-Box** (a “**semantic request script**”)

Advantages

- Facilitates the **integration** of heterogeneous **knowledge** and **data** sources
- Semantic **exposure of DSS processing** to external services
- Some of the **inference steps** of the DSS can be performed via state of the art **logical reasoning services**

Outline

- PESCaDO Use Case: An Environmental DSS
- The Decision Support Knowledge base (DSKB)
 - Problem component
 - Data component
 - Conclusion component
 - Semantic Request Script (SRS)
- Incremental construction of a SRS
- Exploitation of SRSs
- On Engineering the DSKB
- Conclusions

The logo for PESCaDO features a stylized sun with rays in orange and yellow above a blue wave-like shape. Below this, the text 'PESCaDO' is written in a blue, sans-serif font, with 'Ca' in a smaller size. Underneath the text are several vertical green bars of varying heights, resembling a bar chart or a stylized landscape.

PESCaDO Use Case

- A multilingual web-service platform providing personalized environmental information and decision support
- Example **scenarios**:
 - A pollen allergic person, planning to do some outdoor activities, interested in being notified of potentially harmful environmental conditions
 - A city administrator, to be informed whether the current air quality situation requires some actions to be urgently taken.
- The **PESCaDO DSS** demo-video
- PESCaDO FP7 EU Project
 - Demos, Videos, Ontologies, etc: <http://www.pescado-project.eu>



