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FORMALIZING MARKUP LANGUAGES FOR USER INTERFACE

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TECHNICAL REPORT

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1 Overview

This document constitutes a complementary technical report for Master Thesis *Formalizing Markup Languages for User Interface*.

In Chapter 6 — Prototype and Supporting Tools — of the main document, was slightly described all supporting tools involved on the four phases of the process: *transcoding*, *abstraction*, *validation* and *rendering*. It presented the *uiml2vdm.xml* stylesheet, responsible for the *UIML* formal representation (in *VDM-SL*); it described the pretty print *VDM-SL* tool *vdm2uiml.vdm*, which allows the generation of *UIML* from *VDM-SL*; it presented the verifier, which allows to test the coherency of the generated *VDM-SL* code along the transcoding process, and finally, presented some scripts involved on the *UIML* rendering process.

This document aims to present the main features of Prototype and to complement the presentation of achieved tools, their source code and application.

The first part describes the *VDM-SL* module responsible to generate *UIML* syntax for each *VDM-SL* specified element. It was presented as the *Pretty Print* tool working on second phase of formalizing process (Chapter 1 - page 10 of main document).

The second part describes the Prototype (which animates OLAP implemented *table* features), presents its source code and images of their main results, and finally describes the settings and requirements to use it.

2 VDM-SL to UIML

```
module VDM2UIML
  imports
    from IO all ,
    from UIMLSpec all

  exports all

  definitions
```

```
values
  PI : UIMLSpec'String = " <?xmlversion = '1.0' encoding =
'ISO-8859-1'? > ";
  end-doc : UIMLSpec'String = " < /uiml > ";
  end-doc-html : UIMLSpec'String = " < peers >< presentationhow =
'replace'source = 'HTML3.2H armonia1.0.uiml#vocab'base =
'HTML3.2H armonia1.0'/ > \n < /peers >< /uiml > "
```

2.1 VDM to UIML Functions

2.1.1 Function *uiml2str*

Specification:

```

uiml2str : UIMLSpec'Uiml → UIMLSpec'String
uiml2str (ui)  $\triangleq$ 
  PI  $\curvearrowright$ 
  " < uiml > "  $\curvearrowright$ 
  head2str (ui.head)  $\curvearrowright$ 
  members2str (ui.members)  $\curvearrowright$ 
  end-doc-html;

```

Description:

Converts a UIML element into String.

Calls:

head2str, members2str

2.1.2 Function *member2str*

Specification:

```

member2str : [UIMLSpec'Member] → UIMLSpec'String
member2str (m)  $\triangleq$ 
  if m = nil
  then " "
  else cases m :
    mk-UIMLSpec'Peers (-,-,-,-) → peer2str (m),
    mk-UIMLSpec'Interface (-,-,-,-) → interf2str (m),
    mk-UIMLSpec'Template (-,-) → templ2str (m),
    others → " "
  end;

```

Description:

Converts a Member type into String.

Calls:

peer2str, interf2str, templ2str

2.1.3 Function *members2str*

Specification:

```

members2str : [UIMLSpec'Member*] → UIMLSpec'String
members2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    member2str (x)  $\curvearrowright$  members2str (tl (s));

```

Description:

Converts a Member type sequence into String.

Calls:

member2str

2.1.4 Function *head2str*

Specification:

```

head2str : [UIMLSpec'Head] → UIMLSpec'String
head2str (h)  $\triangleq$ 
  if h = nil
  then " "
  else " < head > "  $\curvearrowright$ 
    metas2str (h.meta)  $\curvearrowright$ 
    " < /head > ";

```

Description:

Converts a Head element into String.

Calls:

metas2str

2.1.5 Function *metas2str*

Specification:

```

metas2str : UIMLSpec'Meta* → UIMLSpec'String
metas2str (ms)  $\triangleq$ 
  if ms = []
  then " "
  else let x = hd (ms) in
    meta2str (x)  $\curvearrowright$  metas2str (tl (ms));

```


Description:

Converts a Meta elements sequence into String.

Calls:

meta2str

2.1.6 Function *meta2str*

Specification:

```

meta2str : [UIMLSpec' Meta] → UIMLSpec' String
meta2str (m)  $\triangleq$ 
  if m = nil
  then " "
  else " < metaname = ' "  $\curvearrowright$  m.name  $\curvearrowright$  " 'content = ' "  $\curvearrowright$  m.content  $\curvearrowright$ 
       "' / > ";

```

Description:

Converts a Meta element into String.

Calls:

Standard VDM-SL only

2.1.7 Function *iterator2str*

Specification:

```

iterator2str : [UIMLSpec' Iterator] → UIMLSpec' String
iterator2str (i)  $\triangleq$ 
  if i = nil
  then " "
  else " < iterator "  $\curvearrowright$  id2str (i.id)  $\curvearrowright$  " > "  $\curvearrowright$ 
       iteratorOptions2str (i.iterator)  $\curvearrowright$ 
       " < /iterator > ";

```

Description:

Converts an Iterator element into String.

Calls:

id2str, iteratorOptions2str

2.1.8 Function *iteratorOptions2str*

Specification:

```

iteratorOptions2str : [UIMLSpec' IteratorOptions] → UIMLSpec' String
iteratorOptions2str (i)  $\triangleq$ 
  if i = nil
  then " "
  else cases i :
    mk-UIMLSpec' Constant (-,-,-,-,-,-) → constant2str (i),
    mk-UIMLSpec' Property (-,-,-,-,-,-,-) → property2str (i),
    mk-UIMLSpec' Call (-,-) → call2str (i),
    [i] → [i],
    others → " "
  end;

```

Description:

Converts an IteratorOptions element into String.

Calls:

constant2str, property2str, call2str

2.1.9 Function *repeats2str*

Specification:

```

repeats2str : UIMLSpec' Repeat* → UIMLSpec' String
repeats2str (sr)  $\triangleq$ 
  if sr = []
  then " "
  else let x = hd (sr) in
    repeat2str (x)  $\frown$  repeats2str (tl (sr));

```

Description:

Converts a sequence of Repeat elements into String.

Calls:

repeat2str

2.1.10 Function *repeat2str*

Specification:

```

repeat2str : [UIMLSpec' Repeat] → UIMLSpec' String
repeat2str (r)  $\triangleq$ 
  if r = nil
  then " "
  else " < repeat > "  $\curvearrowright$ 
        iterator2str (r.iterator)  $\curvearrowright$ 
        parts2str (r.parts)  $\curvearrowright$ 
        " < /repeat > ";

```

Description:

Converts a Repeat element into String.

Calls:

*iterator2str, parts2str***2.2 Functions for Peer Components****2.2.1 Function** *peer2str*

Specification:

```

peer2str : [UIMLSpec' Peers] → UIMLSpec' String
peer2str (p)  $\triangleq$ 
  if p = nil
  then " "
  else " < peers "  $\curvearrowright$  id2str (p.id)  $\curvearrowright$ 
        source2str (p.source)  $\curvearrowright$ 
        how2str (p.how)  $\curvearrowright$ 
        export2str (p.export)  $\curvearrowright$  " > "  $\curvearrowright$ 
        prelogs2str (p.prelog)  $\curvearrowright$ 
        " < /peers > ";

```

Description:

Converts a Peers element into String.

Calls:

prelogs2str, id2str, source2str, how2str, export2str

2.2.2 Function *prelog2str*

Specification:

```

prelog2str : (UIMLSpec'Presentation | UIMLSpec'Logic) →
UIMLSpec'String
prelog2str (e)  $\triangleq$ 
  cases e :
    mk-UIMLSpec'Presentation (-,-,-,-,-) → presentation2str (e),
    mk-UIMLSpec'Logic (-,-,-,-,-) → logic2str (e),
    others → " "
  end;

```

Description:

Converts a EqualCPR into String.

Calls:

*presentation2str,logic2str***2.2.3 Function** *prelogs2str*

Specification:

```

prelogs2str : (UIMLSpec'Presentation | UIMLSpec'Logic)* →
UIMLSpec'String
prelogs2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    prelog2str (x)  $\frown$  prelogs2str (tl (s));

```

Description:

Converts a (Presentation — Logic) sequence into String.

Calls:

prelog2str

2.2.4 Function *presentation2str*

Specification:

```

presentation2str : UIMLSpec'Presentation → UIMLSpec'String
presentation2str (p)  $\triangleq$ 
  " < presentation "  $\curvearrowright$ 
  id2str (p.id)  $\curvearrowright$ 
  source2str (p.source)  $\curvearrowright$ 
  how2str (p.how)  $\curvearrowright$ 
  export2str (p.export)  $\curvearrowright$ 
  base2str (p.base)  $\curvearrowright$ 
  " > "  $\curvearrowright$ 
  dclass2str (p.dclass)  $\curvearrowright$ 
  " < /presentation > ";

```

Description:

Converts a Presentation element into String.

Calls:

base2str, id2str, source2str, how2str, export2str, dclass2str

2.2.5 Function *dclass2str*

Specification:

```

dclass2str : [UIMLSpec'D-class] → UIMLSpec'String
dclass2str (d)  $\triangleq$ 
  if d = nil
  then " "
  else " < d-class "  $\curvearrowright$  id2str (d.id)  $\curvearrowright$  source2str (d.source)  $\curvearrowright$ 
    how2str (d.how)  $\curvearrowright$ 
    export2str (d.export)  $\curvearrowright$ 
    att2str (" maps-to", d.maps-to)  $\curvearrowright$ 
    mapstype2str (d.maps-type)  $\curvearrowright$ 
    used-in-tag2str (d.used-in-tag)  $\curvearrowright$ 
    " > "  $\curvearrowright$ 
    dmethods2str (d.dmethod)  $\curvearrowright$ 
    dproperties2str (d.dproperty)  $\curvearrowright$ 
    events2str (d.event)  $\curvearrowright$ 
    listeners2str (d.listener)  $\curvearrowright$ 
    " < /d-class > ";

```

Description:

Converts a D-class element into String.

Calls:

Standard VDM-SL only

2.2.6 Function *dclass2str*

Specification:

```

dclass2str : UIMLSpec'D-class* → UIMLSpec'String
dclass2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    dclass2str (x)  $\curvearrowright$  dclass2str (tl (s));

```

Description:

Converts a D-class sequence into String.

