XMCDA v3

XMCDA history, benefits of XMCDA 3, implementations (Java, R, Python)

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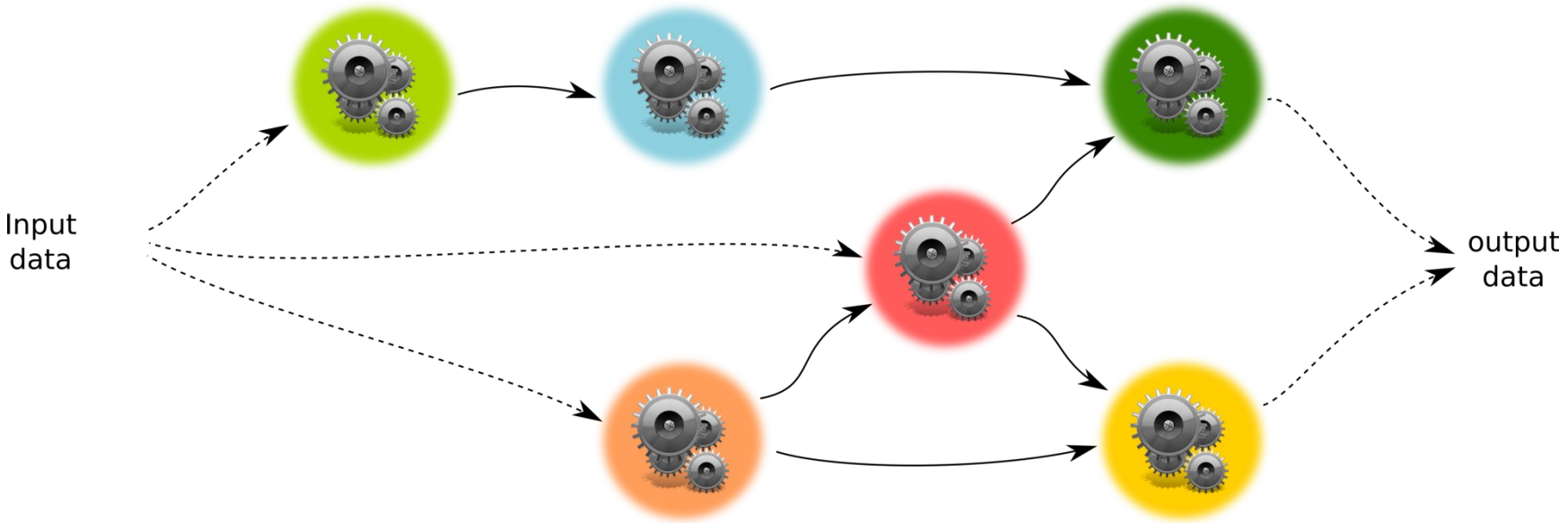
Structure of the presentation

- General purpose of XMCDA
- XMCDA v2 : motivations for an evolution
- What’s new in XMCDA v3 ?
- Consequences
- Tools for developers
- Illustration
- Roadmap

GENERAL PURPOSE OF XMCDA

An MCDA “method” as an algorithmic sequence

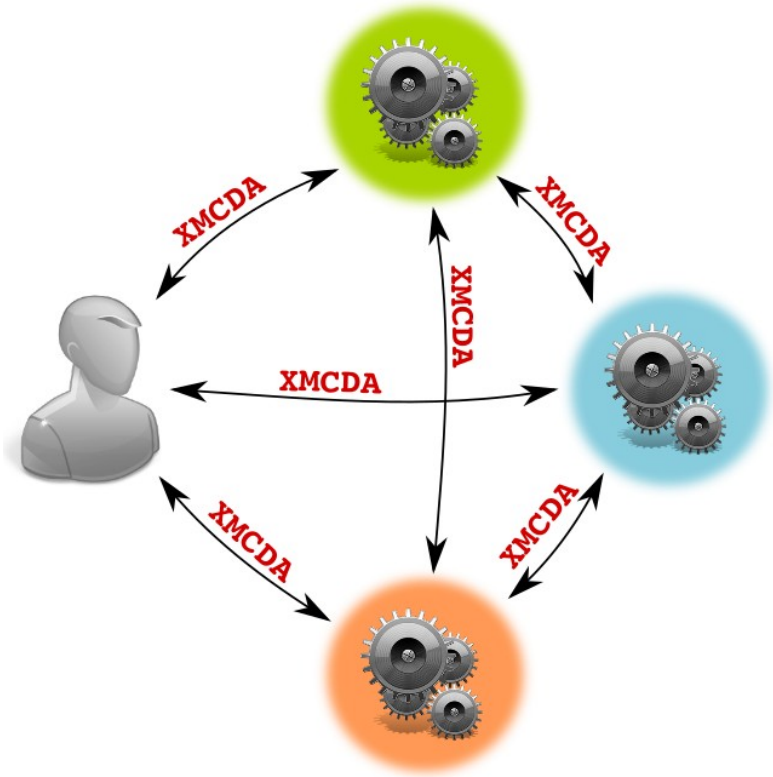


Solutions by Decision Deck

- To make algorithms interoperable : XMCDA, a data standard for MCDA “data”
- To make algorithms easily available : XMCDA web-services
- To create complex algorithmic workflows of algorithms : diviz

