Modularization of Multimodal Interaction Specification

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1 Introduction

Modularization of dialogue systems

- Necessary as complexity increases

Advantages

- Encapsulation of Knowledge

  System resources: Reusability of components

  Human resources: Divide development by discipline
- Structured system development

  Explicit integration points

1 Introduction

Problems:

- Dialogue Management not well-defined task
- No generally agreed-upon architecture

Consequence:

- An attempt to encapsulate a dialogue manager in an API will be difficult!

- So, let's try something else…

1 Scope of this presentation

Modular specification of interaction management

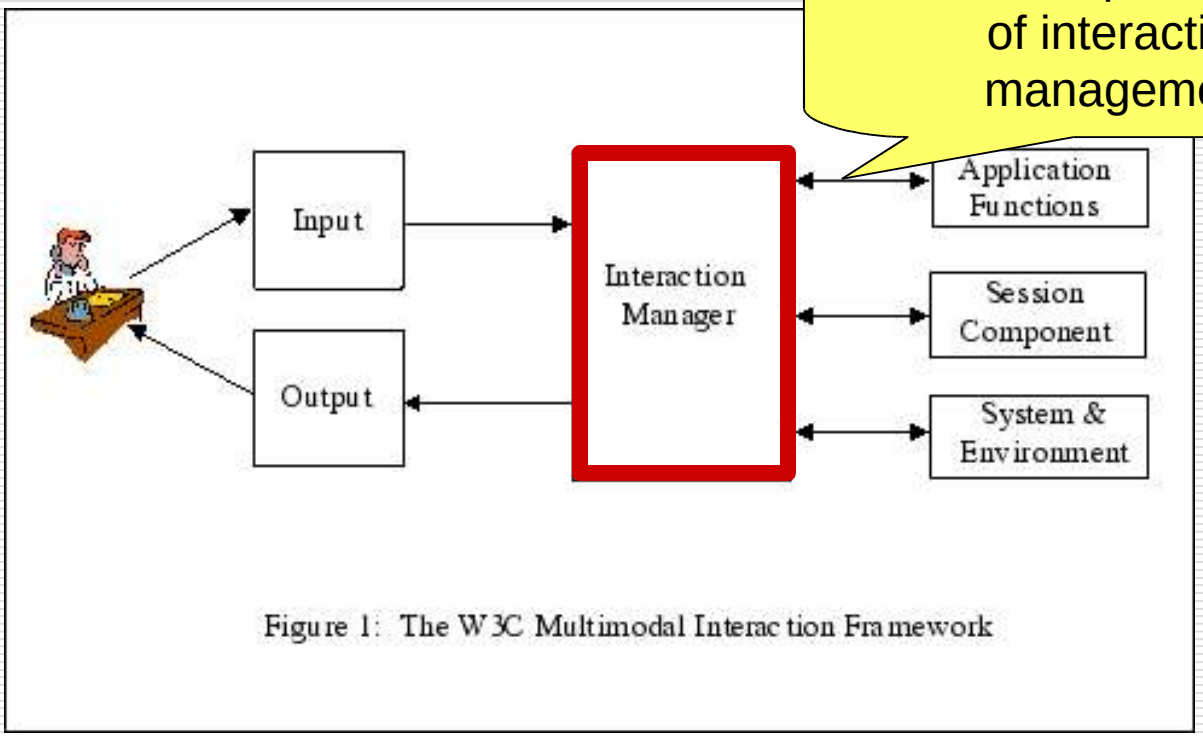
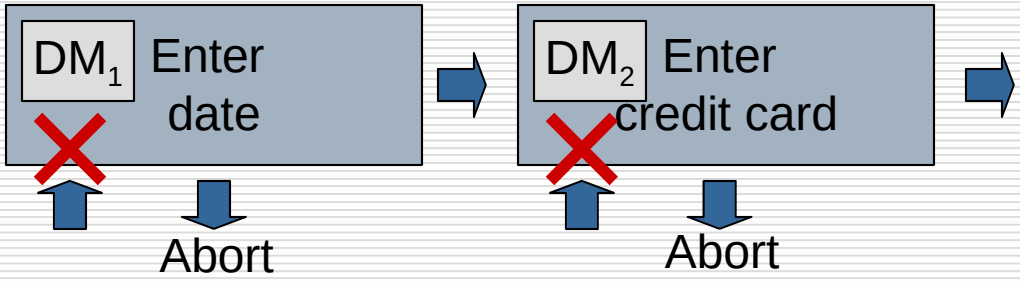