Calls:

part2str

2.2.7 Function *logic2str*

Specification:

```

logic2str : [UIMLSpec'Logic] → UIMLSpec'String
logic2str (l)  $\triangleq$ 
  if l = nil
  then " "
  else " < logic "  $\curvearrowright$ 
    id2str (l.id)  $\curvearrowright$ 
    source2str (l.source)  $\curvearrowright$  how2str (l.how)  $\curvearrowright$ 
    export2str (l.export)  $\curvearrowright$ 
    " / > "  $\curvearrowright$ 
    dcomponents2str (l.dcomponent)  $\curvearrowright$ 
    " < /logic > ";

```

Description:

Converts a Logic element into String.

Calls:

Standard VDM-SL only

2.2.8 Function *script2str*

Specification:

```

script2str : [UIMLSpec' Script] → UIMLSpec' String
script2str (s)  $\triangleq$ 
  if s = nil
  then " "
  else " < script "  $\curvearrowright$ 
    id2str (s.id)  $\curvearrowright$ 
    source2str (s.source)  $\curvearrowright$  how2str (s.how)  $\curvearrowright$ 
    export2str (s.export)  $\curvearrowright$ 
    att2str (" type", s.type)  $\curvearrowright$ 
    " / > "  $\curvearrowright$ 
    s.data  $\curvearrowright$ 
    " < /script > ";

```

Description:

Converts a Script element into String.

Calls:

Standard VDM-SL only

2.3 Functions for Interface Components

2.3.1 Function *interf2str*

Specification:

```

interf2str : [UIMLSpec' Interface] → UIMLSpec' String
interf2str (i)  $\triangleq$ 
  if i = nil
  then " "
  else " < interface "  $\curvearrowright$  id2str (i.id)  $\curvearrowright$ 
    source2str (i.source)  $\curvearrowright$ 
    how2str (i.how)  $\curvearrowright$ 
    export2str (i.export)  $\curvearrowright$ 
    " > "  $\curvearrowright$ 
    inteles2str (i.intele)  $\curvearrowright$ 
    " < /interface > ";

```

Description:

Converts a Interface element into String.

Calls:

Standard VDM-SL only

2.3.2 Function *inteles2str*

Specification:

```

inteles2str : UIMLSpec'InterfaceElements* → UIMLSpec'String
inteles2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    cases x :
      mk-UIMLSpec'Structure (-,-,-,-) → stru2str (x)      ↷
inteles2str (tl (s)),
      mk-UIMLSpec'Style (-,-,-,-) → style2str (x)        ↷
inteles2str (tl (s)),
      mk-UIMLSpec'Content (-,-,-,-) → content2str (x)   ↷
inteles2str (tl (s)),
      mk-UIMLSpec'Behavior (-,-,-,-) → behav2str (x)    ↷
inteles2str (tl (s))
  end;

```

Description:

Converts an InterfaceElements set into String.

Calls:

stru2str, style2str, content2str, behav2str

2.3.3 Function *stru2str*

Specification:

```

stru2str : UIMLSpec'Structure → UIMLSpec'String
stru2str (s)  $\triangleq$ 
  " < structure " ↷ id2str (s.id) ↷ source2str (s.source) ↷
how2str (s.how) ↷ export2str (s.export) ↷ " > " ↷
parts2str (s.parts) ↷
  " < /structure > ";

```

Description:

Converts a Structure element into String.

Calls:

srcatt2str, parts2str

2.3.4 Function *parts2str*

Specification:

```

parts2str : UIMLSpec'Part* → UIMLSpec'String
parts2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    part2str (x)  $\curvearrowright$  parts2str (tl (s));

```

Description:

Converts a Part sequence into String.

Calls:

*part2str***2.3.5 Function** *part2str*

Specification:

```

part2str : [UIMLSpec'Part] → UIMLSpec'String
part2str (p)  $\triangleq$ 
  if p = nil
  then " "
  else " < part "  $\curvearrowright$  id2str (p.id)  $\curvearrowright$ 
    source2str (p.source)  $\curvearrowright$ 
    how2str (p.how)  $\curvearrowright$ 
    export2str (p.export)  $\curvearrowright$ 
    class2str (p.class)  $\curvearrowright$ 
    where2str (p.where)  $\curvearrowright$ 
    wherepart2str (p.where-part)  $\curvearrowright$ 
    " > "  $\curvearrowright$ 
    style2str (p.style)  $\curvearrowright$ 
    content2str (p.content)  $\curvearrowright$ 
    behav2str (p.behavior)  $\curvearrowright$ 
    parts2str (p.parts)  $\curvearrowright$ 
    repeats2str (p.repeats)  $\curvearrowright$ 
    " < /part > ";

```

Description:

Converts a Part element into String.

Calls:

srcatt2str, classs2str, style2str, content2str, behav2str, parts2str

2.3.6 Function *class2str*

Specification:

```

class2str : [UIMLSpec'String] → UIMLSpec'String
class2str (c)  $\triangleq$ 
  if c = nil
  then " "
  else "class = '"  $\curvearrowright$  c  $\curvearrowright$  "'";

```

Description:

Converts a class attribute into String.

Calls:

class2str

2.3.7 Function *properties2str*

Specification:

```

properties2str : UIMLSpec'Property* → UIMLSpec'String
properties2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    property2str (x)  $\curvearrowright$  properties2str (tl (s));

```

Description:

Converts a Property set into String.

Calls:

property2str

2.3.8 Function *property2str*

Specification:

```

property2str : [UIMLSpec'Property] → UIMLSpec'String
property2str (p)  $\triangleq$ 
  if p = nil
  then " "
  else " < property "  $\curvearrowright$ 
    name2str (p.name)  $\curvearrowright$ 
    source2str (p.source)  $\curvearrowright$ 
    how2str (p.how)  $\curvearrowright$ 
    export2str (p.export)  $\curvearrowright$ 
    att2str (" part-name ", p.p-name)  $\curvearrowright$ 
    att2str (" part-class ", p.p-class)  $\curvearrowright$ 
    att2str (" event-name ", p.e-name)  $\curvearrowright$ 
    att2str (" event-class ", p.e-class)  $\curvearrowright$ 
    " > "  $\curvearrowright$ 
    proptypes2str (p.property)  $\curvearrowright$ 
    " < /property > "

```

Description:

Converts a Property element into String.

Calls:

proptypes2str

2.3.9 Function *proptypes2str*

Specification:

```

PropertyTypes = UIMLSpec'String      |      UIMLSpec'Constant      |
UIMLSpec'Property |
                    UIMLSpec'Reference |      UIMLSpec'Call      |
UIMLSpec'Iterator
proptypes2str : PropertyTypes* → UIMLSpec'String
proptypes2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    proptype2str (x)  $\curvearrowright$  proptypes2str (tl (s));

```

Description:

Converts a Property type sequence into String.

Calls:

property2str

2.3.10 Function *proptype2str*

Specification:

```

proptype2str : [PropertyTypes] → UIMLSpec'String
proptype2str (p)  $\triangleq$ 
  if p = nil
  then " "
  else cases p :
    mk-UIMLSpec'Constant (-,-,-,-,-,-) → constant2str (p),
    mk-UIMLSpec'Property (-,-,-,-,-,-,-) → property2str (p),
    mk-UIMLSpec'Reference (-,-) → refer2str (p),
    mk-UIMLSpec'Call (-,-) → call2str (p),
    mk-UIMLSpec'Iterator (-,-) → iterator2str (p),
    others → p
  end;

```

Description:

Converts a Property type into String.

Calls:

*constant2str,property2str,refer2str***2.3.11 Function** *style2str*

Specification:

```

style2str : [UIMLSpec'Style] → UIMLSpec'String
style2str (s)  $\triangleq$ 
  if s = nil
  then " "
  else " < style "  $\curvearrowright$ 
    id2str (s.id)  $\curvearrowright$ 
    source2str (s.source)  $\curvearrowright$ 
    how2str (s.how)  $\curvearrowright$ 
    export2str (s.export)  $\curvearrowright$ 
    " > "  $\curvearrowright$ 
    properties2str (s.property)  $\curvearrowright$ 
    " < /style > ";

```

Description:

Converts a Style element into String.

Calls:

srcatt2str,properties2str

2.3.12 Function *content2str*

Specification:

```

content2str : [UIMLSpec' Content] → UIMLSpec' String
content2str (c)  $\triangleq$ 
  if c = nil
  then " "
  else " < content "  $\curvearrowright$  id2str (c.id)  $\curvearrowright$  source2str (c.source)  $\curvearrowright$ 
    how2str (c.how)  $\curvearrowright$ 
    export2str (c.export)  $\curvearrowright$  " > "  $\curvearrowright$ 
    constants2str (c.constant)  $\curvearrowright$ 
    " < /content > ";

```

Description:

Converts a Content element into String.

Calls:

*srcatt2str, constants2str***2.3.13 Function** *constants2str*

Specification:

```

constants2str : UIMLSpec' Constant* → UIMLSpec' String
constants2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    constant2str (x)  $\curvearrowright$  constants2str (tl (s));

```

Description:

Converts a Constant sequence into String.

Calls:

constant2str

2.3.14 Function *constant2str*

Specification:

```

constant2str : [UIMLSpec' Constant] → UIMLSpec' String
constant2str (c)  $\triangleq$ 
  if c = nil
  then " "
  else " < constant "  $\curvearrowright$ 
    id2str (c.id)  $\curvearrowright$ 
    source2str (c.source)  $\curvearrowright$ 
    how2str (c.how)  $\curvearrowright$ 
    export2str (c.export)  $\curvearrowright$ 
    model2str (c.model)  $\curvearrowright$ 
    value2str (c.value)  $\curvearrowright$ 
    " > "  $\curvearrowright$ 
    constants2str (c.constant)  $\curvearrowright$ 
    " < /constant > ";

```

Description:

Converts a Constant element into String.