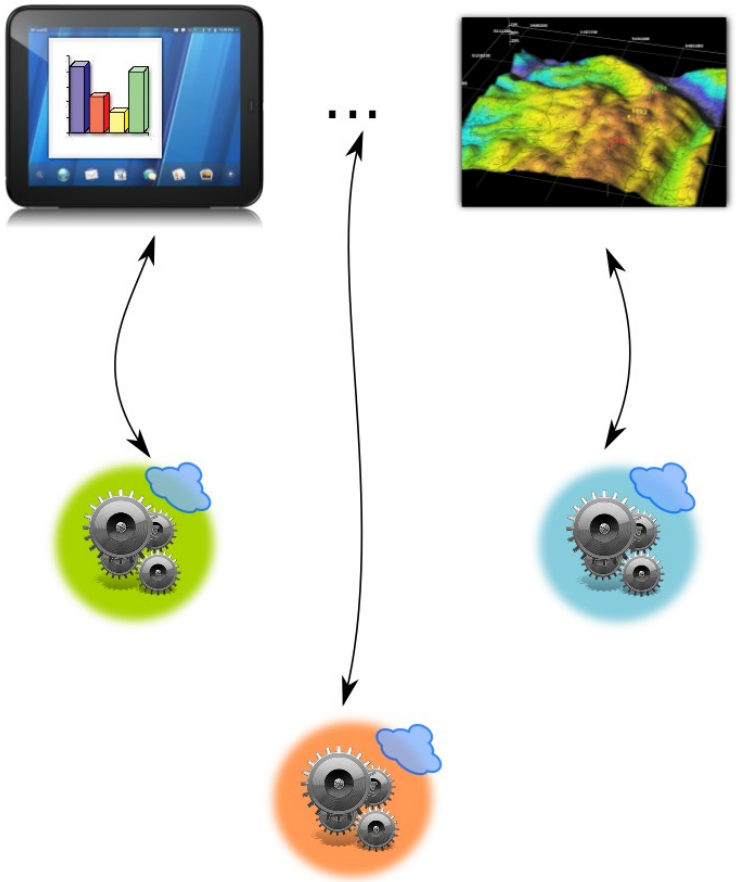
XMCDA

- A unique communication language with and between MCDA algorithms
- Standardization and unification of multiple schools of thought
- Representation of MCDA data elements in XML according to a grammar (the XMCDA XML schema)