Figure 1: The W3C Multimodal Interaction Framework

2 Modularity in Dialogue Systems

Dialogue Objects

- Prepackaged dialogue subsystems
- Reusability of application components

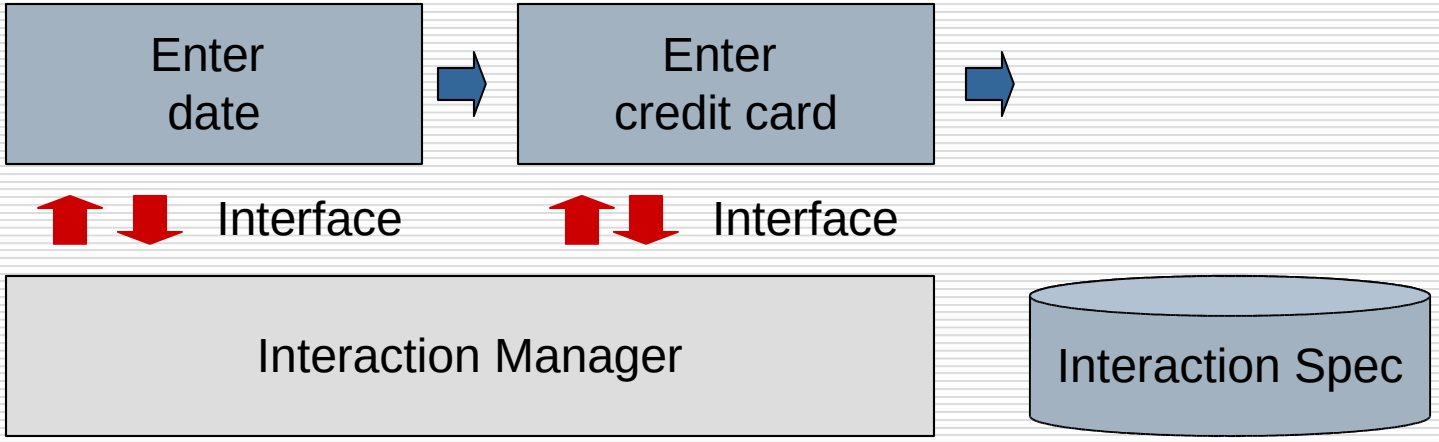


Disadvantages:

- Black box ↙ does not address crosscutting concerns
- Difficult to express dialogue strategies across several components

2 Modularity in Dialogue Systems

What we would like to have is…



2 Modularity in Web pages

HTML and Cascading Style Sheets

Separate:

- What is presented (HTML)
- How it is presented (CSS)

Interface:

- Tag names, class labels

Style sheets cut across multiple web pages

2 HTML and CSS Example

```
<div class="main">
 <h1 class="header1">W3C Workshop</h1>
 The <a class="link1" href="http://www.w3c.org">W3C</a>
 workshop takes place on <em class="em1">July 19 and 20</em>
 in <em class="em2">Sophia Antipolis</em>.
</div>
```