Calls:

*srcatt2str, constant2str***2.3.15 Function** *refer2str*

Specification:

```

refer2str : [UIMLSpec' Reference] → UIMLSpec' String
refer2str (r)  $\triangleq$ 
  if r = nil
  then " "
  else " < reference "  $\curvearrowright$  constantname2str (r.constant-name)  $\curvearrowright$ 
    urlname2str (r.url-name)  $\curvearrowright$  "/ > ";

```

Description:

Converts a Reference into String.

Calls:

Standard VDM-SL only

2.3.16 Function *behav2str*

Specification:

```

behav2str : [UIMLSpec'Behavior] → UIMLSpec'String
behav2str (b)  $\triangleq$ 
  if b = nil
  then " "
  else " < behavior "  $\curvearrowright$  id2str (b.id)  $\curvearrowright$  source2str (b.source)  $\curvearrowright$ 
    how2str (b.how)  $\curvearrowright$ 
    export2str (b.export)  $\curvearrowright$  " > "  $\curvearrowright$ 
    rules2str (b.rules)  $\curvearrowright$ 
    " < /behavior > ";

```

Description:

Converts a Behavior element into String.

Calls:

*srcatt2str, rules2str***2.3.17 Function** *rules2str*

Specification:

```

rules2str : UIMLSpec'Rule* → UIMLSpec'String
rules2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    rule2str (x)  $\curvearrowright$  rules2str (tl (s));

```

Description:

Converts a Rule set into String.

Calls:

rule2str

2.3.18 Function *rule2str*

Specification:

```

rule2str : [UIMLSpec'Rule] → UIMLSpec'String
rule2str (r)  $\triangleq$ 
  if r = nil
  then " "
  else " < rule "  $\curvearrowright$  id2str (r.id)  $\curvearrowright$  source2str (r.source)  $\curvearrowright$ 
    how2str (r.how)  $\curvearrowright$ 
    export2str (r.export)  $\curvearrowright$  " > "  $\curvearrowright$ 
    condition2str (r.condition)  $\curvearrowright$ 
    action2str (r.action)  $\curvearrowright$ 
    " < /rule > ";

```

Description:

Converts a Rule into String.

Calls:

*rule2str***2.3.19 Function** *action2str*

Specification:

```

action2str : UIMLSpec'Action → UIMLSpec'String
action2str (a)  $\triangleq$ 
  " < action > "  $\curvearrowright$ 
  cases a :
    mk-UIMLSpec'ActionType1 (-,-) → acttypes2str (a.type)  $\curvearrowright$ 
    event2str (a.event),
    mk-UIMLSpec'ActionType2 (-,-,-) →
      whentrue2str (a.whentrue)  $\curvearrowright$ 
      whenfalse2str (a.whenfalse)  $\curvearrowright$ 
      bydefault2str (a.bydefault),
    others → " "
  end  $\curvearrowright$ 
  " < /action > "

```

Description:

Converts an Action into String.

Calls:

acttypes2str, *event2str*

2.3.20 Function *acttypes2str*

Specification:

```

    ActionType = UIMLSpec'Property      |      UIMLSpec'Call      |
    UIMLSpec'Restructure
    acttypes2str : ActionType* → UIMLSpec'String
    acttypes2str (s)  $\triangleq$ 
    if s = []
    then " "
    else let x = hd (s) in
        acttype2str (x)  $\frown$  acttypes2str (tl (s));

```

Description:

Converts an Action type sequence into String.

Calls:

*acttype2str***2.3.21 Function** *acttype2str*

Specification:

```

    acttype2str : ActionType → UIMLSpec'String
    acttype2str (s)  $\triangleq$ 
    cases s :
    mk-UIMLSpec'Property (-,-,-,-,-,-,-) → property2str (s),
    mk-UIMLSpec'Call (-,-) → call2str (s),
    mk-UIMLSpec'Restructure (-,-,-,-,-) → restructure2str (s),
    others → " "
    end;

```

Description:

Converts a Action type set into String.

Calls:

acttype2str

2.3.22 Function *events2str*

Specification:

```

events2str : UIMLSpec' Event* → UIMLSpec' String
events2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
        event2str (x)  $\curvearrowright$  events2str (tl (s));

```

Description:

Converts an Event sequence into String.

Calls:

event2str

2.3.23 Function *event2str*

Specification:

```

event2str : [UIMLSpec' Event] → UIMLSpec' String
event2str (e)  $\triangleq$ 
  if e = nil
  then " "
  else " < event "  $\curvearrowright$ 
        att2str (" name ", e.name)  $\curvearrowright$ 
        att2str (" class ", e.class)  $\curvearrowright$ 
        att2str (" part-name ", e.p-name)  $\curvearrowright$ 
        att2str (" part-class ", e.p-class)  $\curvearrowright$ 
        " / > ";

```

Description:

Converts a Event into String.

Calls:

Standard VDM-SL only

2.3.24 Function *condition2str*

Specification:

```

condition2str : [UIMLSpec'Condition] → UIMLSpec'String
condition2str (c)  $\triangleq$ 
  if c = nil
  then " "
  else cases c.type :
    mk-UIMLSpec'Equal (-,-) → " < condition > "  $\curvearrowright$ 
equal2str (c.type)  $\curvearrowright$  " < /condition > ",
    mk-UIMLSpec'Event (-,-,-,-) → " < condition >
"  $\curvearrowright$  event2str (c.type)  $\curvearrowright$ 
" < /condition > "
  end;

```

Description:

Converts a Condition into String.

Calls:

*equal2str, event2str***2.3.25 Function** *equal2str*

Specification:

```

equal2str : [UIMLSpec'Equal] → UIMLSpec'String
equal2str (e)  $\triangleq$ 
  if e = nil
  then " "
  else " < equal > "  $\curvearrowright$ 
event2str (e.event)  $\curvearrowright$ 
cpro2str (e.other)  $\curvearrowright$ 
" < /equal > "

```

Description:

Converts a Equal into String.

Calls:

event2str, cpr2str

2.3.26 Function *cpro2str*

Specification:

```

EqualCPRO = UIMLSpec' Constant | UIMLSpec' Property |
UIMLSpec' Reference | UIMLSpec' Op
cpro2str : EqualCPRO → UIMLSpec' String
cpro2str (e)  $\triangleq$ 
  cases e :
    mk-UIMLSpec' Constant (-,-,-,-,-,-) → constant2str (e),
    mk-UIMLSpec' Property (-,-,-,-,-,-,-,-) → property2str (e),
    mk-UIMLSpec' Reference (-,-) → refer2str (e),
    mk-UIMLSpec' Op (-,-) → op2str (e),
    others → " "
  end;

```

Description:

Converts a EqualCPR into String.

Calls:

*constant2str,property2str,refer2str***2.3.27 Function** *call2str*

Specification:

```

call2str : [UIMLSpec' Call] → UIMLSpec' String
call2str (c)  $\triangleq$ 
  if c = nil
  then " "
  else " < call "  $\curvearrowright$ 
    att2str (" name ", c.name)  $\curvearrowright$ 
    " / > "  $\curvearrowright$ 
    params2str (c.params)  $\curvearrowright$ 
    " < / call > ";

```

Description:

Converts a Call element into String.

Calls:

Standard VDM-SL only

2.3.28 Function *params2str*

Specification:

```

params2str : UIMLSpec'Param* → UIMLSpec'String
params2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    param2str (x)  $\frown$  params2str (tl (s));

```

Description:

Converts a Params type sequence into String.

Calls:

param2str

2.3.29 Function *param2str*

Specification:

```

param2str : [UIMLSpec'Param] → UIMLSpec'String
param2str (s)  $\triangleq$ 
  if s = nil
  then " "
  else cases s.type :
    mk-UIMLSpec'Constant (-,-,-,-,-) → constant2str (s.type),
    mk-UIMLSpec'Property (-,-,-,-,-,-,-) → property2str (s.type),
    mk-UIMLSpec'Reference (-,-) → refer2str (s.type),
    mk-UIMLSpec'Op (-,-) → op2str (s.type),
    mk-UIMLSpec'Event (-,-,-) → event2str (s.type),
    mk-UIMLSpec'Call (-,-) → call2str (s.type),
    mk-UIMLSpec'Iterator (-,-) → iterator2str (s.type),
    others → s.type
  end;

```

Description:

Converts a Param element into String.

Calls:

Standard VDM-SL only

2.4 Functions for Reusable Interface Components

2.4.1 Function *dmethods2str*

Specification:

```

dmethods2str : UIMLSpec'D-method* → UIMLSpec'String
dmethods2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    dmethod2str (x)  $\curvearrowright$  dmethods2str (tl (s));

```

Description:

Converts a D-method sequence into String.

Calls:

dmethod2str

2.4.2 Function *dmethod2str*

Specification:

```

dmethod2str : [UIMLSpec'D-method] → UIMLSpec'String
dmethod2str (d)  $\triangleq$ 
  if d = nil
  then " "
  else " < d-method > "  $\curvearrowright$ 
    " / > "  $\curvearrowright$ 
    dparams2str (d.dparam)  $\curvearrowright$ 
    script2str (d.script)  $\curvearrowright$ 
    " < /d-method > ";

```

Description:

Converts a D-method element into String.

Calls:

Standard VDM-SL only

2.4.3 Function *dproperties2str*

Specification:

```

dproperties2str : UIMLSpec'D-property* → UIMLSpec'String
dproperties2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    dproperty2str (x)  $\curvearrowright$  dproperties2str (tl (s));

```

Description:

Converts a D-property set into String.

Calls:

dproperty2str

2.4.4 Function *dproperty2str*

Specification:

```

dproperty2str : [UIMLSpec'D-property] → UIMLSpec'String
dproperty2str (d)  $\triangleq$ 
  if d = nil
  then " "
  else " < d-property "  $\curvearrowright$ 
    id2str (d.id)  $\curvearrowright$ 
    att2str (" maps-to ", d.maps-to)  $\curvearrowright$ 
    mapstype2str (d.maps-type)  $\curvearrowright$ 
    att2str (" return-type ", d.return-type)  $\curvearrowright$ 
    " / > "  $\curvearrowright$ 
    " < /d-property > ";

```

Description:

Converts a D-property element into String.