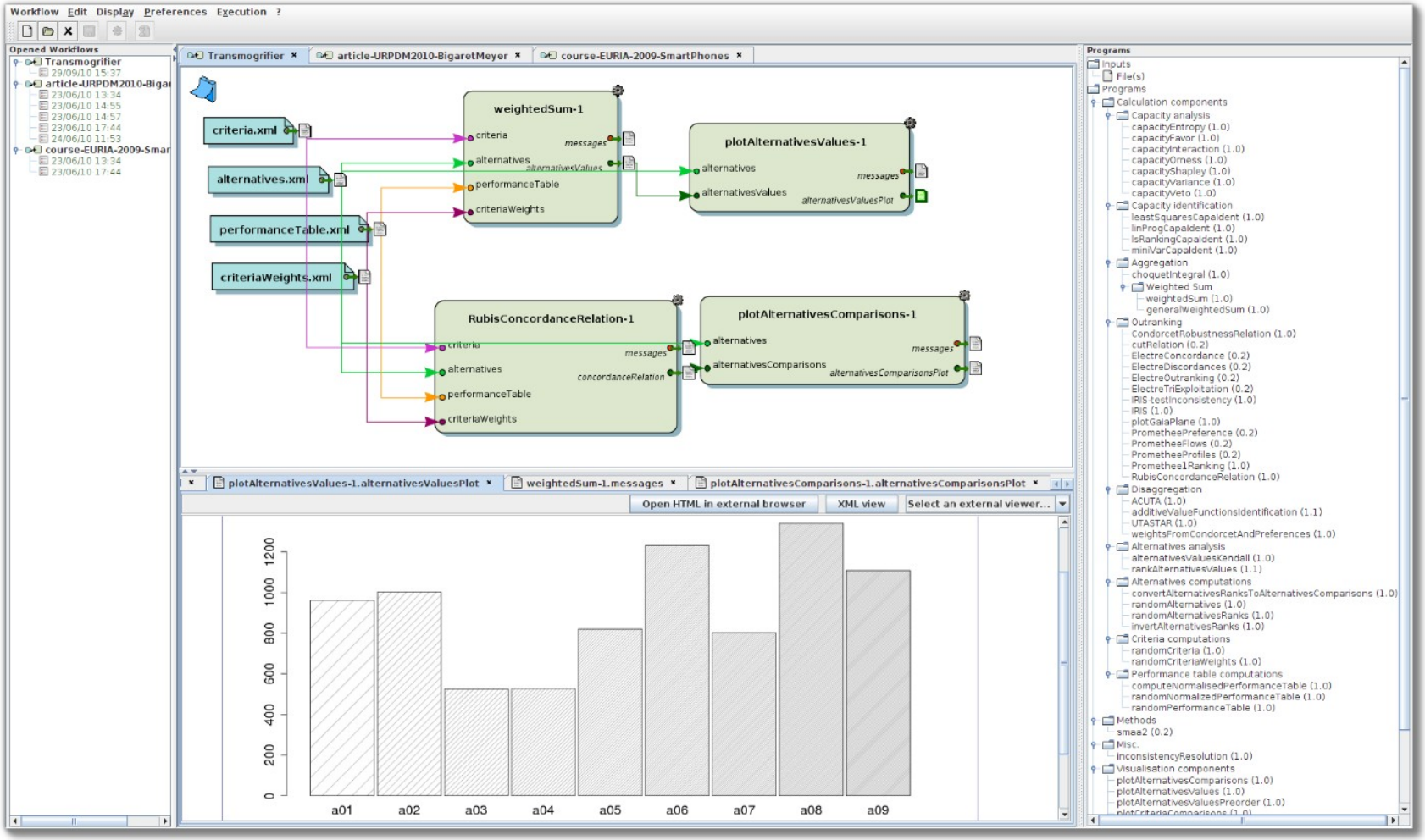


Calculation resources

- MCDA algorithms which are made available for anybody over the Internet : XMCDA web-services
- Hosted at Télécom Bretagne, Centrale Supélec, OVH
- Maintained by the TB diviz team
- Many different contributors



diviz



A tool for composing the XMCDA web-services and local resources

XMCDA v2 : MOTIVATIONS FOR AN EVOLUTION

XMCDA v2

- Lack of coherence :

  A discrimination threshold is stored in `<criterion>` whereas a weight can be stored outside

- Non-unicity of the representation :

  A weight can either be stored in `<criterion>`, or outside of it in a `<criterionValue>`

- Potentially uncontrollable increase of the number of tags in case of evolutions :

  `<rankedLabel>`, `<fuzzyLabel>`, `<rationalLabel>`, `<labelledLabel>` …

- Multiple “ad-hoc” implementations

  Java, R, Python, C++, …

XMCDA v2

- Some consequences :
  - A danger for the interoperability of the programs / web-services
  - An extensive implementation of XMCDA is very difficult, and the resulting API would be very complex
  - Failure of many developments and student projects
- **=>** Necessity for an evolution

XMCDA v3

Approved by the consortium at the
11th Decision Deck workshop in Paris

(23-24 / 09 / 2013)

WHAT'S NEW IN XMCDA v3

Declaration of main MCDA “objects”

- Alternatives, criteria and categories are declared without any supplementary data / preferential information
  - no weight, scale or thresholds in criterion, no rank in category, …
- Also for sets of alternatives, criteria and categories
  - set of learning alternatives, . . .
- These are the only “objects” that can be referenced in other XMCDA tags

Data and preferential information

- No choices, i.e., no duplicate places to store a certain information
  - Values are now stored once and for all in a `<values>` compound tag, even if it is a single value
  - Relations are one and for all represented by matrices
- The `mcdaConcept` attribute becomes central : it specifies what information is contained in a general tag
  - In XMCDA 2, categories had ranks. In XMCDA 3, ranks are now stored in the general `<categoriesValues>` tag

Outputs

`<programExecutionResult>`

- Messages for the user about the execution: informations at different levels (debug, info., warnings & errors)

- A formal status:

  `OK, WARNING, ERROR, TERMINATED`

Outputs: prg. execution status

```
<programExecutionResult>
   <status>error</status>
   <messages>
      <message level="error">
        <text>
Parameter nb_iter_max: invalid value 7.3 (real)
The value must be a positive integer</text>
      </message>
  </messages>
</programExecutionResult>
```

CONSEQUENCES

XMCDA v3 consequences

- Real interoperability between programs / web-services
  - No need for human intervention to guarantee this interoperability
- Simplification of the xsl + css (representation of the data in browsers / diviz)
- Easier generation of man/machine interfaces for data input / output
- Facilitated integration into existing software

TOOLS FOR DEVELOPERS

Observations … and difficulties

- Writing or extending partial XMCDA parsers
- Writing or adapting algorithms to XMCDA web-services infrastructure

1. Standard implementation of XMCDA v3

- In Java
- Can be called from other programming languages
  - Currently experimented from Python and R
- Reading / writing of XMCDA v3 / v2 files
- Conversion of v2 <-> v3
- Manipulation of XMCDA objects (adding, deleting, …)