PESCaDO Use Case



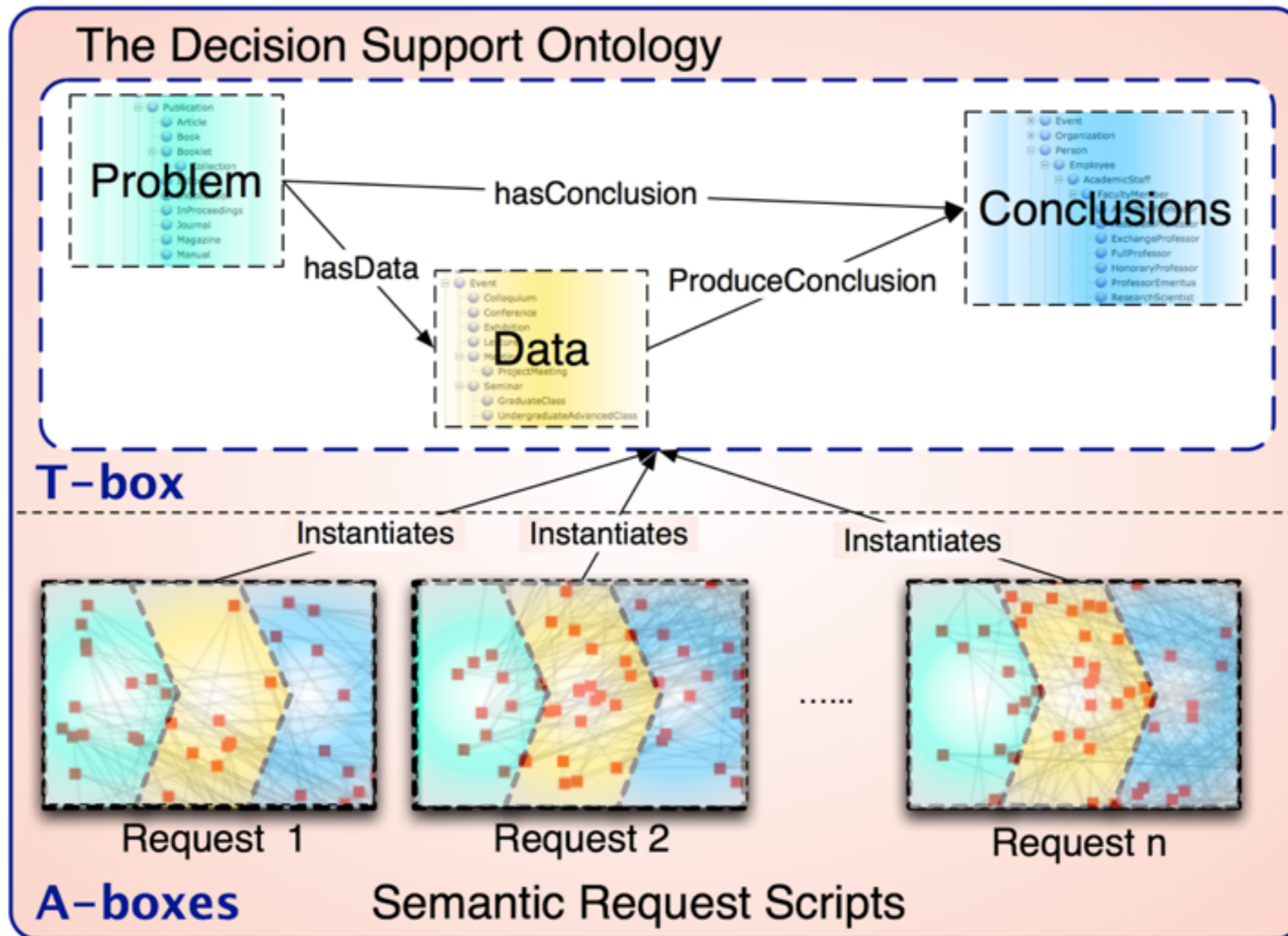
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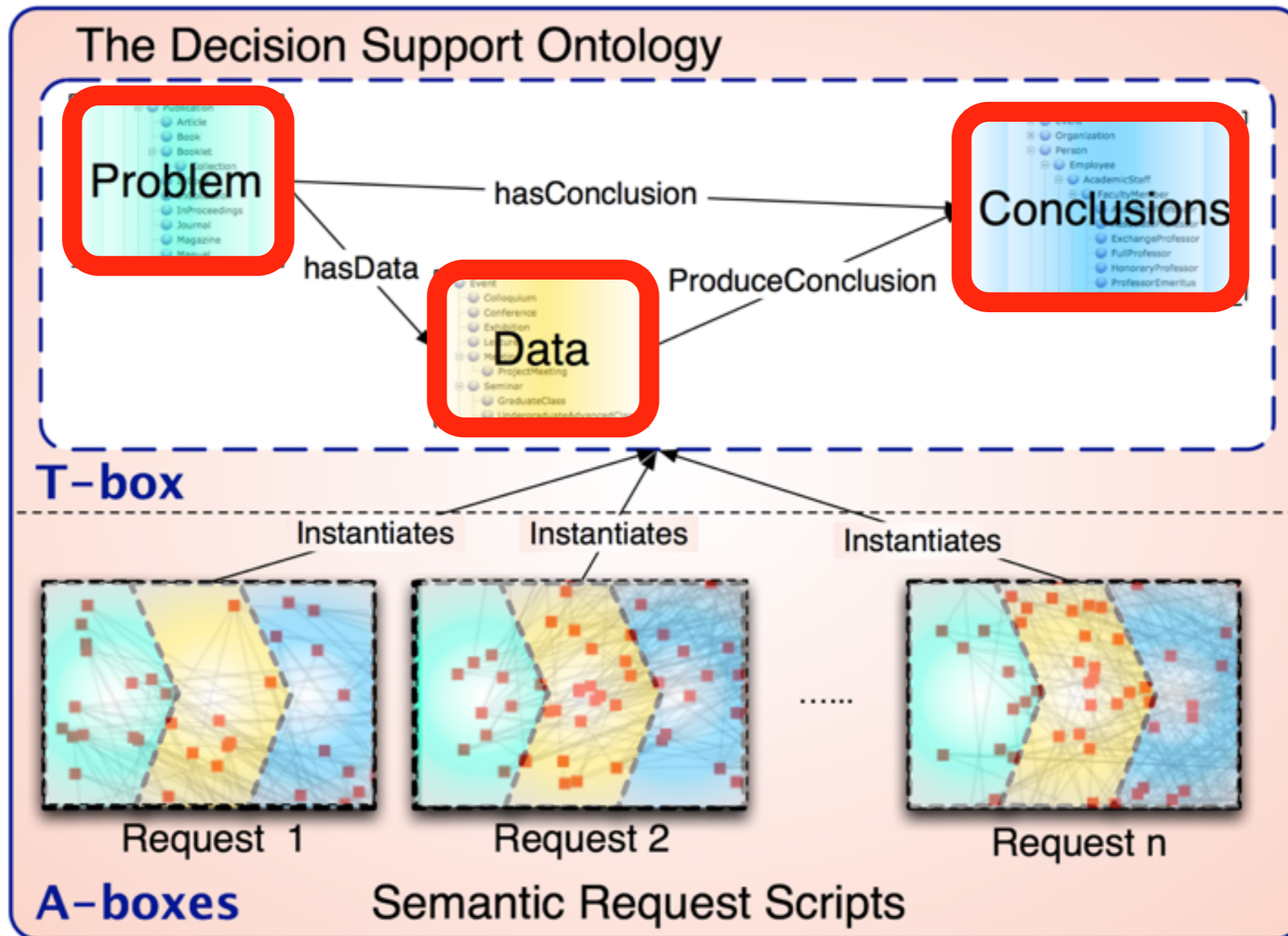