Calls:

Standard VDM-SL only

2.4.5 Function *dcomponents2str*

Specification:

```

dcomponents2str : UIMLSpec'D-component* → UIMLSpec'String
dcomponents2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    dcomponent2str (x)  $\curvearrowright$  dcomponents2str (tl (s));

```

Description:

Converts a D-param sequence into String.

Calls:

dproperty2str

2.4.6 Function *dcomponent2str*

Specification:

```

dcomponent2str : [UIMLSpec'D-component] → UIMLSpec'String
dcomponent2str (d)  $\triangleq$ 
  if d = nil
  then " "
  else " < d-component "  $\curvearrowright$ 
    id2str (d.id)  $\curvearrowright$ 
    source2str (d.source)  $\curvearrowright$  how2str (d.how)  $\curvearrowright$ 
    export2str (d.export)  $\curvearrowright$ 
    att2str (" maps-to", d.maps-to)  $\curvearrowright$ 
    att2str (" location", d.location)  $\curvearrowright$ 
    " / > "  $\curvearrowright$ 
    dmethods2str (d.dmethod)  $\curvearrowright$ 
    " < /d-component > ";

```

Description:

Converts a D-component element into String.

Calls:

Standard VDM-SL only

2.4.7 Function *dparams2str*

Specification:

```

dparams2str : UIMLSpec'D-param* → UIMLSpec'String
dparams2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    dparam2str (x)  $\frown$  dparams2str (tl (s));

```

Description:

Converts a D-param sequence into String.

Calls:

dproperty2str

2.4.8 Function *dparam2str*

Specification:

```

dparam2str : [UIMLSpec'D-param] → UIMLSpec'String
dparam2str (d)  $\triangleq$ 
  if d = nil
  then " "
  else " < d-param "  $\frown$ 
    id2str (d.id)  $\frown$ 
    att2str (" type ", d.type)  $\frown$ 
    " / > "  $\frown$ 
    d.data  $\frown$ 
    " < /d-param > ";

```

Description:

Converts a D-param element into String.

Calls:

Standard VDM-SL only

2.4.9 Function *templ2str*

Specification:

```

templ2str : [UIMLSpec' Template] → UIMLSpec' String
templ2str (t)  $\triangleq$ 
  if t = nil
  then " "
  else cases t.src-ele :
    mk-UIMLSpec' Behavior (-,-,-,-) → behav2str (t.src-ele),
    mk-UIMLSpec' Structure (-,-,-,-) → stru2str (t.src-ele),
    mk-UIMLSpec' Style (-,-,-,-) → style2str (t.src-ele),
    mk-UIMLSpec' Content (-,-,-,-) → content2str (t.src-ele),
    mk-UIMLSpec' Constant (-,-,-,-,-) → constant2str (t.src-ele),
    mk-UIMLSpec' Property (-,-,-,-,-,-,-) → property2str (t.src-ele),
    mk-UIMLSpec' Peers (-,-,-,-) → peer2str (t.src-ele),
    mk-UIMLSpec' Presentation (-,-,-,-,-) → presentation2str (t.src-ele),
    mk-UIMLSpec' Logic (-,-,-,-) → logic2str (t.src-ele),
    mk-UIMLSpec' Part (-,-,-,-,-,-,-,-,-) → part2str (t.src-ele),
    mk-UIMLSpec' Restructure (-,-,-,-,-) → restructure2str (t.src-ele),
    mk-UIMLSpec' Interface (-,-,-,-,-) → interf2str (t.src-ele),
    mk-UIMLSpec' Rule (-,-,-,-,-) → rule2str (t.src-ele),
    mk-UIMLSpec' Script (-,-,-,-,-) → script2str (t.src-ele),
    mk-UIMLSpec' D-class (-,-,-,-,-,-,-,-,-) → dclass2str (t.src-ele),
    mk-UIMLSpec' D-component (-,-,-,-,-,-,-) → dcomponent2str (t.src-ele),
    others → " "
  end;

```

Description:

Converts a Template element into String.

Calls:

Standard VDM-SL only

2.4.10 Function *listeners2str*

Specification:

```

listeners2str : UIMLSpec' Listener* → UIMLSpec' String
listeners2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    listener2str (x)  $\frown$  listeners2str (tl (s));

```

Description:

Converts a Listener sequence into String.

Calls:

dmethod2str

2.4.11 Function *listener2str*

Specification:

```

listener2str : [UIMLSpec'Listener] → UIMLSpec'String
listener2str (l)  $\triangleq$ 
  if l = nil
  then " "
  else " < listener "  $\curvearrowright$ 
    att2str (" class ", l.class)  $\curvearrowright$ 
    att2str (" attacher ", l.attacher)  $\curvearrowright$ 
    " / > ";

```

Description:

Converts a Listener element into String.

Calls:

Standard VDM-SL only

2.4.12 Function *whentrue2str*

Specification:

```

whentrue2str : [UIMLSpec'When-true] → UIMLSpec'String
whentrue2str (w)  $\triangleq$ 
  " < when-true "  $\curvearrowright$  whentrue2str (w.type)  $\curvearrowright$ 
  restructure2str (w.restructure)  $\curvearrowright$ 
  op2str (w.op)  $\curvearrowright$ 
  equal2str (w.equal)  $\curvearrowright$  event2str (w.event)  $\curvearrowright$ 
  " < /when-true > ";

```

Description:

Converts a When-true element into String.

Calls:

whentrue2str, restructure2str, op2str, equal2str, event2str

2.4.13 Function *whenfalse2str*

Specification:

```

whenfalse2str : [UIMLSpec' When-false] → UIMLSpec' String
whenfalse2str (w)  $\triangleq$ 
  " < when-false "  $\curvearrowright$  whenruetypes2str (w.type)  $\curvearrowright$ 
  restructure2str (w.restructure)  $\curvearrowright$ 
  op2str (w.op)  $\curvearrowright$ 
  equal2str (w.equal)  $\curvearrowright$  event2str (w.event)  $\curvearrowright$ 
  " < /when-false > ";

```

Description:

Converts a When-false element into String.

Calls:

*whenruetypes2str, restructure2str, op2str, equal2str, event2str***2.4.14 Function** *bydefault2str*

Specification:

```

bydefault2str : [UIMLSpec' By-default] → UIMLSpec' String
bydefault2str (w)  $\triangleq$ 
  " < by-default "  $\curvearrowright$  whenruetypes2str (w.type)  $\curvearrowright$ 
  restructure2str (w.restructure)  $\curvearrowright$ 
  op2str (w.op)  $\curvearrowright$ 
  equal2str (w.equal)  $\curvearrowright$  event2str (w.event)  $\curvearrowright$ 
  " < /by-default > ";

```

Description:

Converts a By-default element into String.

Calls:

*whenruetypes2str, restructure2str, op2str, equal2str, event2str***2.4.15 Function** *restructure2str*

Specification:

```

restructure2str : [UIMLSpec' Restructure] → UIMLSpec' String
restructure2str (r)  $\triangleq$ 
  if r = nil
  then " "
  else " < restructure "  $\curvearrowright$ 
    att2str (" at-part ", r.at-part)  $\curvearrowright$ 
    how2str (r.how)  $\curvearrowright$ 
    where2str (r.where)  $\curvearrowright$ 
    att2str (" where-part ", r.where-part)  $\curvearrowright$ 
    source2str (r.source)  $\curvearrowright$ 
    "/ > "  $\curvearrowright$ 
    templ2str (r.template)  $\curvearrowright$ 
    " < /restructure > ";

```

Description:

Converts a Restructure element into String.

Calls:

Standard VDM-SL only

2.4.16 Function *whentruetype2str*

Specification:

```

whentruetype2str : (UIMLSpec' Property | UIMLSpec' Call)
→ UIMLSpec' String
whentruetype2str (c)  $\triangleq$ 
  cases c :
    mk-UIMLSpec' Property (-,-,-,-,-,-,-,-) → property2str (c),
    mk-UIMLSpec' Call (-,-) → call2str (c)
  end;

```

Description:

Converts a When-true type element into String.

Calls:

Standard VDM-SL only

2.4.17 Function *whentruetypes2str*

Specification:

```

whentruetypes2str : (UIMLSpec'Property | UIMLSpec'Call)*
→ UIMLSpec'String
whentruetypes2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
    whentruetype2str (x)  $\curvearrowright$  whentruetypes2str (tl (s));

```

Description:

Converts a When-true type sequence into String.

Calls:

Standard VDM-SL only

2.4.18 Function *op2str*

Specification:

```

op2str : [UIMLSpec'Op] → UIMLSpec'String
op2str (o)  $\triangleq$ 
  if o = nil
  then " "
  else " < op > "  $\curvearrowright$ 
    optypes2str (o.type)  $\curvearrowright$ 
    name2str (o.name)  $\curvearrowright$ 
    " < /op > ";

```

Description:

Converts a Op element into String.

Calls:

Standard VDM-SL only

2.4.19 Function *optype2str*

Specification:

```

optype2str : OpType → UIMLSpec'String
optype2str (o)  $\triangleq$ 
  cases o :
    mk-UIMLSpec'Constant (-,-,-,-,-,-) → constant2str (o),
    mk-UIMLSpec'Property (-,-,-,-,-,-,-) → property2str (o),
    mk-UIMLSpec'Reference (-,-) → refer2str (o),
    mk-UIMLSpec'Op (-,-) → op2str (o),
    mk-UIMLSpec'Event (-,-,-,-) → event2str (o),
    mk-UIMLSpec'Call (-,-) → call2str (o),
    others → " "
  end

```

Description:

Converts a Op type element into String.

Calls:

Standard VDM-SL only

2.4.20 Function *optypes2str*

Specification:

```

OpType = UIMLSpec'Property | UIMLSpec'Call |
UIMLSpec'Reference | UIMLSpec'Constant |
          UIMLSpec'Event | UIMLSpec'Op
optypes2str : OpType* → UIMLSpec'String
optypes2str (s)  $\triangleq$ 
  if s = []
  then " "
  else let x = hd (s) in
        op2str (x)  $\frown$  optypes2str (tl (s));

```

Description:

Converts an Op type sequence into String.