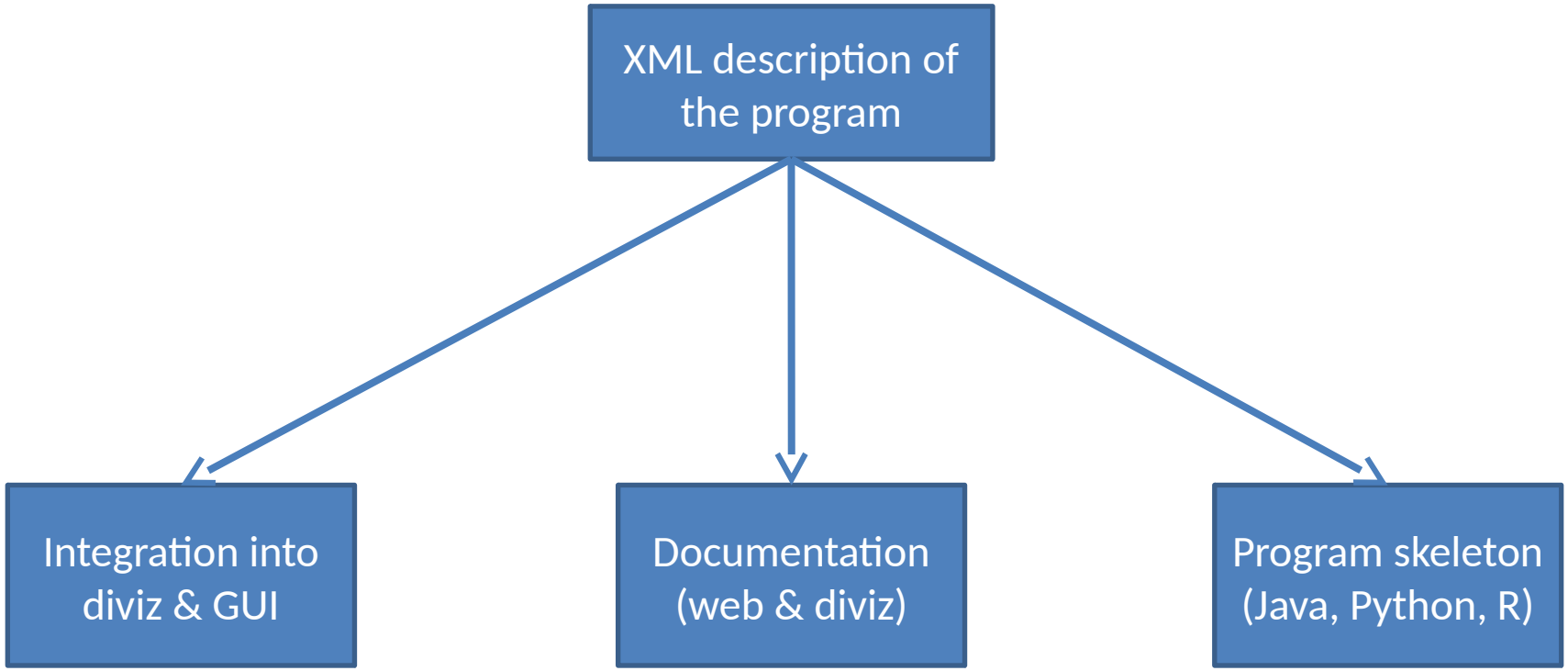
1. Standard implementation of XMCDA v3

- Latest stable version: http://www.decision-deck.org/xmcda/developers.html
- Source code on gitlab: https://gitlab.com/XMCDA-library/XMCDA-java
- Examples of use in Java, Jython & R: https://gitlab.com/groups/XMCDA-library

2. Program skeleton generator

- Inputs :
  - programming language
  - standardized description of the program
- Output : files hierarchy with identified todo spots
- => Simplified coding & integration

3. Program description



ILLUSTRATION

Illustration

weightedSum-DDWS13: a simple weightedSum

- Two inputs:
  - A performance table
  - The criteria' weights
- One parameter: the aggregation operator, either "weightedSum" or "normalizedWeightedSum"
- Pre-requisites: the set of criteria is the same in the performance table and in the criteria' weights

weightedSum description (1/3)
inputs

```
<input id="performanceTable" name="performanceTable"
       displayName="performanceTable"
       isoptional="0">
  <documentation>…</documentation>
  <xmcda tag="performanceTable"/>
</input>

<input id="criteriaWeights" name="criteriaWeights"
       displayName="weights" isoptional="0">
  <documentation>…</documentation>
  <xmcda tag="criteriaValues"/>
</input>
```

weightedSum description (2/3) **parameter**

```
  <input id="parameters" name="parameters" displayName="operator" isoptional="0">
    <documentation>…</documentation>
    <xmcda tag="methodParameters"><![CDATA[
<methodParameters>
  <parameter name="operator">
    <value>
      <label>%1</label>
    </value>
  </parameter>
</methodParameters>
]]></xmcda>
    <gui status="preferGUI">
      <entry id="%1" type="enum" displayName="operator">
        <documentation>
          <description>Aggregation operator</description>
        </documentation>
        <items>
          <item id="weightedSum">
            <description>weighted sum of the evaluations of alternatives on criteria</description>
            <value>sum</value>
          </item>
          <item id="Normalized weighted sum">
            <description>Computes the normalized weighted sum …</description>
            <value>normalizedWeightedSum</value>
          </item>
        </items>
      </entry>
    </gui>
  </input>
```