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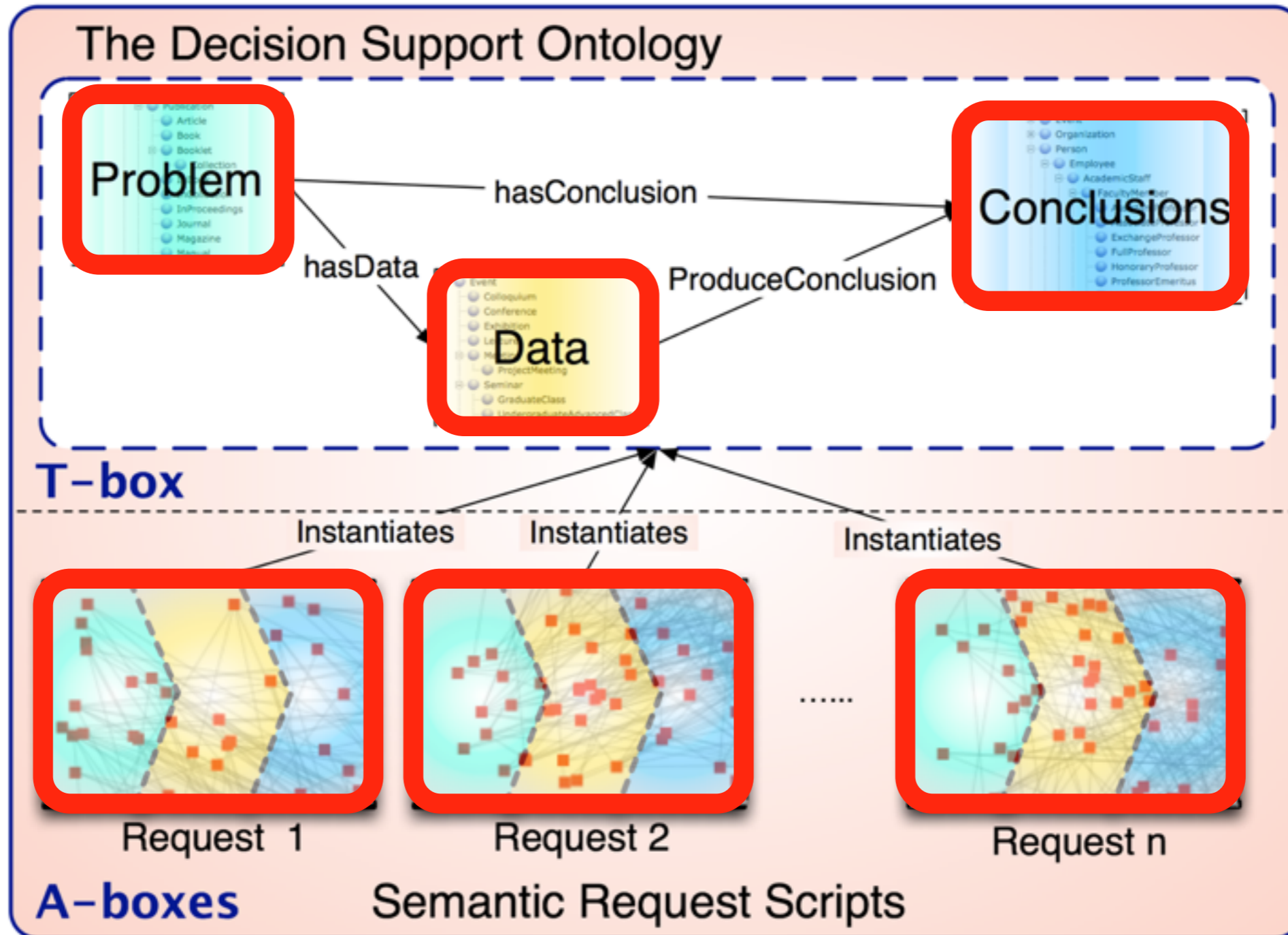
The Decision Support Knowledge Base