Calls:

actype2str

2.5 Attributes handling functions

2.5.1 Function *id2str*

Specification:

```

id2str : [UIMLSpec'ID] → UIMLSpec'String
id2str (id)  $\triangleq$ 
  cases id :
    mk-UIMLSpec'ID (i) → "id = '"  $\curvearrowright$  i  $\curvearrowright$  "'",
    others → " "
  end;

```

Description:

Converts a Id attribute into String.

Calls:

Standard VDM-SL only

2.5.2 Function *name2str*

Specification:

```

name2str : UIMLSpec'String → UIMLSpec'String
name2str (s)  $\triangleq$ 
  if s = " "
  then " "
  else "name = '"  $\curvearrowright$  s  $\curvearrowright$  "'";

```

Description:

Converts a Name attribute into String.

Calls:

Standard VDM-SL only

2.5.3 Function *base2str*

Specification:

```

base2str : UIMLSpec'String → UIMLSpec'String
base2str (s)  $\triangleq$ 
  if s = " "
  then " "
  else "base = '"  $\curvearrowright$  s  $\curvearrowright$  "'";

```


Description:

Converts a Base attribute into String.

Calls:

Standard VDM-SL only

2.5.4 Function *source2str*

Specification:

```

source2str : UIMLSpec'String → UIMLSpec'String
source2str (s)  $\triangleq$ 
  if s = " "
  then " "
  else "source = '"  $\curvearrowright$  s  $\curvearrowright$  "'";

```

Description:

Converts a Source attribute into String.

Calls:

Standard VDM-SL only

2.5.5 Function *how2str*

Specification:

```

how2str : UIMLSpec'SourcesModes → UIMLSpec'String
how2str (s)  $\triangleq$ 
  cases s :
    APPEND → "how = 'append'",
    CASCADE → "how = 'cascade'",
    REPLACE → "how = 'replace'",
    UNION → "how = 'union'",
    others → " "
  end;

```

Description:

Converts a how attribute into String.

Calls:

Standard VDM-SL only

2.5.6 Function *export2str*

Specification:

```

export2str : UIMLSpec'ExportOptions → UIMLSpec'String
export2str (s)  $\triangleq$ 
  cases s :
    HIDDEN → " export = 'hidden' ",
    OPTIONAL → " export = 'optional' ",
    REQUIRED → " export = 'required' ",
    others → " "
  end;

```

Description:

Converts a Export attribute into String.

Calls:

Standard VDM-SL only

2.5.7 Function *where2str*

Specification:

```

where2str : UIMLSpec'WhereOptions → UIMLSpec'String
where2str (s)  $\triangleq$ 
  cases s :
    FIRST → " where = 'first' ",
    LAST → " where = 'last' ",
    BEFORE → " where = 'before' ",
    AFTER → " where = 'after' ",
    others → " "
  end;

```

Description:

Converts a Where attribute into String.

Calls:

Standard VDM-SL only

2.5.8 Function *mapstype2str*

Specification:

```

mapstype2str : UIMLSpec'mapsTypes → UIMLSpec'String
mapstype2str (s)  $\triangleq$ 
  cases s :
    ATTRIBUTE → "maps-type = 'attribute'",
    TAG → "maps-type = 'tag'",
    CLASS → "maps-type = 'class'",
    others → " "
  end;

```

Description:

Converts a maps-to attribute into String.

Calls:

Standard VDM-SL only

2.5.9 Function *used_in_tag2str*

Specification:

```

used-in-tag2str : UIMLSpec'used-in-tagTypes → UIMLSpec'String
used-in-tag2str (s)  $\triangleq$ 
  cases s :
    EVENT → "used-in-tag = 'event'",
    LISTENER → "used-in-tag = 'listener'",
    PART → "used-in-tag = 'part'",
    others → " "
  end;

```

Description:

Converts a used-in-tag attribute into String.

Calls:

Standard VDM-SL only

2.5.10 Function *value2str*

Specification:

```

value2str : UIMLSpec'String → UIMLSpec'String
value2str (s)  $\triangleq$ 
  if s = " "
  then " "
  else "value = ' "  $\curvearrowright$  s  $\curvearrowright$  " '";

```

Description:

Converts a Value attribute into String.

Calls:

Standard VDM-SL only

2.5.11 Function *model2str*

Specification:

```

model2str : UIMLSpec'String → UIMLSpec'String
model2str (s)  $\triangleq$ 
  if s = " "
  then " "
  else "model = ' "  $\curvearrowright$  s  $\curvearrowright$  " '";

```

Description:

Converts a Model attribute into String.

Calls:

Standard VDM-SL only

2.5.12 Function *wherepart2str*

Specification:

```

wherepart2str : UIMLSpec'String → UIMLSpec'String
wherepart2str (s)  $\triangleq$ 
  if s = " "
  then " "
  else "where-part = ' "  $\curvearrowright$  s  $\curvearrowright$  " '";

```

Description:

Converts a Where-part attribute into String.

Calls:

Standard VDM-SL only

2.5.13 Function *constantname2str*

Specification:

```

constantname2str : UIMLSpec'String → UIMLSpec'String
constantname2str (s)  $\triangleq$ 
  if s = " "
  then " "
  else "constant-name = '"  $\curvearrowright$  s  $\curvearrowright$  "'";

```

Description:

Converts a Constant-name attribute into String.

Calls:

Standard VDM-SL only

2.5.14 Function *urlname2str*

Specification:

```

urlname2str : UIMLSpec'String → UIMLSpec'String
urlname2str (s)  $\triangleq$ 
  if s = " "
  then " "
  else "url-name = '"  $\curvearrowright$  s  $\curvearrowright$  "'";

```

Description:

Converts a Url-name attribute into String.

Calls:

Standard VDM-SL only

2.5.15 Function *att2str*

Specification:

```

att2str : UIMLSpec'String × [UIMLSpec'String] → UIMLSpec'String
att2str (e, v)  $\triangleq$ 
  if v = nil
  then " "
  else if v = " "
  then " "
  else " "  $\curvearrowright$  e  $\curvearrowright$  " = ' "  $\curvearrowright$  v  $\curvearrowright$  " '";

```

Description:

Converts a pair (attribute(a),value(v)) a to String a='v'.

Calls:

Standard VDM-SL only

2.5.16 Function *toFileHTML*

Specification:

```

toFileHTML : UIMLSpec'Uiml × UIMLSpec'String →  $\mathbb{B}$ 
toFileHTML (ui, f)  $\triangleq$ 
  IO'fecho (f, PI, START)  $\wedge$ 
  IO'fecho (f, " <!DOCTYPEuimlPUBLIC'-//UIT//DTDUIML"  $\curvearrowright$ 
    "2.0Draft//EN'\n",
    APPEND)  $\wedge$ 
  IO'fecho (f, "'UIML20g.dtd' > \n", APPEND)  $\wedge$ 
  IO'fecho (f, " < uiml > ", APPEND)  $\wedge$ 
  IO'fecho (f, head2str (ui.head), APPEND)  $\wedge$ 
  IO'fecho (f, members2str (ui.members), APPEND)  $\wedge$ 
  IO'fecho (f, end-doc-html, APPEND)

```

Description:

Output an UIML element to HTML file f.

Calls:

head2str, members2str

2.6 Operations

2.6.1 Operation $writeF$

Specification:

$$\begin{aligned}
 &FileName = UIMLSpec'String \\
 &writeF : FileName \times UIMLSpec'Uiml \xrightarrow{o} \mathbb{B} \\
 &writeF(fn, ui) \triangleq \\
 &\quad IO'fecho(fn, uiml2str(ui), START)
 \end{aligned}$$

Description:

Writes the String generated from the UIML element in file fn .

Calls:

fecho, uiml2str

3 Tests

VDM-SL methods call in expression:

$VDM2UIML'toFileHTML(UIMLSpecTab'TU2U(UIMLSpecTab't), "t.uiml")$

Test Suite : UIML.tc
Module : VDM2UIML

Name	#Calls	Coverage
VDM2UIML'id2str	39	37%
VDM2UIML'op2str	0	0%
VDM2UIML'writeF	0	0%
VDM2UIML'att2str	52	47%
VDM2UIML'how2str	52	63%
VDM2UIML'base2str	0	0%
VDM2UIML'call2str	0	0%
VDM2UIML'cpro2str	0	0%
VDM2UIML'head2str	1	38%
VDM2UIML'meta2str	0	0%
VDM2UIML'name2str	13	90%
VDM2UIML'part2str	20	98%
VDM2UIML'peer2str	0	0%
VDM2UIML'rule2str	0	0%
VDM2UIML'stru2str	1	√
VDM2UIML'uiml2str	0	0%
VDM2UIML'behav2str	20	14%

Name	#Calls	Coverage
VDM2UIML 'class2str	20	90%
VDM2UIML 'equal2str	0	0%
VDM2UIML 'event2str	0	0%
VDM2UIML 'logic2str	0	0%
VDM2UIML 'metas2str	0	0%
VDM2UIML 'model2str	0	0%
VDM2UIML 'param2str	0	0%
VDM2UIML 'parts2str	41	√
VDM2UIML 'refer2str	0	0%
VDM2UIML 'rules2str	0	0%
VDM2UIML 'style2str	20	√
VDM2UIML 'templ2str	0	0%
VDM2UIML 'value2str	0	0%
VDM2UIML 'where2str	20	63%
VDM2UIML 'action2str	0	0%
VDM2UIML 'dclass2str	0	0%
VDM2UIML 'dparam2str	0	0%
VDM2UIML 'events2str	0	0%
VDM2UIML 'export2str	52	66%
VDM2UIML 'interf2str	1	97%
VDM2UIML 'member2str	1	52%
VDM2UIML 'optype2str	0	0%
VDM2UIML 'params2str	0	0%
VDM2UIML 'prelog2str	0	0%
VDM2UIML 'repeat2str	0	0%
VDM2UIML 'script2str	0	0%
VDM2UIML 'source2str	52	50%
VDM2UIML 'toFileHTML	1	√
VDM2UIML 'acttype2str	0	0%
VDM2UIML 'content2str	20	14%
VDM2UIML 'dclass2str	0	0%
VDM2UIML 'dmethod2str	0	0%
VDM2UIML 'dparams2str	0	0%
VDM2UIML 'intele2str	2	42%
VDM2UIML 'members2str	2	√
VDM2UIML 'optypes2str	0	0%
VDM2UIML 'prelogs2str	0	0%
VDM2UIML 'repeats2str	20	27%
VDM2UIML 'urlname2str	0	0%
VDM2UIML 'acttypes2str	0	0%
VDM2UIML 'constant2str	0	0%
VDM2UIML 'dmethods2str	0	0%
VDM2UIML 'iterator2str	0	0%
VDM2UIML 'listener2str	0	0%