Tag + class

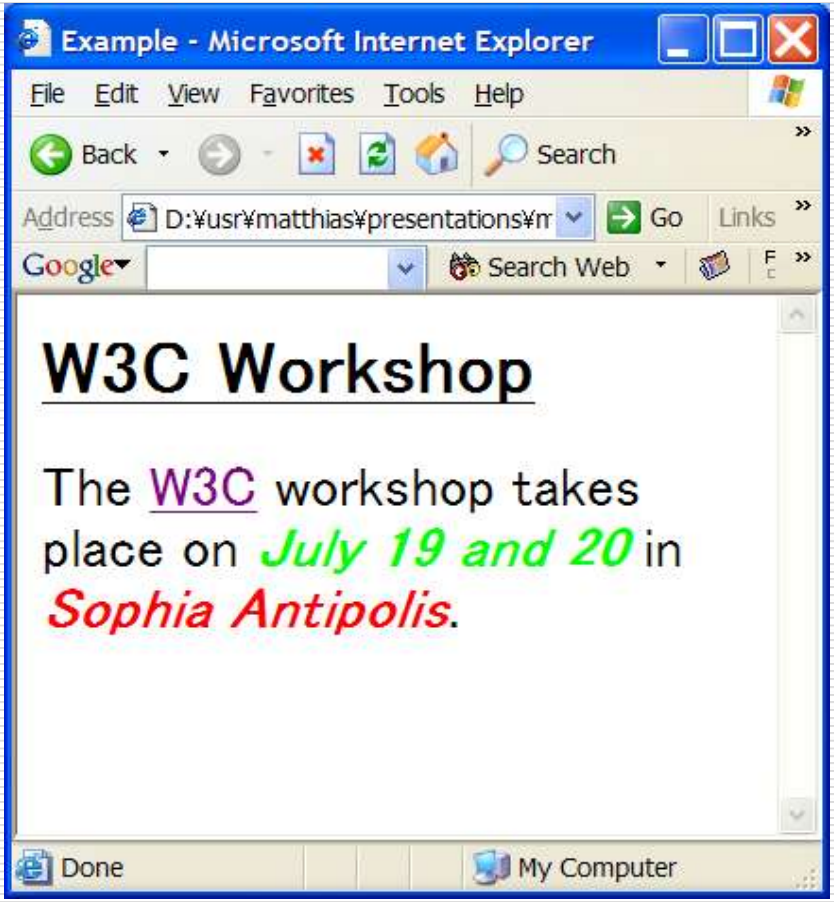
Tag + class

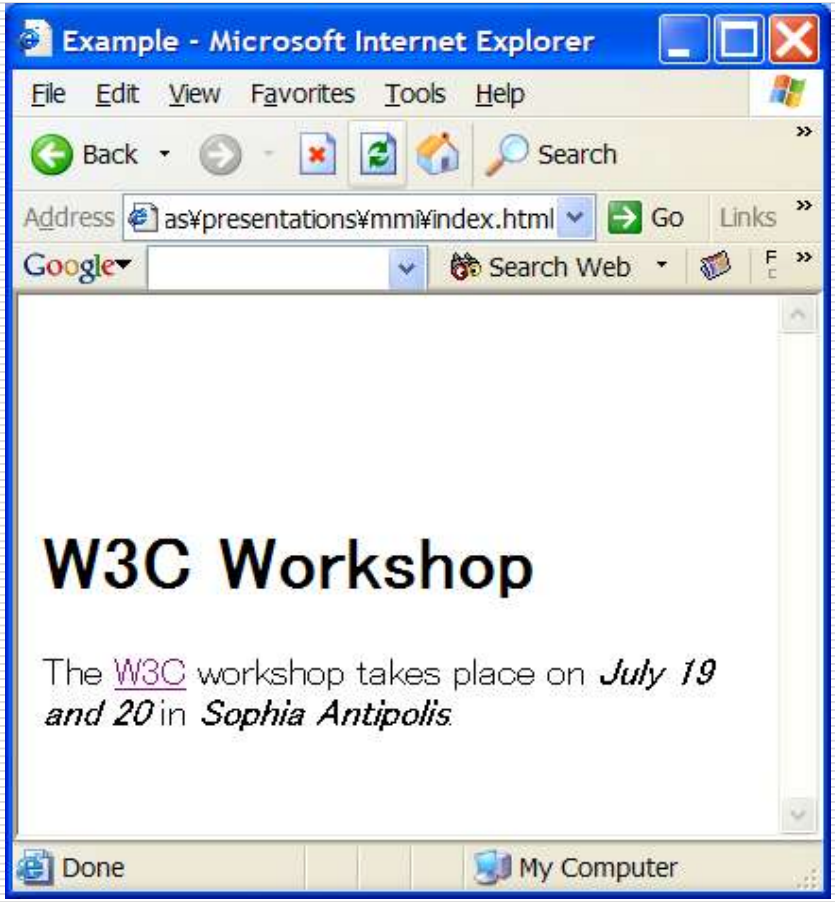
```
div.main {
  font-size:large
}
a.link1:link {
  color: #333399
}…
```

Tag + class

```
div.main {
  position:absolute;
  left:10; top:300;
}
a.link1:link {
  color: #333399;
}…
```

2 HTML and CSS Example





3 How about Dialogue Systems?

In multimodal dialogue systems:

Can we separate, similar to HTML and CSS,

5. What we talk about

- Credit card
- Date,…

from

9. How we talk about it?

- What is the date?
- Please enter the date on the number pad

3 Examples

If one slot has been prompted twice, and remains unfilled or with low confidence, abort the dialogue

If the last two times speech was used a problem occurred, actively suggest to use a different input channel