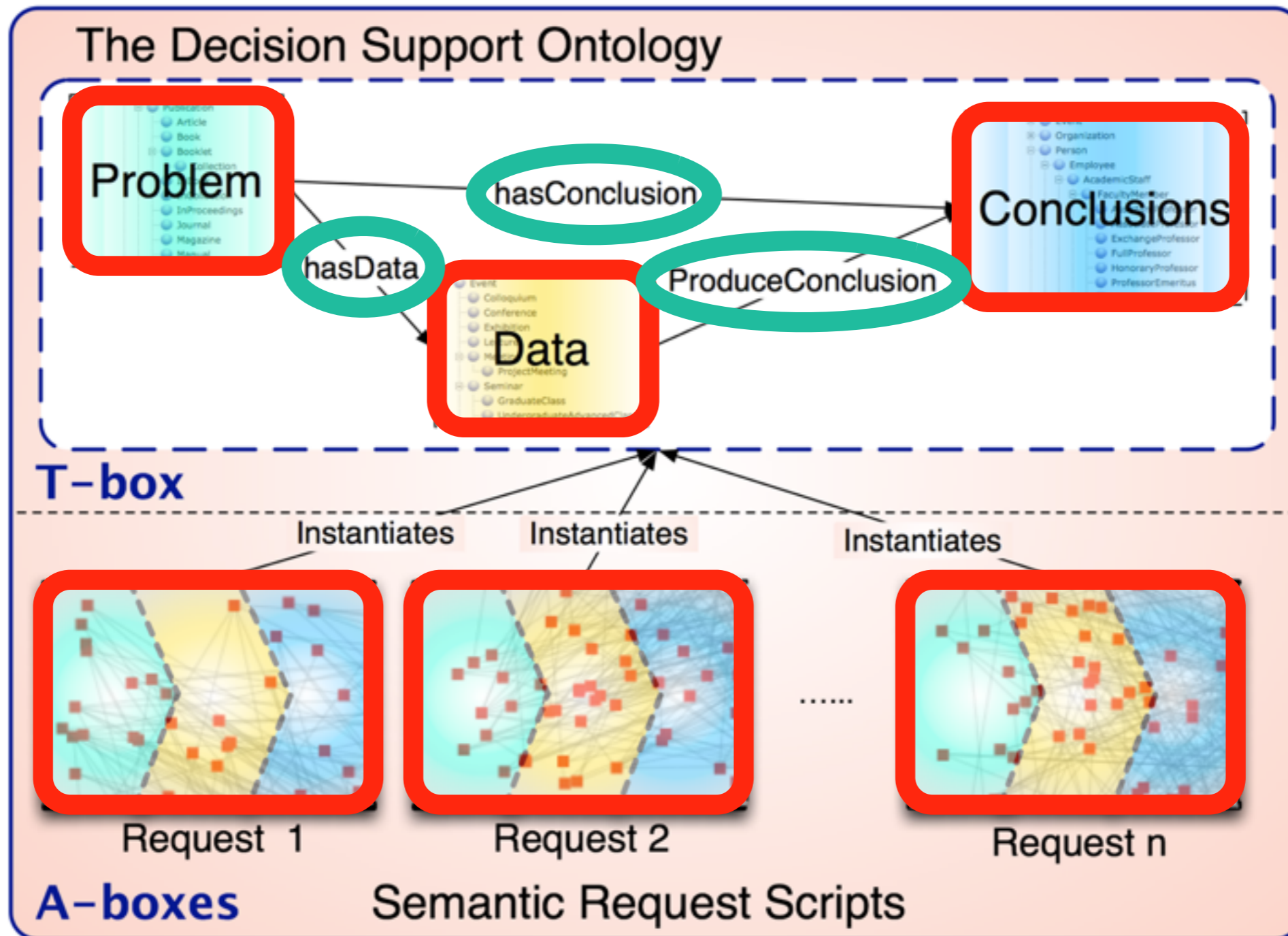
The Decision Support Knowledge Base



The Decision Support Knowledge Base



The Decision Support Knowledge Base



The Problem Component

- Formally describes all the aspects of **decision support problems** that the user can submit to the DSS
- **Examples** of content:
 - taxonomy of the request types supported by the system
 - input parameters needed by the DSS to provide adequate decision support
 - users profile
 - ...
- May also be used to **dynamically constrain** the

The Problem Component

- Organized in **sub-modules** (Request, User, Activity)
- These three sub-modules are **interrelated** by object properties and subclass axioms
 - Example of constrains:
 - CheckAirQualityLimits subClassOf hasRequestUser only AdministrativeUser
 - AnyHealthIssue subClassOf hasRequestActivity some (AttendingOpenAirEvent or PhysicalOutdoorActivity or Traveling)
 - Used in the PESCaDO UI to **guide the users** in formulating their decision support problems
- Additional Parameters: time, location

The Problem Component

- ▼ ● Request
 - ▼ ● InstructionRequest
 - SuggestAdministrativePlan
 - ▼ ● ReportRequest
 - CheckAirQualityLimits
 - CheckBlackIceCondition
 - CompareAirQualityInMultipleRegions
 - ReportAirQualityForecast
 - ▼ ● WarningRequest
 - AnyHealthIssue
 - AnyRestrictionForPrivateTransport
 - WarningDueToEnvironmentalConditions

- ▼ ● Activity
 - AttendingOpenAirEvent
 - ▼ ● LongTermStaying
 - GoingOnHolidayLongTermStaying
 - LivingLongTermStaying
 - PhysicalOutdoorActivity
 - ▼ ● Travelling
 - BikeOrFeetTravelling
 - FeetTravelling
 - BikeTravelling
 - CarTravelling
 - PublicTransportTravelling

- ▼ ● User
 - AdministrativeUser
 - ▼ ● EndUser
 - AdultUser
 - ChildUser
 - ▶ ● ElderlyUser
 - InfantUser
 - PregnantFemaleUser
 - ▶ ● UserSensitiveToAirPollutant
 - ▼ ● UserSensitiveToPollen
 - ▶ ● UserSensitiveToAlderPollen
 - ▶ ● UserSensitiveToBirchPollen
 - ▶ ● UserSensitiveToGrassesPollen
 - ▶ ● UserSensitiveToMugwortPollen
 - ▶ ● UserSensitiveToWeather
 - ▶ ● UserSufferingOfAllergicRhinitis
 - ▶ ● UserSufferingOfCirculatoryDisease
 - ▶ ● UserSufferingOfNasalOrEyeAllergy
 - ▶ ● UserSufferingOfRespiratoryDisease
 - YoungUser
 - Expert

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The Data Component

- Formally describes the **data accessed** and **manipulated** by the DSS (aka *domain ontology* of the DSS)
- An ontology to be used as data component may be **already available** in the web
- It favors the **integration** of (structured) data provided by **heterogeneous sources** (web-sites, LOD)

The Data Component

- It describes **environmental** related **data**:
 - meteorological data (e.g., temperature, wind speed)
 - pollen count data
 - air quality data (e.g., NO₂, PM₁₀, air quality index)
 - traffic and road conditions
- **Details** represented
 - observed, forecast, or historical data,
 - the time period covered
 - type of the data (e.g., instantaneous, average, minimum, maximum)
 - mapping between **qualitative** and **quantitative** values
 - moderate birch pollen count corresponds to 10 - 100 grains per meter cube of air
 - **data source** (e.g., measurement station, web-site, web-service) details, e.g., geographical location, confidence value.
- It facilitated the integration of **data obtained** from heterogenous sources, and with **different techniques**
 - e.g. content distillation from text and images

The Data Component

- It describes **environmental** related **data**:
 - meteorological data (e.g., temperature, wind speed)
 - pollen count data