weightedSum description (2/3)
parameter

- XMCDA v3 tag: methodParameters

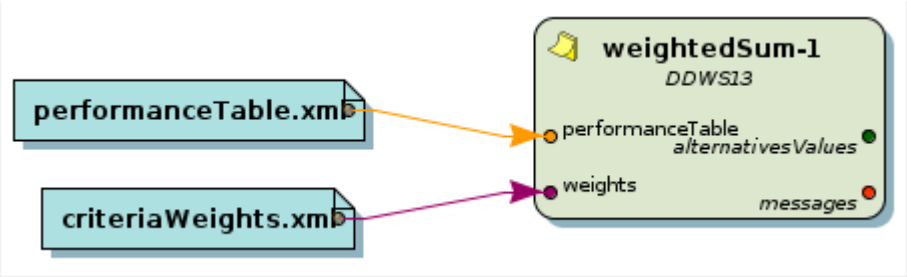
- One parameter id: operator of type enum

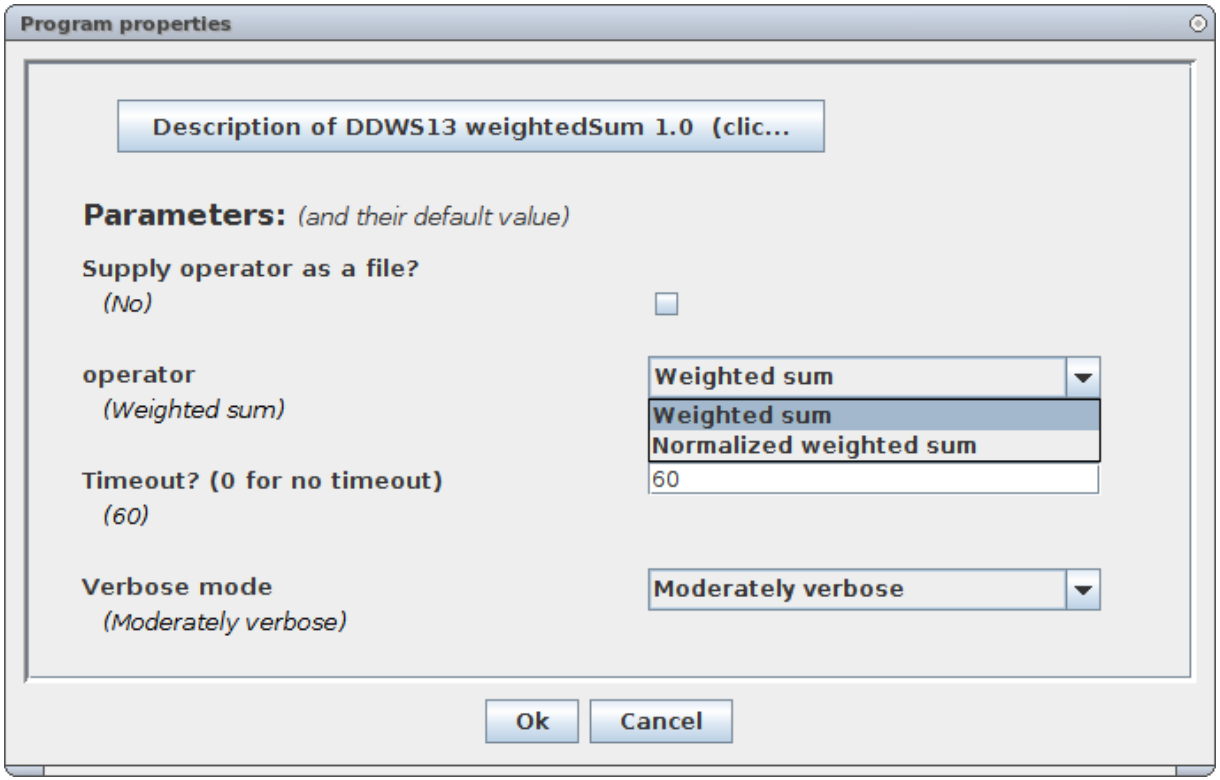
- Valid values:
  - **`weightedSum`**
  - **`normalizedWeightedSum`**