Name	#Calls	Coverage
VDM2UIML 'mapstype2str	0	0%
VDM2UIML 'property2str	13	98%
VDM2UIML 'proptype2str	13	30%
VDM2UIML 'whentruetrue2str	0	0%
VDM2UIML 'bydefault2str	0	0%
VDM2UIML 'condition2str	0	0%
VDM2UIML 'constants2str	0	0%
VDM2UIML 'dproperty2str	0	0%
VDM2UIML 'listeners2str	0	0%
VDM2UIML 'proptypes2str	26	√
VDM2UIML 'whenfalse2str	0	0%
VDM2UIML 'wherepart2str	20	50%
VDM2UIML 'dcomponent2str	0	0%
VDM2UIML 'properties2str	30	√
VDM2UIML 'dcomponents2str	0	0%
VDM2UIML 'dproperties2str	0	0%
VDM2UIML 'restructure2str	0	0%
VDM2UIML 'used-in-tag2str	0	0%
VDM2UIML 'constantname2str	0	0%
VDM2UIML 'presentation2str	0	0%
VDM2UIML 'whentruetype2str	0	0%
VDM2UIML 'whentruetypes2str	0	0%
VDM2UIML 'iteratorOptions2str	0	0%
Total Coverage		23%

end VDM2UIML

4 Prototype

In order to experiment the animation of VDM methods, mainly *OLAP* functions, we have decided to create a HTML prototype whereby we can visualize all table transformations. This application uses our VDM specifications, *UIMLSpec* and *UIML-SpecTab*. From CGI HTML forms behavior, the *VDM-SL* methods are called, than UIML is generated and render again to HTML.

The prototype was developed using CGI mechanism, with PHP technology and Java Applets.

Figure 1 depicts the architecture of our prototype and Figure 2 depicts its front-end. The methods prototyped are:

- Rotate
- Partitioning and Projection
- Get and Set column

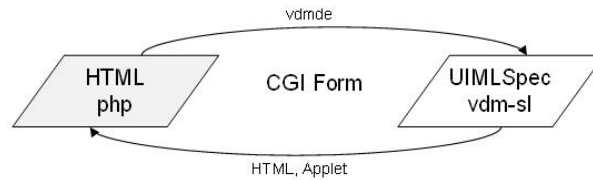


Figure 1: Prototype architecture

VDM/UIML integration

.	Color	Year	Mark	Qty
r3	Red	2004	Austin	12
r2	Red	2002	Ford	75
r1	Black	2002	Ford	100

Table Operations:

Rotate

. Col: Partitionning

Get Col: Row:

Set Col: Row: Value:

Summarize Col: Func: Max Null:

Consolidate Col: Func: Sum Null:

Mda Cols: Col: Func: sum Null:

Rows: Func: Hide

Columns: Func: Hide

.. +OLAP

Figure 2: VDM/UIML integration prototype

- Summarize
- Consolidate
- Multidimensional analysis
- Hide, Show, Add, Delete columns and rows
- Roll-Up and Drill-Down

4.1 Source code

Listing 1: PHP CGI for HTML prototype

```

2 <?php
  // -----
4 //by lufer
  // -----

```

```

    if (!session_is_registered('Me')) {
        $filearray=array();
10     session_register('Me');
        $vdm_exp="";
12     }
    else {
14         session_start();
    }
16 ?>

18 <HTML>
    <HEAD>
20     <TITLE>Table IO</TITLE>
    <link rel="stylesheet" type="text/css" href="style.css">
22 </HEAD>
    <BODY>
24 <center>
    <TABLE border="0" width="620">
26 <TR><TD>
    <H2>VDM/UIML integration </H2>
28 </TD></TR>
    <TR><TD align="center">
30 <TABLE class="vdm" cellpadding="3" cellspacing="0" border="1"
    bordercolor="#000080" style="border-collapse: collapse">

    <?PHP

    import_request_variables("gP","_");

38 //----- main -----

40 if (empty($_FirstPass)){
    global $filearray;

    if (file_exists("t.arg")) {
44     $filearray=file("t.arg");
        file2str($filearray);
46     }
    ShowForm();
48     $fp = fopen("t1.arg","w");
    fwrite($fp,$vdm_exp);
50     fclose($fp);
    }
52 else{
    if (file_exists("t1.arg")){
54     $filearray=file("t1.arg");
        file2str($filearray);
56     }
    if (!empty($_B)){
58     foreach ( $_B as $key => $value ) {
        output($key,$value,$filearray);
60     }
    }
62 }

64 exit;

//----- functions -----

function output ($key,$value,$filearray){
70     global $prefix;
        global $suffix;

```

```

72     global $vdm_exp;
       global $_row;
74     global $_col;
       global $_rowvalue, $_colvalue, $_newvalue, $_tipo, $_colTable;
76     global $_mdaType, $_mdaCols, $_mdaCol, $_mdaNull;
       global $_colfunc, $_func, $_nullvalue;
78     global $_getCol, $_getRow;
       global $_setCol, $_setRow, $_setNew;
80     global $_consCol, $_consFunc, $_consNull;
       global $_sumCol, $_sumFunc, $_sumNull;
82     global $_colOper, $_rowOper;

84     // clean strings
       $_mdaCols=clear($_mdaCols);
86     $_mdaCol=clear($_mdaCol);
       $_consCol=clear($_consCol);
88     $_sumCol=clear($_sumCol);
       $_getCol = clear($_getCol);
90     $_getRow = clear($_getRow);
       $_setCol = clear($_setCol);
92     $_setRow = clear($_setRow);
       $_setNew = clear($_setNew);
94     $_colTable = clear($_colTable);
       $_row = clear($_row);
96     $_col = clear($_col);

98     switch($key){
       case "ROTATE":
100         case "rotate":
           $fp = fopen("t1.arg","w");
102           $fp1 = fopen("tout.arg","w");
           $pref_oper="UIMLSpecAbs'rotate(";
104           $suf_oper=")";
           $vdm_exp = $pref_oper . $vdm_exp . $suf_oper;

           $prefix = "UIMLSpecAbs'outHtml(";
108           $suffix=",\`res.html\`,1)";

110           fwrite($fp1, $prefix);
           fwrite($fp1, $vdm_exp);
112           fwrite($fp1, $suffix);
           fclose($fp1);
114           fwrite($fp, $vdm_exp);
           fclose($fp);
116           exec('vdmtest tout.arg');
           ShowForm();
           break;
       case "table":
120         switch($_tipo){
           case "Part":
122             $fp = fopen("t1.arg","w");
             $fp1 = fopen("tout.arg","w");
124             $pref_oper="UIMLSpecAbs'partition(";
             $suf_oper=",{`".$_colTable.`}";
126             $vdm_exp = $pref_oper . $vdm_exp . $suf_oper;

128             $prefix = "UIMLSpecAbs'outHtml(";
             $suffix=",\`res.html\`,1)";

             fwrite($fp1, $prefix);
             fwrite($fp1, $vdm_exp);
132             fwrite($fp1, $suffix);
             fclose($fp1);
134             fwrite($fp, $vdm_exp);
             fclose($fp);
136             exec('vdmtest tout.arg');

```

```

138         ShowForm();
139         break;
140     case "Proj":
141         $fp = fopen("t1.arg","w");
142         $fp1 = fopen("tout.arg","w");
143         $pref_oper="UIMLSpecAbs 'project(";
144         $suf_oper="{ " . $_colTable."}";
145         $vdm_exp = $pref_oper . $vdm_exp . $suf_oper;
146
147         $prefix = "UIMLSpecAbs 'outHtml(";
148         $suffix=",\" res.html \",1)";
149
150         fwrite($fp1, $prefix);
151         fwrite($fp1, $vdm_exp);
152         fwrite($fp1, $suffix);
153         fclose($fp1);
154         fwrite($fp, $vdm_exp);
155         fclose($fp);
156         exec('vdmtest tout.arg ');
157         ShowForm();
158         break;
159     };
160     break;
161
162     case "MDA":
163         $fp = fopen("t1.arg","w");
164         $fp1 = fopen("tout.arg","w");
165         $pref_oper="UIMLSpecAbs 'mda[ Value ](";
166         $suf_oper="{ " . $_mdaCols."} , " . $_mdaCol." , UIMLSpecAbs ' " .
167         $_mdaType." , " . $_mdaNull." )";
168         $vdm_exp = $pref_oper . $vdm_exp . $suf_oper;
169         fwrite($fp1, "UIMLSpecAbs 'mda2html(";
170         fwrite($fp1, $vdm_exp);
171         fwrite($fp1, " , \" res.html \")");
172         fclose($fp1);
173         fwrite($fp, $vdm_exp);
174         fclose($fp);
175         exec('vdmtest tout.arg ');
176         ShowForm();
177         break;
178
179     case "Sumariz":
180         $fp = fopen("t1.arg","w");
181         $fp1 = fopen("tout.arg","w");
182         $pref_oper="UIMLSpecAbs 'summarize[ int , int ](";
183         $suf_oper=" , " . $_sumCol." , UIMLSpecAbs ' " . $_sumFunc." , " . $_sumNull." )";
184         $vdm_exp = $pref_oper . $vdm_exp . $suf_oper;
185         fwrite($fp1, "UIMLSpecAbs 'outHtmlValue(";
186         fwrite($fp1, $vdm_exp);
187         fwrite($fp1, " , \" resOper.html \")");
188         fclose($fp1);
189         fwrite($fp, $vdm_exp);
190         fclose($fp);
191         exec('vdmtest tout.arg ');
192         ShowForm();
193         break;
194
195     case "Consolid":
196         $fp = fopen("t1.arg","w");
197         $fp1 = fopen("tout.arg","w");
198         $pref_oper="UIMLSpecAbs 'consolidate[ int , int ](";
199         $suf_oper=" , " . $_consCol." , UIMLSpecAbs ' " . $_consFunc." , " . $_consNull." )";
200         $vdm_exp = $pref_oper . $vdm_exp . $suf_oper;
201         fwrite($fp1, "UIMLSpecAbs 'outHtmlValue(";
202         fwrite($fp1, $vdm_exp);