● EnvironmentalData

- EnvironmentalData **SubClassOf** hasFromDateTime **some** dateTime
- EnvironmentalData **SubClassOf** hasEnvironmentalDataNature **exactly** 1 EnvironmentalDataNature
- EnvironmentalData **SubClassOf** hasEnvironmentalDataEnvironmentalDataType **exactly** 1 EnvironmentalDataType
- EnvironmentalData **SubClassOf** hasToDateTime **some** dateTime

● EnvironmentalNode

- EnvironmentalNode **SubClassOf** hasEnvironmentalNodeLocation **max** 1 Location
- EnvironmentalNode **SubClassOf** hasEnvironmentalNodeEnvironmentalNodeAreaType **max** 1 EnvironmentalNodeAreaType
- EnvironmentalNode **SubClassOf** hasEnvironmentalNodeName **exactly** 1 string
- EnvironmentalNode **SubClassOf** hasEnvironmentalNodeForm **exactly** 1 EnvironmentalNodeForm
- EnvironmentalNode **SubClassOf** hasEnvironmentalNodeEnvironmentalNodeType **max** 1 EnvironmentalNodeType
- EnvironmentalNode **SubClassOf** hasEnvironmentalNodeConfidenceValue **max** 1 double
- EnvironmentalNode **SubClassOf** hasEnvironmentalNodeEnvironmentalData **only** EnvironmentalData
- EnvironmentalNode **SubClassOf**
hasEnvironmentalNodeEnvironmentalNodeSourceOfEmissionType **max** 1 EnvironmentalNodeSourceOfEmissionType
- EnvironmentalNode **SubClassOf** hasEnvironmentalNodeURL **max** 1 anyURI
- EnvironmentalNode **SubClassOf** hasEnvironmentalNodeEnvironmentalNodeLandUseType **max** 1 EnvironmentalNodeLandUseType

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 - e.g. content distillation from text and images

The Conclusion Component

- Formally describes the **output** produced by the DSS by processing the problem description and the data available, e.g.
 - warnings/suggestions/instructions/decisions
 - data aggregations, data analysis results
- A **weight** (e.g. confidence, relevance) may be assigned to the conclusions produced
- **Tracking** of the data that triggered conclusions (“ProduceConclusion” object property)
- **User feedback** (degree of satisfaction) may also be included

The Conclusion Component

- It describes conclusion types like
 - **exceedances** of air pollutants limit values detected from data
 - **warnings** and **recommendations** that may be triggered by environmental conditions

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- ▼ ● **ConclusionType**
 - ▶ ● **ExplanationType**
 - ▶ ● **RecommendationType**
 - ▼ ● **WarningType**
 - ▼ ● **AirQualityRelatedWarningType**
 - **CORelatedWarningType**
 - **NO2RelatedWarningType**
 - **O3RelatedWarningType**
 - **SO2RelatedWarningType**
 - **PollenRelatedWarningType**
 - ▼ ● **WeatherRelatedWarningType**
 - **RainRelatedWarningType**
 - **TemperatureRelatedWarningType**
 - **UVRelatedWarningType**
 - **WindRelatedWarningType**

The Conclusion Component

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 - **exceedances** of air pollutants limit values detected from data
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 - ▶ ● ExplanationType
 - ▶ ● RecommendationType
 - ▼ ● WarningType
 - ▼ ● AirQualityRelatedWarningType
 - CORelatedWarningType
 - NO2RelatedWarningType
 - O3RelatedWarningType
 - SO2RelatedWarningType
 - PollenRelatedWarningType
 - ▼ ● WeatherRelatedWarningType
 - RainRelatedWarningType
 - TemperatureRelatedWarningType
 - UVRelatedWarningType
 - WindRelatedWarningType

◆ warningType_NO2limit

Type NO2RelatedWarningType

message [language: en]



Nitrogen dioxide causes respiratory symptoms especially in children and asthmatics, because high concentrations of this gas cause contraction of the bronchial airways. It may increase the sensitivity of the airways to other irritants such as cold air and pollen.

message [language: fi]



Typpidioksidi lisää hengityselinoireita erityisesti lapsilla ja astmaatikolla, koska se korkeina pitoisuuksina supistaa keuhkoputkia. Typpidioksidi voi lisätä hengitysteiden herkkyyttä muille ärsykkeille, kuten kylmälle ilmalle ja siitepölyille.

message [language: sv]



Kvävedioxiden ökar andningsorgansymptomer speciellt bland barn och astmatiker, eftersom den höga kvävedioxidhalten sammandrar luftrörer. Kvävedioxiden kan öka känsligheten för andra irriterande, till exempel för kall luft eller pollen.

SRS: An A-Box of the DSKB

```
◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasFromDateTime "2011-04-28T00:00:00+03:00"^^dateTime
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasRequestActivity activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasRequestPrimaryUser allenAllergic
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b Type AnyHealthIssue
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasRequestLanguage englishLanguage
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasToDateTime "2011-04-29T00:00:00+03:00"^^dateTime
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasRequestGeoArea geoArea_2d84e62e-c70e-4ac4-a257-0cedaa85bcb0
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasData temperature_2d84e62e-c70e
  .
  .
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasConclusion rule_-1cfe18bc_134615edfe6_-7cd1
  .
  .
◆ allenAllergic
  ◆ allenAllergic Type EndUser
  ◆ allenAllergic hasUserAge 40
  ◆ allenAllergic hasUserPreferredLanguage finnishLanguage
  ◆ allenAllergic hasUserGender maleGender
  ◆ allenAllergic hasUserName "Allen Allergic"^^string
  ◆ allenAllergic isUserSensitiveTo birchPollen
◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde
  ◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde hasPhysicalOutdoorActivityPhysicalOutdoorActivityType hiking
  ◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde Type PhysicalOutdoorActivity
```