weightedSum description (3/3)
outputs

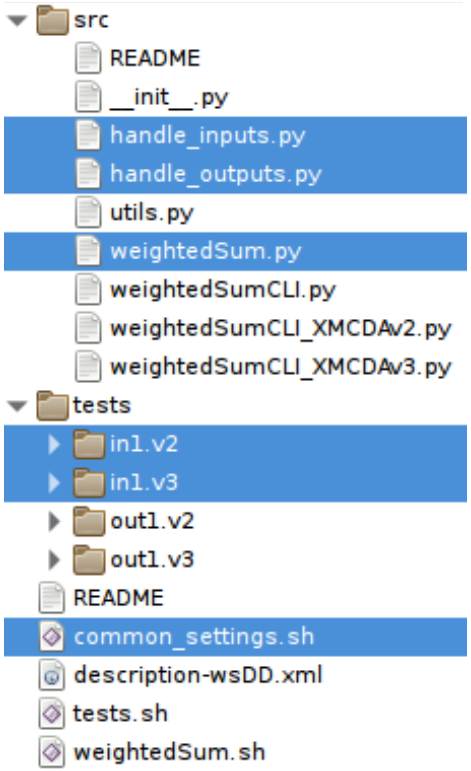
```
<output id="alternativesValues" name="alternativesValues"
        displayName="alternativesValues">
      <documentation>…</documentation>
      <xmcda tag="alternativesValues"/>
</output>

<output id="msg" name="messages" displayName="messages">
      <documentation>…</documentation>
      <xmcda tag="methodMessages"/>
</output>
```

Appearance in diviz



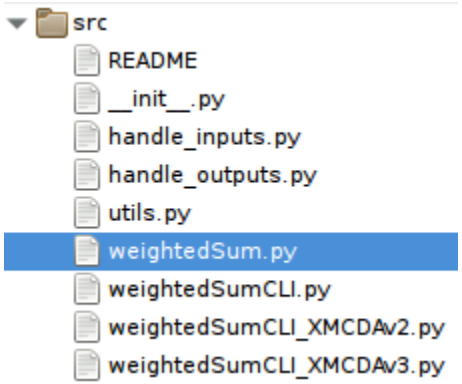


weightedSum: code generation (Python)



TODO markers in comments

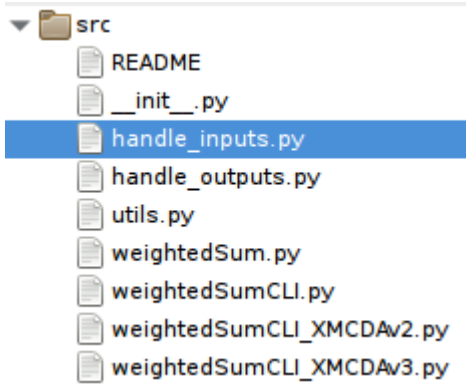
weightedSum:
Step #1: write the algorithm




```
def calculate_weighted_sum(inputs): # TODO
    """
    """
    # calculation goes here

    return ...
```

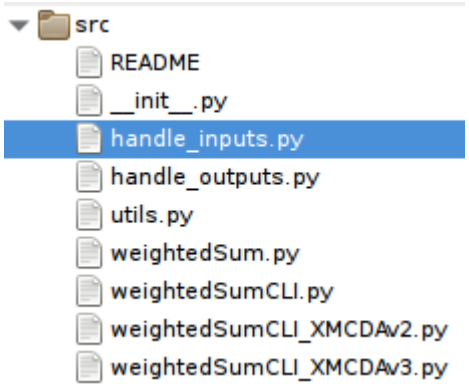
```
def calculate_weighted_sum(inputs):
    """
    Calculates the weighted sum.

    Parameter performance_table: a dictionary (alternative id,criterion id)->value}

    Parameter weights: a dictionary { criterion id -> weight }

    Returns: a dictionary { alternative id -> double }
    """
    performance_table = inputs.performance_table
    weights = inputs.weights

    # iterate on (alternative_id, criterion_id):
    # add the evaluation of each criterion on each alternative,
    # multiplied by the criterion's weight, to the alternative's weighted sum

    return alternatives_values
```

weightedSum – Step #2
XMCDA → data to feed the algorithm




```python
class Inputs:
    """
    Class Inputs gathers all the information retrieved from the XMCDA inputs
    """
    def __init__(self):
        pass # TODO -- related to check_and_extract_inputs()


def check_and_extract_inputs(xmcda, xmcda_exec_results):

    inputs = Inputs()
    check_inputs(inputs, xmcda, xmcda_exec_results)

    if not (xmcda_exec_results.isOk() or xmcda_exec_results.isWarning()):
        return None

    return extract_inputs(inputs, xmcda, xmcda_exec_results)


def check_inputs(inputs, xmcda, xmcda_exec_results): # TODO

    # ... check XMCDA inputs

    # Check as much things as possible before signalling an error
    # so that the user gets the maximum nb of errors we can detect

    if not (xmcda_exec_results.isOk() or xmcda_exec_results.isWarning()):
        return None

    return inputs


def extract_inputs(inputs, xmcda, xmcda_execution_results): # TODO
    "transform XMCDA inputs into what we need for the algorithm"

    # ...

    # we may encounter errors here as well, in which case, deal as above
    # and try to collect more errors before exiting.

    return inputs
```