If the user asks for help more than twice, switch modes

3 Proposal for a Framework

Three things needed:

2. Content specification (~ HTML)

   Assuming: something like RDFS + RDF

3. Interface declaration (~ Tags + classes)

   Introduce vocabulary 1. + 3. can use

   Schema-like document

4. Interaction specification (~ CSS)

   Specify dialogue management

3 Content Representation (~HTML)

RDFS: modularized vocabulary

- Common upper ontology
- Domain specific concepts

Annotated with facets (Denecke & Yang 2000)

- ~EMMA+abstraction, partial order
- Numeric intervals and symbols

act_getinfo, high, once
ARG obj_flight, high, once, sp + gst
DEP date, high, once
DAY 17th, low, twice, sp
MON Oct, low, twice, gst

Confidence
times prompted
Input channels

3 Interface Declaration (~Class labels)

Introduce shared vocabulary containing

1. Facets
2. Common Upper Ontology
3. Abstract dialogue state (Denecke 2000)

Abstract Dialogue State

- Collection of features describing dialogue state
- Aggregate information in facets, content
  1) Over time
  2) Over location in representations

3 Abstract Dialogue State (~Classes)

Example:

- # slots w/ low confidence in this turn
- # slots w/ low confidence up until now
- # times speech used
- # times handwriting used
- # corrections in speech channel
- # corrections in handwriting channel