Problem

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◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasFromDateTime "2011-04-28T00:00:00+03:00"^^dateTime
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasRequestActivity activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasRequestPrimaryUser allenAllergic
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b Type AnyHealthIssue
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasRequestLanguage englishLanguage
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasToDateTime "2011-04-29T00:00:00+03:00"^^dateTime
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasRequestGeoArea geoArea_2d84e62e-c70e-4ac4-a257-0cedaa85bcb0
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasData temperature_2d84e62e-c70e
  .
  .
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasConclusion rule_-1cfe18bc_134615edfe6_-7cd1
  .
  .
◆ allenAllergic
  ◆ allenAllergic Type EndUser
  ◆ allenAllergic hasUserAge 40
  ◆ allenAllergic hasUserPreferredLanguage finnishLanguage
  ◆ allenAllergic hasUserGender maleGender
  ◆ allenAllergic hasUserName "Allen Allergic"^^string
  ◆ allenAllergic isUserSensitiveTo birchPollen
◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde
  ◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde hasPhysicalOutdoorActivityPhysicalOutdoorActivityType hiking
  ◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde Type PhysicalOutdoorActivity
```

Problem

```
◆ temperature_2d84e62e-c70e
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataRating temperature_2d84e62e-c70e_rating
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataAggregationType maxAggregationType
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataValue temperature_2d84e62e-c70e_value
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataEnvironmentalDataType temperature
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataNature forecasted
  ◆ temperature_2d84e62e-c70e hasFromDateTime "2011-04-28T00:00:00+03:00"^^dateTime
  ◆ temperature_2d84e62e-c70e hasToDateTime "2011-04-29T00:00:00+03:00"^^dateTime
  ◆ temperature_2d84e62e-c70e Type EnvironmentalData
  ◆ temperature_2d84e62e-c70e ProduceConclusion rule_-1cfe18bc_134615edfe6_-7cd1
◆ temperature_2d84e62e-c70e_rating
  ◆ temperature_2d84e62e-c70e_rating Type Rating
  ◆ temperature_2d84e62e-c70e_rating hasRatingWeight 1.0
  ◆ temperature_2d84e62e-c70e_rating hasRatingRatingValue coolTemperatureRating
◆ temperature_2d84e62e-c70e_value
  ◆ temperature_2d84e62e-c70e_value hasValueValue 9.4
  ◆ temperature_2d84e62e-c70e_value Type TemperatureValue
  ◆ temperature_2d84e62e-c70e_value hasUnit degreeC
  .
  .
```

Data

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```
◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasFromDateTime "2011-04-28T00:00:00+03:00"^^dateTime
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  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasRequestPrimaryUser allenAllergic
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b Type AnyHealthIssue
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasRequestLanguage englishLanguage
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasToDateTime "2011-04-29T00:00:00+03:00"^^dateTime
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasRequestGeoArea geoArea_2d84e62e-c70e-4ac4-a257-0cedaa85bcb0
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasData temperature_2d84e62e-c70e
  .
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasConclusion rule_-1cfe18bc_134615edfe6_-7cd1
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◆ allenAllergic
  ◆ allenAllergic Type AnyHealthIssue
  ◆ allenAllergic hasRequestLanguage englishLanguage
  ◆ allenAllergic hasRequestPrimaryUser allenAllergic
  ◆ allenAllergic hasRequestLanguageType finnishLanguage
  ◆ allenAllergic hasRequestLanguageType englishLanguage
  ◆ allenAllergic hasRequestLanguageType russianLanguage
  ◆ allenAllergic hasUserName "Allen Allergic"^^string
  ◆ allenAllergic isUserSensitiveTo birchPollen
◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde
  ◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde hasPhysicalOutdoorActivityPhysicalOutdoorActivityType hiking
  ◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde Type PhysicalOutdoorActivity
```