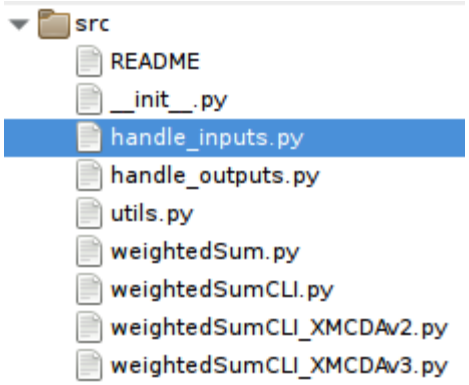
weightedSum
Step #2a: prepare data structure



- Performance table
- Weights
- Aggregation operator

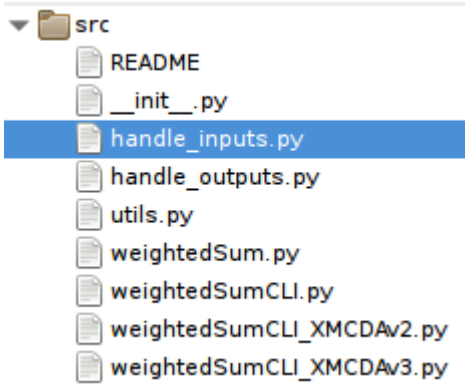
```
WEIGHTED_SUM = "weightedSum"
NORMALIZED_WEIGHTED_SUM = "normalizedWeightedSum"
AGGREGATION_OPERATORS = (WEIGHTED_SUM, NORMALIZED_WEIGHTED_SUM)

class Inputs:
    """
    Class Inputs gathers all the information retrieved from the XMCDA inputs
    """
    def __init__(self):
        self.performance_table={} # { (alternative id, criterion id) -> value }
        self.weights={} # { criterion -> weights }
        self.operator=None
```

weightedSum
Step #2b: check XMCDA inputs



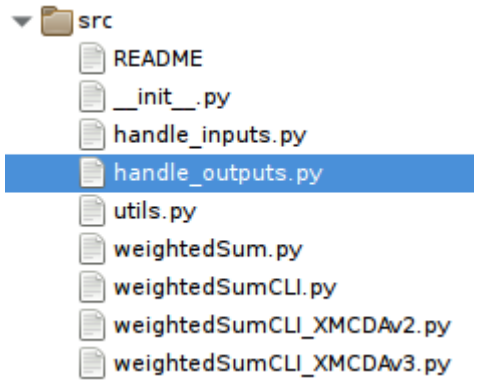

```python
def check_inputs(inputs, xmcda, xmcda_exec_results):

    # Check the performance table object:
    # - we have one and only one performance table
    # - it has no missing values
    # - all values are numeric

    # Check weights
    # - we have one and only one performance table
    # - all values are numeric

    # Check that perf.table and weights have the same
    # set of criteria

    # Check parameters
    # - one and only one <programParameter>
    # - it has a single paraneter whose id is 'operator'
    # - the value of the operator is known

    return inputs
```

weightedSum
Step #2c: extract XMCDA inputs



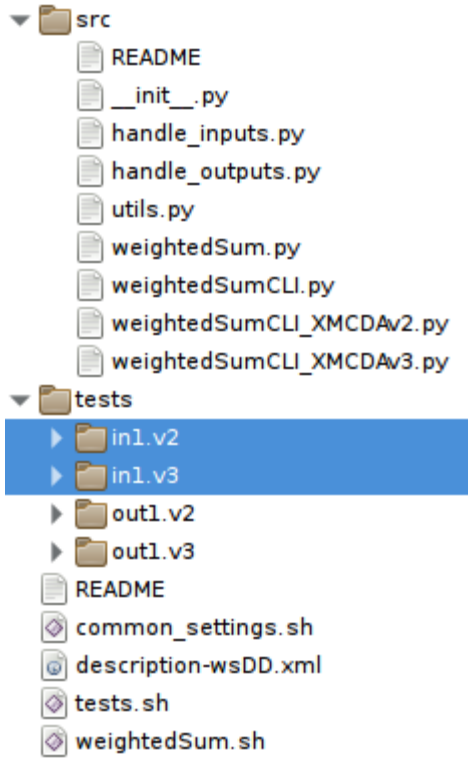

```python
def extract_inputs(inputs, xmcda, xmcda_execution_results):
    "Transform XMCDA inputs into what we need for the algorithm"

    # get the operator
    inputs.operator = ...

    xmcda_perf_table = xmcda.performanceTablesList.get(0)

    # Build input.performance_table by extracting
    # each criterion's id and alternative's id and their value

    inputs.performance_table = ...

    # Build inputs.weights by extracting the weight associated
    # the each criterion's id
    inputs.weights = ...

    # Remember: the algorithm only takes a perf.table and a
    # vector of weights! → normalize the weights if needed

    if inputs.operator == NORMALIZED_WEIGHTED_SUM:
        # normalize inputs.weights
        ...

    return inputs
```