```

```

204         fwrite($fp1, ",\n" resOper . html \ " ");
           fclose($fp1);
206         fwrite($fp, $vdm_exp);
           fclose($fp);
208         exec(' vdmtest tout . arg ');
           ShowForm();
210         break;

212     case "SET":
           $fp = fopen(" t1 . arg ", "w");
214           $fp1 = fopen(" tout . arg ", "w");
           $pref_oper="UIMLSpecAbs ' setCell (" ;
216           $suf_oper=" , " . $_setRow . " , " . $_setCol . " , " . $_setNew . " ) " ;
           $vdm_exp = $pref_oper . $vdm_exp . $suf_oper ;

           $prefix = "UIMLSpecAbs ' outHtml (" ;
220           $suffix = ",\n" res . html \ " , 1 ) " ;

222           fwrite($fp1, $prefix);
           fwrite($fp1, $vdm_exp);
224           fwrite($fp1, $suffix);
           fclose($fp1);
226           fwrite($fp, $vdm_exp);
           fclose($fp);
228           exec(' vdmtest tout . arg ');
           ShowForm();
230           break;

232     case "GET":
           $fp = fopen(" t1 . arg ", "w");
234           $fp1 = fopen(" tout . arg ", "w");
           $pref_oper="UIMLSpecAbs ' getCellValue (" ;
236           $suf_oper=" , " . $_getRow . " , " . $_getCol . " ) " ;
           $vdm_exp = $pref_oper . $vdm_exp . $suf_oper ;

           $prefix = "UIMLSpecAbs ' outHtmlValue (" ;
240           $suffix = ",\n" resOper . html \ " ) " ;

242           fwrite($fp1, $prefix);
           fwrite($fp1, $vdm_exp);
244           fwrite($fp1, $suffix);
           fclose($fp1);
246           fwrite($fp, $vdm_exp);
           fclose($fp);
248           exec(' vdmtest tout . arg ');
           ShowForm();
250           break;

252     case "ROWOPER":
           switch($_rowOper){
254             case "hide":
                   $fp = fopen(" t1 . arg ", "w");
256                   $fp1 = fopen(" tout . arg ", "w");
                   $pref_oper="UIMLSpecAbs ' hideRow (" ;
258                   $suf_oper=" , " . $_row . " ) " ;
                   $vdm_exp = $pref_oper . $vdm_exp . $suf_oper ;

                   $prefix = "UIMLSpecAbs ' outHtml (" ;
262                   $suffix = ",\n" res . html \ " , 1 ) " ;

264                   fwrite($fp1, $prefix);
                   fwrite($fp1, $vdm_exp);
266                   fwrite($fp1, $suffix);

268                   fclose($fp1);
                   fwrite($fp, $vdm_exp);

```

```

270         fclose($fp);
          exec('vdmtest tout.arg');
272         ShowForm();
          break;
274     case "show":
          $fp = fopen("t1.arg","w");
276         $fp1 = fopen("tout.arg","w");
          $pref_oper="UIMLSpecAbs'showRows(";
278         $suf_oper=")";
          $vdm_exp = $pref_oper . $vdm_exp . $suf_oper;

          $prefix = "UIMLSpecAbs'outHtml(";
282         $sufix=",\res.html\",1)";

284         fwrite($fp1,$prefix);
          fwrite($fp1,$vdm_exp);
286         fwrite($fp1,$sufix);

288         fclose($fp1);
          fwrite($fp,$vdm_exp);
290         fclose($fp);
          exec('vdmtest tout.arg');
292         ShowForm();
          break;
294     case "add":
          $fp = fopen("t1.arg","w");
296         $fp1 = fopen("tout.arg","w");
          $pref_oper="UIMLSpecAbs'addRow(";
298         $suf_oper="," . $_row."{)";
          $vdm_exp = $pref_oper . $vdm_exp . $suf_oper;

          $prefix = "UIMLSpecAbs'outHtml(";
302         $sufix=",\res.html\",1)";

304         fwrite($fp1,$prefix);
          fwrite($fp1,$vdm_exp);
306         fwrite($fp1,$sufix);

308         fclose($fp1);
          fwrite($fp,$vdm_exp);
310         fclose($fp);
          exec('vdmtest tout.arg');
312         ShowForm();
          break;
314     case "del":
          $fp = fopen("t1.arg","w");
316         $fp1 = fopen("tout.arg","w");
          $pref_oper="UIMLSpecAbs'dellRow(";
318         $suf_oper="," . $_row.")";
          $vdm_exp = $pref_oper . $vdm_exp . $suf_oper;

          $prefix = "UIMLSpecAbs'outHtml(";
322         $sufix=",\res.html\",1)";

324         fwrite($fp1,$prefix);
          fwrite($fp1,$vdm_exp);
326         fwrite($fp1,$sufix);
          fclose($fp1);
328         fwrite($fp,$vdm_exp);
          fclose($fp);
330         exec('vdmtest tout.arg');
          ShowForm();
332         break;
    };break;
334 case "COLOPER": switch ($_colOper){
        case "hide":

```

```

336     $fp = fopen("t1.arg","w");
337     $fp1 = fopen("tout.arg","w");
338     $pref_oper="UIMLSpecAbs'hideCol(";
339     $suf_oper="," . $_col.");";
340     $vdm_exp = $pref_oper . $vdm_exp . $suf_oper;

342     $prefix = "UIMLSpecAbs'outHtml(";
343     $suffix=",\"res.html\",1)";

346     fwrite($fp1,$prefix);
347     fwrite($fp1,$vdm_exp);
348     fwrite($fp1,$suffix);

350     fclose($fp1);
351     fwrite($fp,$vdm_exp);
352     fclose($fp);
353     exec('vdmtest tout.arg');
354     ShowForm();
355     break;
356 case "show":
357     $fp = fopen("t1.arg","w");
358     $fp1 = fopen("tout.arg","w");
359     $pref_oper="UIMLSpecAbs'showCol(";
360     $suf_oper="," . $_col.");";
361     $vdm_exp = $pref_oper . $vdm_exp . $suf_oper;

363     $prefix = "UIMLSpecAbs'outHtml(";
364     $suffix=",\"res.html\",1)";

367     fwrite($fp1,$prefix);
368     fwrite($fp1,$vdm_exp);
369     fwrite($fp1,$suffix);

371     fclose($fp1);
372     fwrite($fp,$vdm_exp);
373     fclose($fp);
374     exec('vdmtest tout.arg');
375     ShowForm();
376     break;
377     break;
378 case "add":
379     $fp = fopen("t1.arg","w");
380     $fp1 = fopen("tout.arg","w");
381     $pref_oper="UIMLSpecAbs'addCol(";
382     $suf_oper="," . $_col.",{)";
383     $vdm_exp = $pref_oper . $vdm_exp . $suf_oper;

385     $prefix = "UIMLSpecAbs'outHtml(";
386     $suffix=",\"res.html\",1)";

389     fwrite($fp1,$prefix);
390     fwrite($fp1,$vdm_exp);
391     fwrite($fp1,$suffix);

393     fclose($fp1);
394     fwrite($fp,$vdm_exp);
395     fclose($fp);
396     exec('vdmtest tout.arg');
397     ShowForm();
398     break;
399 case "addN":
400     $fp = fopen("t1.arg","w");
401     $fp1 = fopen("tout.arg","w");
402     $pref_oper="UIMLSpecAbs'addColls(";
403     $suf_oper="," . $_col.");";
404     $vdm_exp = $pref_oper . $vdm_exp . $suf_oper;

```



```

404         $prefix = "UIMLSpecAbs'outHtml(";
         $suffix=",\\"res.html\",1)";

406         fwrite($fp1,$prefix);
         fwrite($fp1,$vdm_exp);
408         fwrite($fp1,$suffix);

410         fclose($fp1);
         fwrite($fp,$vdm_exp);
412         fclose($fp);
         exec('vdmtest tout.arg');
414         ShowForm();
         break;

416     };
    break;

    case "reset":
420         $fp = fopen("resOper.html","w");
         fclose($fp);
422         exec('vdmtest t0.arg');
         ShowForm();
424         $vdm_exp="";
         $filearray=file("t.arg");
426         file2str($filearray);
         $fp = fopen("t1.arg","w");
428         fwrite($fp,$vdm_exp);
         fclose($fp);
430         break;
    }

}

436 //-----

438 function body($fp,$filearray){
    while(list($oneline)=each($filearray)){
440         fwrite($fp,$oneline);
    }
442 }

444 //-----

446 function file2str($filearray){
    global $vdm_exp;
448     while(list($oneline)=each($filearray)){
        $vdm_exp .= $oneline;
450     }
}

//-----

//remove character \
456 function clear($x)
{
458     $x = ereg_replace("[\\]", "", $x);
    return(trim($x));
460 }

462 //-----

464 function ShowForm() {
    global $PHP_SELF;

?>