hasData

Problem

temperature_2d84e62e-c70e

```
◆ temperature_2d84e62e-c70e
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataRating temperature_2d84e62e-c70e_rating
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataAggregationType maxAggregationType
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataValue temperature_2d84e62e-c70e_value
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataEnvironmentalDataType temperature
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataNature forecasted
  ◆ temperature_2d84e62e-c70e hasFromDateTime "2011-04-28T00:00:00+03:00"^^dateTime
  ◆ temperature_2d84e62e-c70e hasToDateTime "2011-04-29T00:00:00+03:00"^^dateTime
  ◆ temperature_2d84e62e-c70e Type EnvironmentalData
  ◆ temperature_2d84e62e-c70e ProduceConclusion rule_-1cfe18bc_134615edfe6_-7cd1
◆ temperature_2d84e62e-c70e_rating
  ◆ temperature_2d84e62e-c70e_rating Type Rating
  ◆ temperature_2d84e62e-c70e_rating hasRatingWeight 1.0
  ◆ temperature_2d84e62e-c70e_rating hasRatingRatingValue coolTemperatureRating
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  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasRequestLanguage englishLanguage
  ◆ request_c4644d75-1ff9-451a-880c-5f2c40741b2b hasToDate "2011-04-29T00:00:00+03:00"^^dateTime
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◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde
  ◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde Type AnyHealthIssue
  ◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde hasRequestActivity activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde
  ◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde hasRequestPrimaryUser allenAllergic
  ◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde hasRequestLanguage finnish
  ◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde hasRequestGeoArea geoArea_2d84e62e-c70e-4ac4-a257-0cedaa85bcb0
  ◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde hasData temperature_2d84e62e-c70e
  ◆ activity_56c2e15e-43f2-4920-80dd-b2bc7dba5fde hasConclusion rule_-1cfe18bc_134615edfe6_-7cd1
  .
◆ rule_-1cfe18bc_134615edfe6_-7cd1
  ◆ rule_-1cfe18bc_134615edfe6_-7cd1 Type Recommendation
  ◆ rule_-1cfe18bc_134615edfe6_-7cd1 hasRecommendationRecommendationType recommendationType_endUser_AnyHealthIssue
  ◆ rule_-1cfe18bc_134615edfe6_-7cd1 hasConclusionWeight 1.0
  .
```