weightedSum – Step #3
Transform algorithm data to XMCDA




```
XMCDA_v3_TAG_FOR_FILENAME = {
    # output name -> XMCDA v3 tag
    'alternativesValues': 'alternativesValues',
    'messages': 'programExecutionResult',
}

[...]

def convert(results, xmcda_execution_results):
    """
    Converts the outputs of the computation to XMCDA objects

    Returns: a map with keys being the names of the outputs,
             and their corresponding XMCDA v3 values
             (NOT including 'messages.xml')
    """
    # for XMCDA tag: alternativesValues
    xmcda_alternatives_values = XMCDA()
    # ...

    return {
        'alternativesValues': xmcda_alternatives_values,
        }
```

weightedSum:
Step #4: write XMCDA input files



Example: parameters.xml (XMCDA v3)

```
<?xml version="1.0" ?>
<xmcda:XMCDA … >
<programParameters>
   <parameter id="operator">
      <values>
         <value>
           <label>weightedSum</label>
         </value>
      </values>
   </parameter>
</programParameters>
</xmcda:XMCDA>
```

weightedSum
Run it!

```
./weightedSum.sh –-v3  \
      -i tests/in1.v3  \
      -o tests/out1.v3

./weightedSum.sh --v2  \
      -i tests/in1.v2  \
      -o tests/out1.v2
```

weightedSum tests

./tests.sh --v2

./tests.sh --v3

Properties / comments

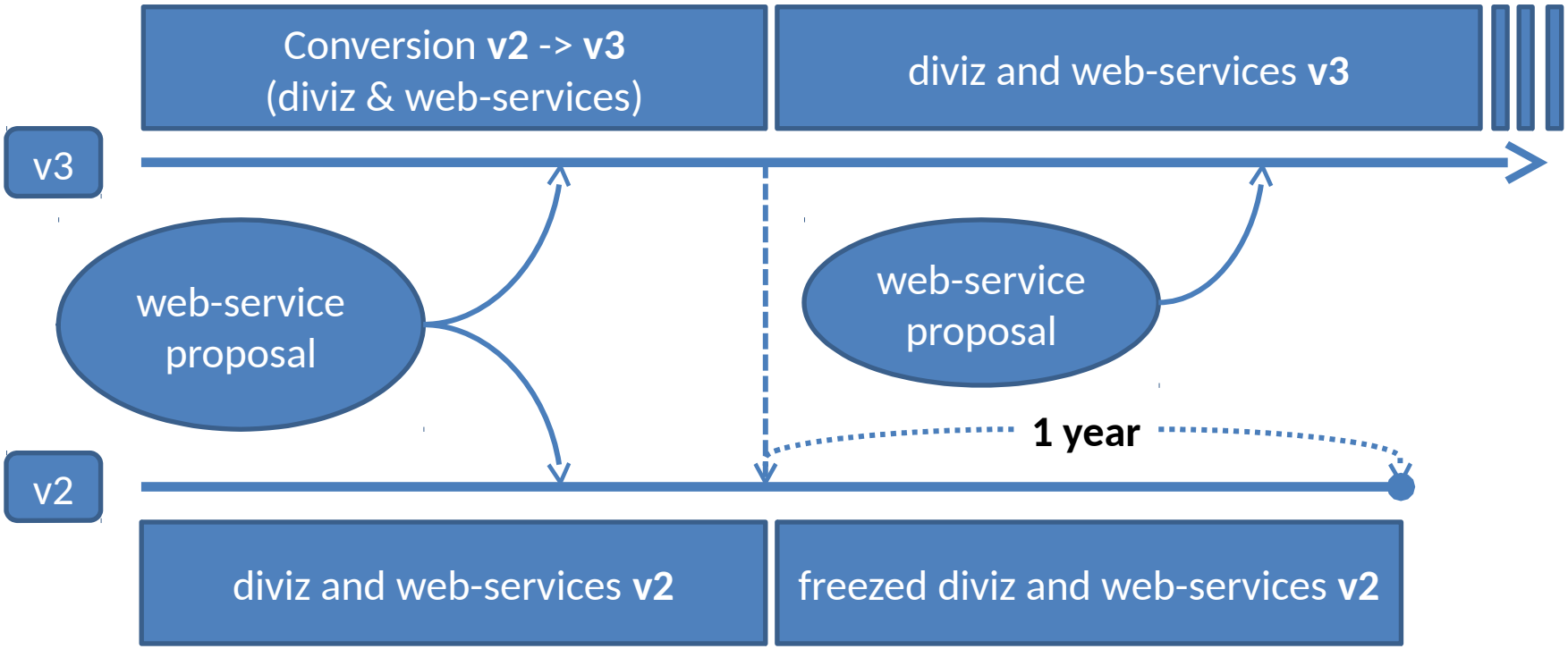
- Your coding is independent of v2 and v3
- Tests allow validation of the deployed web-service

The full source code for this example can be found at:

https://gitlab.com/XMCDA-library/example-simpleWeightedSum

ROADMAP

Roadmap


Conversion **v2** -> **v3**
(diviz & web-services)
diviz and web-services **v3**
v3
web-service
proposal
web-service
proposal
1 year
v2
diviz and web-services **v2**
freezed diviz and web-services **v2**