3 Interaction Specification (~CSS)

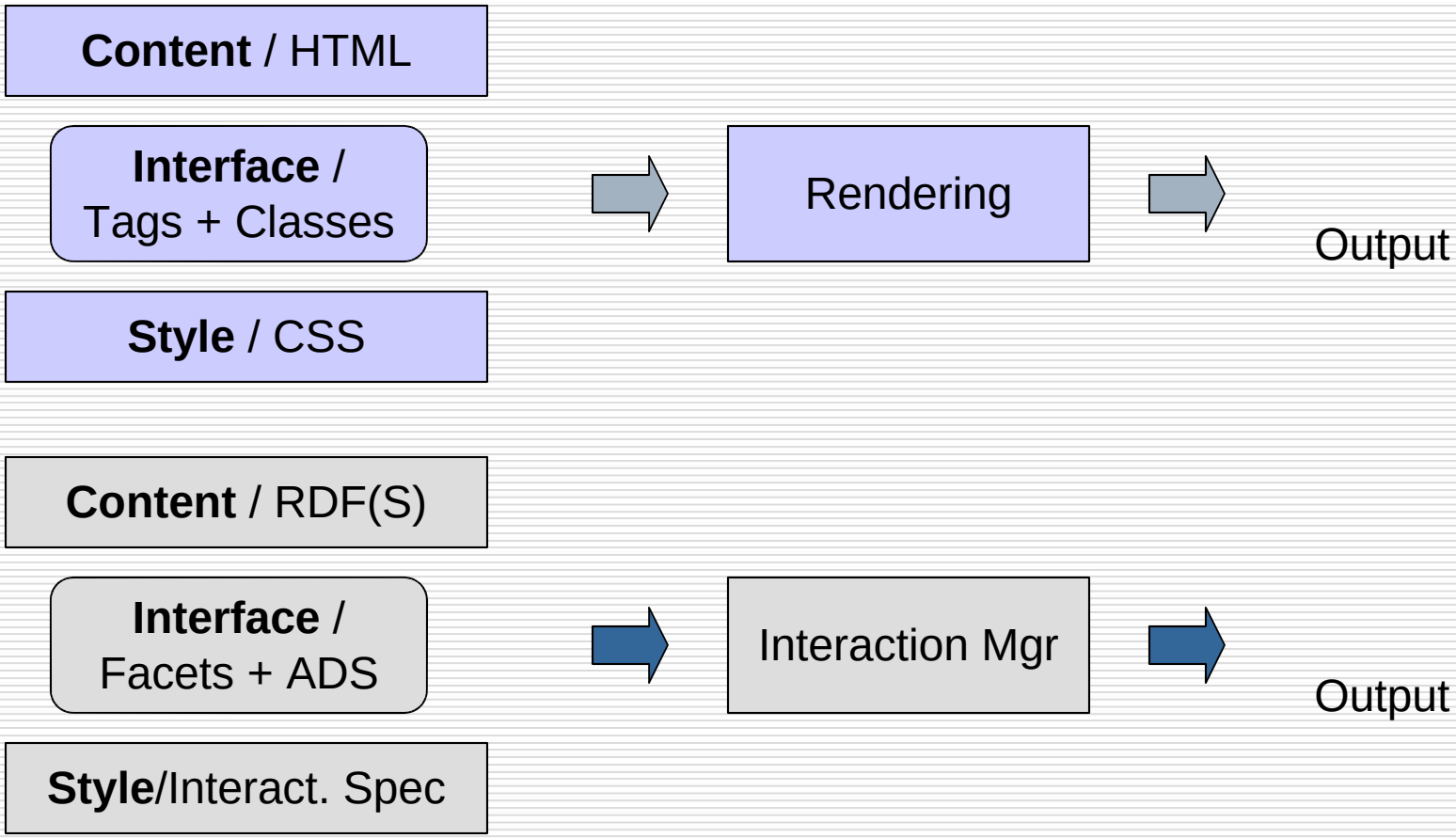
Concrete representations hidden

- Use ADS, facets, Common Ontology only
- Proprietary implementations encapsulated