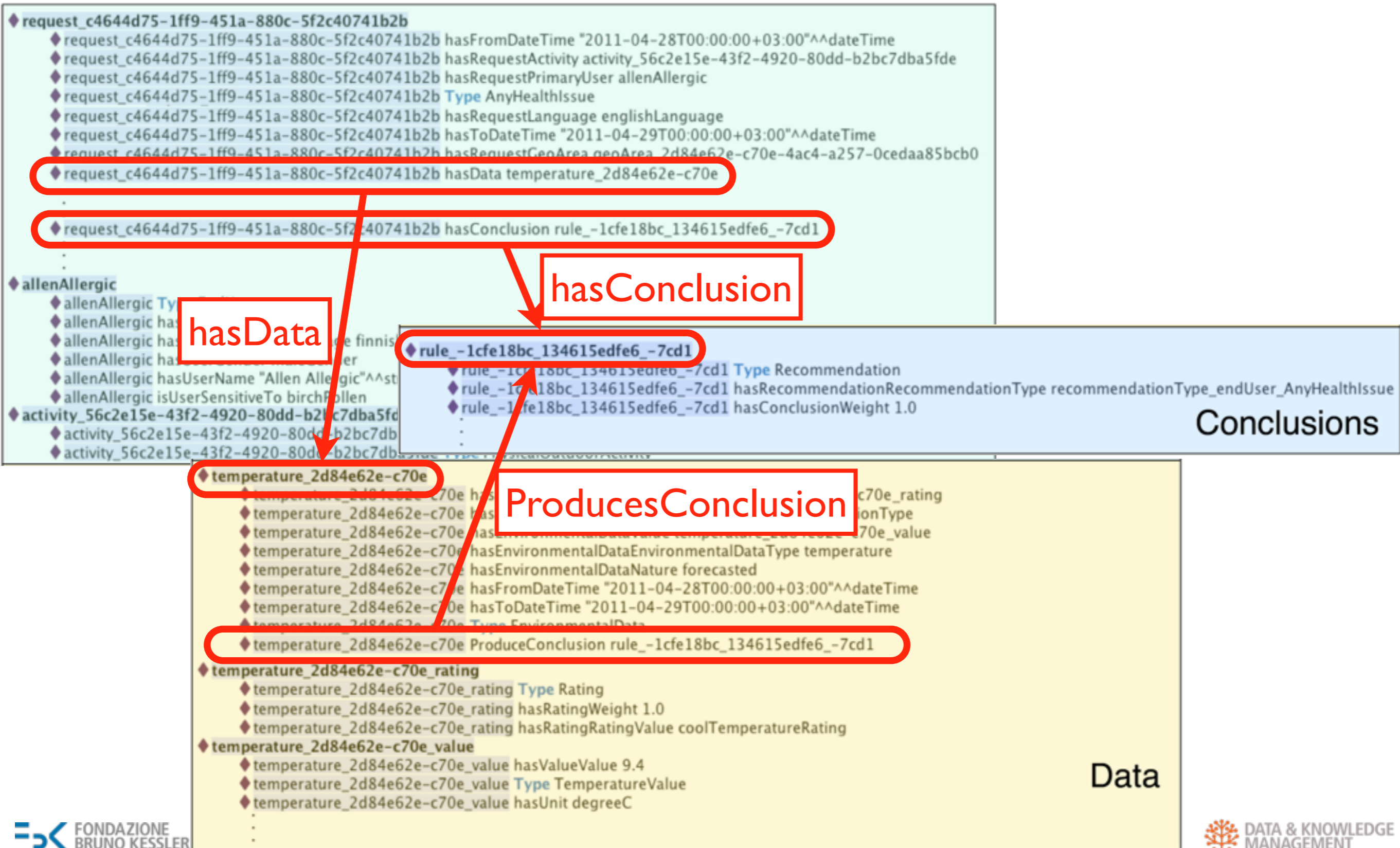
hasData

Conclusions

```
◆ temperature_2d84e62e-c70e
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataRating temperature_2d84e62e-c70e_rating
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataAggregationType maxAggregationType
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataValue temperature_2d84e62e-c70e_value
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataEnvironmentalDataType temperature
  ◆ temperature_2d84e62e-c70e hasEnvironmentalDataNature forecasted
  ◆ temperature_2d84e62e-c70e hasFromDate "2011-04-28T00:00:00+03:00"^^dateTime
  ◆ temperature_2d84e62e-c70e hasToDate "2011-04-29T00:00:00+03:00"^^dateTime
  ◆ temperature_2d84e62e-c70e Type EnvironmentalData
  ◆ temperature_2d84e62e-c70e ProduceConclusion rule_-1cfe18bc_134615edfe6_-7cd1
◆ temperature_2d84e62e-c70e_rating
  ◆ temperature_2d84e62e-c70e_rating Type Rating
  ◆ temperature_2d84e62e-c70e_rating hasRatingWeight 1.0
  ◆ temperature_2d84e62e-c70e_rating hasRatingRatingValue coolTemperatureRating
◆ temperature_2d84e62e-c70e_value
  ◆ temperature_2d84e62e-c70e_value hasValueValue 9.4
  ◆ temperature_2d84e62e-c70e_value Type TemperatureValue
  ◆ temperature_2d84e62e-c70e_value hasUnit degreeC
  .
```

Data

SRS: An A-Box of the DSKB



Incrementally building SRSs

Exploitation of Logical Reasoning

- Phase 1: Instantiation of the **problem**
 - consistency check to verify that the **user request is compliant** with the problem supported by the DSS
- Phase 2: Instantiation of the **data**
 - **data relevant for the user problem** may be determined via ontology reasoning
 - PESCADO: using “owl:hasValue” restrictions
 - e.g. userSensitiveToBirchPollen subClassOf RelevantAspect value Rain
- Phase 3: Instantiation of the **conclusions**
 - instantiation depends on the decision support techniques adopted by the DSS
 - PESCADO: two layers **DL+RuleBased reasoning** framework

Exploitation of SRSs

Natural language generation of DSS report

- A SRS provides a complete “**semantic**” **snapshot** of all the information processed and produced by the DSS for a request, with “**explanations**”
- A **natural language report** can be **automatically** generated from it
 - especially appreciated by laymen, media corporations, ...
- PESCADO: multilingual personalized information generation from SRSs.
 - **text planning** module
 - enrich the SRS with information on the content to be selected, and the way the text should be organized
 - **linguistic generation** module
 - produces the text in the three languages supported by the system

Exploitation of SRSs

Natural language generation of DSS report

Situation in the selected area between 08h00 and 20h00 of 07/05/2012. The ozone warning threshold value (240g/m³) was exceeded between 13h00 and 14h00 (247g/m³), the ozone information threshold value (180g/m³) between 12h00 and 13h00 (208g/m³) and between 14h00 and 15h00 (202g/m³). The minimum temperature was 2C and the maximum temperature 17C. The wind was weak (S). There is no data available for carbon monoxide, rain and humidity.

Ozone warning: ozone irritates eyes and the mucous membranes of nose and throat. It may also exacerbate allergy symptoms caused by pollen. Persons with respiratory diseases may experience increased coughing and shortness of breath and their functional capacity may weaken. Sensitive groups, like children, asthmatics of all ages and elderly persons suffering from coronary heart disease or chronic obstructive pulmonary disease, may experience symptoms. [...]

Exploitation of SRSs

Semantic Archive of SRSs

- SRSs could be **archived** in a semantic repository (e.g. Sesame, Virtuoso), **incrementally** fed
- Enables to:
 - **fine-tune** the decision support strategies implemented in the DSS
 - strengthen the **cases selection** in case-based reasoning DSSs
 - **expose** to the world the DSS processing in **LOD format**, favoring its exploitation by other applications/web-services
 - easily compute relevant **statistics**

On Engineering the DSKB

- Checks on the DSKB
 - formal **consistency check**
 - **correct instantiation** with the usage in the DSS
- Assessment of the **adequacy** of the DSKB for the DSS
 - all decision support **problems** to be supported by the DSS are formally **representable** in the **Problem** component
 - all the **data** relevant for the DSS are **characterized** in the **Data** component
 - all the **conclusions** and **explanations** to be generated by the DSS are **formalized** in the **Conclusions** component
- In PESCaDO:
 - Problem: all the types of problems defined in the use cases can be represented
 - Data: environmental experts assessment (appropriateness: 94% - completeness: 92%)
 - Conclusions: environmental experts assessment (appropriateness: 90% - completeness: 87%)

Conclusions

- We propose to adopt an **ontology-based knowledge base** as the **main data structure** in **DSSs**
- Each decision support request submitted to the DSS corresponds a **semantic request script** which describes
 - the request itself
 - the data relevant for the request
 - the conclusions/suggestions/decisions generated by DSSs
- Demonstrated the **advantages** in a concrete implementation for an environmental DSS (PESCaDO EU project)
 - **integration of heterogeneous sources** of data available in the web (e.g., web sites, web services)
 - **tracking and exposure** in a structured form of all the **content processed** and **produced** by the DSS for each request
 - **exploitation of logical reasoning** for several of the inference steps of the **DSS decision-making** process

Thank you! Questions?

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<https://www.pescado-project.eu>

An Ontological Framework for Decision Support
Marco Rospocher, Luciano Serafini