```

```

468 <?
    if ( file_exists (" res . html ")){
470         include (" res . html " );
    }
472 else {
        include (" res - i . html " );
474     }

476 if ( file_exists (" resOper . html " )) { include (" resOper . html " );}

478 $HTML=<<<HTML
    </tr ></table >
480 <center >
    <br />
482 <p >
    <FORM ACTION =" $PHP_SELF ">
484     <INPUT TYPE =" HIDDEN " NAME =" FirstPass " VALUE =" No ">
        <p >
486         <hr >
            <table class =" oper " cellSpacing =" 1 " cellPadding =" 1 " border =" 0 "
488             style =" border : 2px solid #000000 ">

490         <tr >
            <td colspan = 3 ><b >Table Operations :</b ></td >
492         </tr >
            <tr ><td >Rotate </td >
494         <td ><input type =" image " src =" web . gif " height =" 20 " width =" 20 "
            border =" 0 " Alt =" Submit " name =" B [ ROTATE ] "></td >
496         </tr >
            <tr >
498         <tr ><td >.</td >
            <td >Col :<input type =" text " name =" colTable " size =" 5 "></td >
500         <td >
            <select name =" tipo ">
502             <option value =" Part ">Partitionning </option >
            <option value =" Proj ">Projection </option >
504         </select >
            </td >
506         <td ><input type =" image " src =" web . gif " height =" 20 " width =" 20 "
            border =" 0 " Alt =" Submit " name =" B [ table ] "></td >

            <tr >
510             <td >Get </td >
                <td >Col :<input type =" text " name =" getCol " size =" 5 "></td >
512                 <td >Row :<input type =" text " name =" getRow " size =" 5 "></td >
                <td ><input type =" image " src =" web . gif " height =" 20 " width =" 20 "
514                 border =" 0 " Alt =" Submit " name =" B [ GET ] "></td >
            </tr >

            <tr >
518             <td >Set </td >
                <td >Col :<input type =" text " name =" setCol " size =" 5 "></td >
520                 <td >Row :<input type =" text " name =" setRow " size =" 5 "></td >
                <td >Value :<input type =" text " name =" setNew " size =" 5 "></td >
522                 <td ><input type =" image " src =" web . gif " height =" 20 " width =" 20 "
                    border =" 0 " Alt =" Submit " name =" B [ SET ] "></td >
524             </tr >

526         <tr >
            <td >Summarize </td >
528             <td >Col :<input type =" text " name =" sumCol " size =" 5 "></td >
                <td >Func :
530                 <select name =" sumFunc ">
                    <option value =" max ">Max </option >
532                     <option value =" min ">Min </option >
                </select >

```

```

534     </td>
        <td>Null:<input type="text" name="sumNull" size="5"></td>
536 <td><input type="image" src="web.gif" height="20" width="20"
        border="0" Alt="Submit" name="B[ Sumariz]"></td>
538 </tr>
<tr>
540 <td>Consolidate </td>
        <td>Col:<input type="text" name="consCol" size="5"></td>
542 <td>Func:
        <select name="consFunc">
544         <option value="sum">Sum</option>
            <option value="avg">Avg</option>
546         <option value="count">Count</option>
        </select>
548 </td>
        <td>Null:<input type="text" name="consNull" size="5"></td>
550 <td><input type="image" src="web.gif" height="20" width="20"
        border="0" Alt="Submit" name="B[ Consolid]"></td>
552 </tr>

554 <!--MDA -->
<tr>
556 <td>Mda</td>
        <td>Cols:<input type="text" name="mdaCols" size="15"></td>
558         <td>Col:<input type="text" name="mdaCol" size="5"></td>
            <td>Func:
560             <select name="mdaType">
                <option value="sum">sum</option>
562                 <option value="avg">avg</option>
            </select>
564 </td>
            <td>Null:<input type="text" name="mdaNull" size="5"></td>
566 <td><input type="image" src="web.gif" height="20" width="20"
        border="0" Alt="Submit" name="B[MDA]"></td>
568 </tr>

570 <tr><td colspan=6><hr></td></td>
<tr>
572 <td>Rows: </td>
        <td><input type="text" name="row" size="5"></td>
574 <td>Func:
        <select name="rowOper">
576         <option value="hide">Hide</option>
            <option value="show">Show</option>
578         <option value="add">Add</option>
            <option value="del">Del</option>
580 </select>
        </td>
582 <td><input type="image" src="web.gif" height="20" width="20"
        border="0" Alt="Submit" name="B[ROWOPER]"></td>
584 </tr>

586 <tr>
        <td>Columns: </td>
588 <td><input type="text" name="col" size="5"></td>
        <td>Func:
590         <select name="colOper">
            <option value="hide">Hide</option>
592             <option value="show">Show</option>
            <option value="add">Add</option>
594 </select>
        </td>
596 <td><input type="image" src="web.gif" height="20" width="20"
        border="0" Alt="Submit" name="B[COLOPER]"></td>
598 </tr>

```

```

600 <tr>
      <td>..</td>
602 <td><input type="submit" value="reset" name="B[reset]"></td>
      <td><a href="entrada1.php">+OLAP</a></td>
604 </tr>
      </table>
606 </p>
      HTML;
608 echo $HTML;
      } # End of function ShowForm

      ?>
612 </TR></TR></TABLE>
      </center>
614 </BODY>
      </HTML>

```

4.2 Prototype settings and requirements

Our prototype works on *Windows* platform with any *httpd* server (we used IIS) which allow PHP processing. There are some particular files to system configuration and particular scripts (batch files) to support the process.

It is necessary to have VDM-SL installed as well as Harmonia UIML rendering engines (<http://www.harmonia.com>) mainly *u2ji* (java rendering), *u2h* (HTML rendering) and *u2w* (WML rendering).

Once installed UIML renderers, one must set windows system variables according to *Harmonia* documentation (<http://www.harmonia.com/products/index.htm>). *Harmonia LiquidUI* browser (trial release) is also important to be installed. Once expired, one can contact directly *Harmonia* (support@harmonia.com) to get an academic license.

Listing 2: *vdmtest.bat*: UIML VDM-SL testing batch file

```

@echo off
2 rem Tests the UIML specification for one test argument

4 rem -- Output the argument to stdout (for redirect) and
  rem -- "con" (for user feedback)
6 echo VDM Test: '%1' > con
  echo VDM Test: '%1'

  rem Assumes specification in Word RTF Format. Change below if otherwise.

  set SPEC=UIMLSpec30.vdm
12 set SPEC1=VDM2UIML.vdm
  set IO=io.vdm
14 set TC= UIML.tc

16 PATH = %SYSTEMROOT%\SYSTEM32;%SYSTEMROOT%;%SYSTEMROOT%\SYSTEM32\WBEM;
  PATH = %PATH%;D:\TEXMF\MIKTEX\BIN;H:\PROGRAM FILES\THE IFAD VDM-SL TOOLBOX V3.7.2\BIN

  vdmde -i -P -R %TC% -O %1.res %1 %SPEC1% %SPEC% %IO%

  rem -- Check for difference between result of execution and
22 rem -- expected result.

24 if EXIST %1.exp fc /w %1.res %1.exp

26 :end

```

 Listing 3: Batch file to renderer Java from UIML

```
u2ji %1
```

 Listing 4: Java Applet viewer from UIML

```
appletviewer -J-Djava.security.policy=.java.policy resJava.html
```

 Listing 5: *final.prj*: VDM-TOOLS project

```
b6,k11,ProjectFilef3,f3,e2,m4,filem42,io.vdme2,m4,filem50,
2 UIMLSpec30.vdme2,m4,filem56,TableIOCaseStudy.vdm
```

 Listing 6: VDM-TOOLS utilization

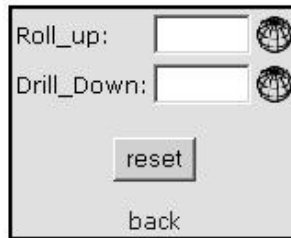
```
2 1 - start VDM-SL ToolBox
4 2 - Load project final.prj
6 3 - Open Interpreter window:
8     a) init
10    b) push UIMLSpecTab
12    c) now any command can be test. Examples:
14        - p t
          - p outHtml(t,"file.html",1)
```


4.3 Some frontend results


Next figures depict the results of applying the main OLAP features over initial data set.

VDM/UIML integration

.	Type	City	Qty
r4	15	Coimbra	10
r3	14	Lisboa	12
r2	13	Braga	75
r1	12	Porto	100



Roll_up: 

Drill_Down: 

back

Figure 3: VDM/UIML integration test case - OLAP

VDM/UIML integration

.	r3	r2	r1
Color	Red	Red	Black
Year	2004	2002	2002
Mark	Austin	Ford	Ford
Qty	12	75	100

Figure 4: Rotation operation

VDM/UIML integration

City	Qty
North	175
South	25
Center	10

Figure 5: Roll-Up operation

VDM/UIML integration

.	Color	Year	Mark	Qty
r3	Red	2004	Austin	12
r2	Red	2002	Ford	75
r1	Black	2002	Ford	100

187

Figure 6: Consolidation operation (*sum of Qty*)

VDM/UIML integration

.	r2
Color	Red
Year	2002
Mark	Ford
Qty	75

Figure 7: Projection ("r3") after Rotation operation

VDM/UIML integration

.	Color	Year	Mark
r3	Red	2004	Austin
r2	Red	2002	Ford
r1	Black	2002	Ford

Figure 8: Hiding column operation

VDM/UIML integration

.	Color	Year	Mark	Qty
r2	Red	2002	Ford	75
r1	Black	2002	Ford	100

Figure 9: Hiding row operation

VDM/UIML integration

.	Teste	Color	Year	Mark	Qty
r3	[]	Red	2004	Austin	12
r2	[]	Red	2002	Ford	75
r1	[]	Black	2002	Ford	100

-

Figure 10: Add column operation ("Teste")

VDM/UIML integration

.	Color	Year	Mark	Qty
r3	Yellow	2004	Austin	12
r2	Red	2002	Ford	75
r1	Black	2002	Ford	100

-

Figure 11: Set cell value (r3,Color)="yellow"

VDM/UIML integration

.	Color
r3	Red
r1	Black

-

Col: "Color" Partitionning

Figure 12: Partition operation on Color column

VDM/UIML integration

.	Color	Year	Mark	Qty
r3	Red	2004	Austin	12
r2	Red	2002	Ford	75
r1	Black	2002	Ford	100

100

Col: "Qty" Func: Max Null: 0

Figure 13: Summarize operation on Qty column

VDM/UIML integration

Mark	Qty
Ford	87.5
Austin	12

-

Cols: "Qty","Mark" Col: "Qty" Func: avg Null: 0

Figure 14: Multidimensional Analysis (average) over Qty