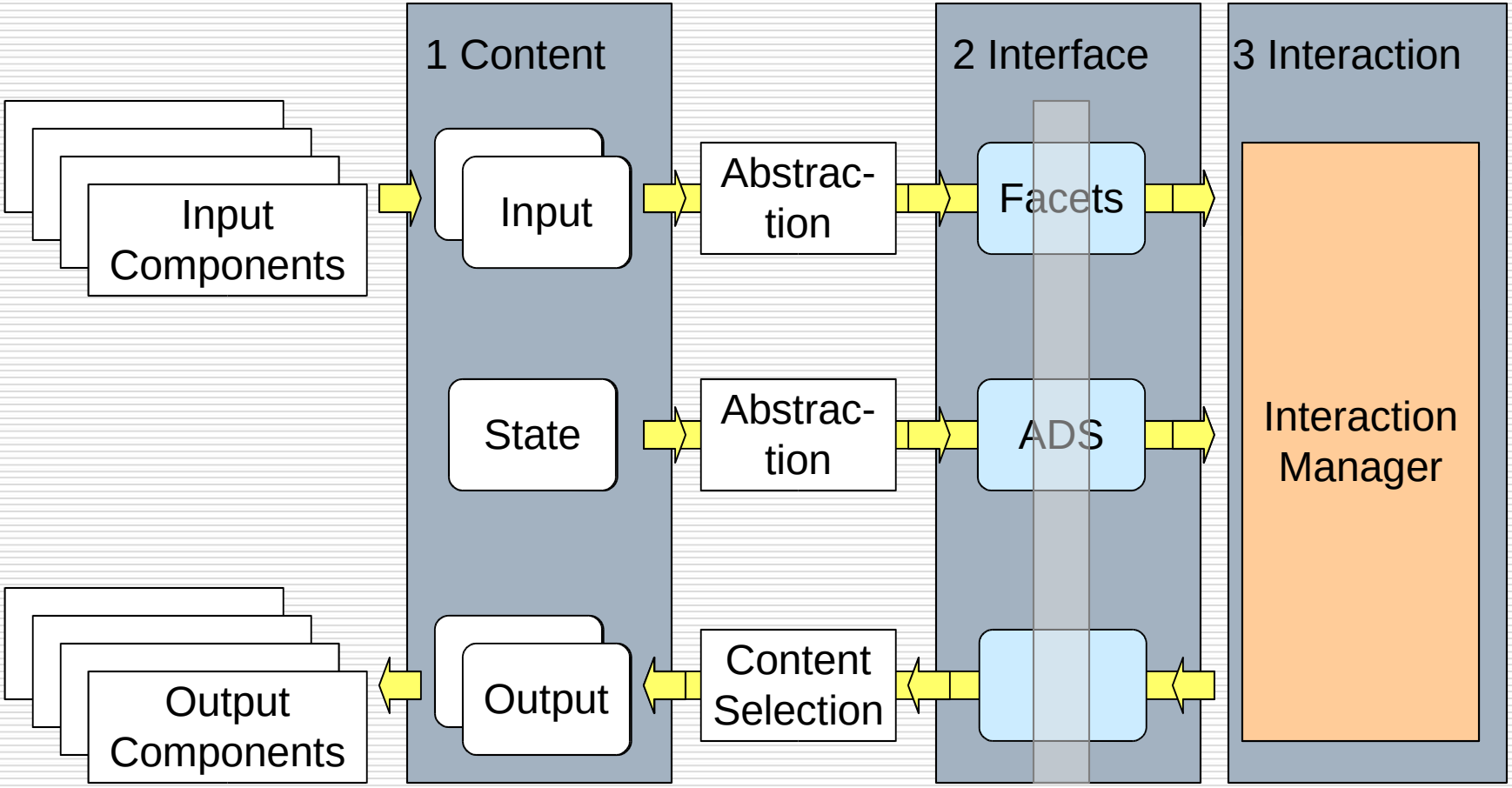
Express interaction management

- In terms of vocabulary defined in interface
  - Interface spec encourages reusability, but
  - Designer determines degree of domain dependence
- Overcomes difficulties of API approach

3 Comparison



3 Multimodal Interaction Framework



4 Implementation of Interaction Mgr

IM can be seen as

- f: ADS x Input ↙ Output

Two ways:

1. Fix f, specify parameters

   $f_{<Parms>}$: ADS x Input ↙ Output

2. f becomes parameter to Interpretation Mgr

   Provide API or scripting language to access facets, ADS, ontology

4 Interaction Implementation Way 1

Generic multimodal algorithm $f_{<Parms>}$

- Parametrized by domain specific information
- Cf VoiceXML

Features:

- Control over application specification

  Given by parameters
- Closed system
- Tool support easy, but too limited?

4 Interaction Implementation Way 2

No generic algorithm

- Provide access to ADS, facets
- Implement own IM

Features:

- No control over application specification

  Can be anything: rule based, learned,…
- Open system
- More complex

5 Example 1

If one slot has been prompted twice, and remains unfilled or with low confidence, abort the dialogue

```
If (exists path(p) :
      #prompts(p) == 2 &&
      (confidence(p) == low ||
       filler(p) == nil)
Then
    abort();
```

Blue : facets

5 Example 2

If the confidence of the last utterance is low, and the used channel is unreliable, suggest another channel

```
Confidence($lastUtterance) == low

ChannelRel($lastChannel) ∋
   unreliable
```

red : ADS variables

5 Applications: Channel Management

Observations:

1. Initial use establishes suboptimal patterns (Bhavnani 2000)
2. Multiple input channels:
   - Compensate for imperfect input
   - Quality of input component hidden

Input Channel Management necessary

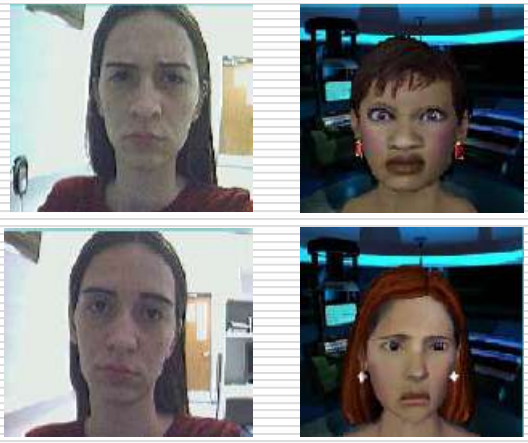
1. Control interaction (vocabulary size)
2. Suggest alternative input channels

5 Applications: Affective Interfaces

Affective Interfaces (Picard 1997)

- React to users' changing emotions
  - Encapsulate appropriate reactions

- Areas:
  - Telemarketing
  - Health care
  - User interfaces…



Empathic avatar
(Lisetti et al, 2003)

5 Applications: Virtual Personalities

Specify character in Interaction Manager

Applications:

- Education / Tutoring systems
  Didactic vs socratic teaching
  (Fiedler 2003)
- Games
- Marketing

www.yellostrom.de

6 What has been done?

Some ideas implemented

- Unimodal systems
- Facets, ADS work together with reinforcement learning (Denecke et al 2004)
- Facets, ADS allow encapsulation of rule-based dialogue strategies (Denecke et al 2003)
- Open source system www.opendialog.org

6 What is missing?

Examples require increasingly complex abstractions

- Can they be found?
- Can they be expressed in the interface declaration?
- Do they capture necessary information?

Abstractions needed for input and output

Summary

- Need for modularization in interaction mgmt
- Existing approaches insufficient
- Proposal motivated by HTML + CSS

  Allows cross cutting across application

  Requires appropriate abstractions

Thank you!

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