Joint handling of Rational and Behavioral reactions in Assistant Conversational Agents

Jean-Paul Sansonnet François Bouchet

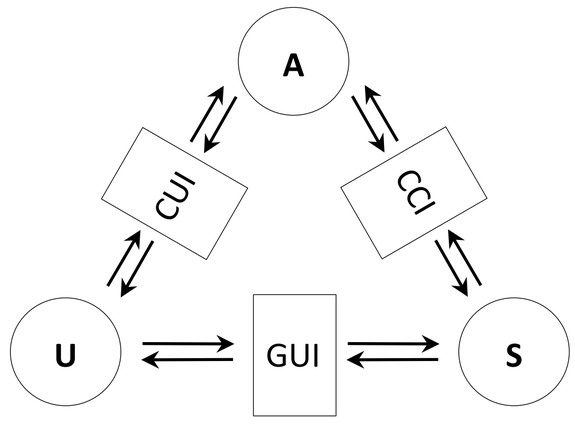
Introduction

Context: Assistant Conversational Agents (ACA)
assistant: rational agents to assist novice users
conversational: virtual characters, personality, multimodality ($\subset$ NL)

Classic Architecture: 3 actors, 3 bilateral interaction interfaces

Actors:
U **User** (Human person)
S **System** (Computer application)
A **Agent** (Software tool)

Interfaces:
GUI Graphical User Interface
CUI Conversational User Interface
CCI Control Command Interface



Issue: different roles (presenter, help, companion, coach...)
$\Rightarrow$ different behaviors expected, taking psychology into account,
$\Rightarrow$ impact even on rational decisions.

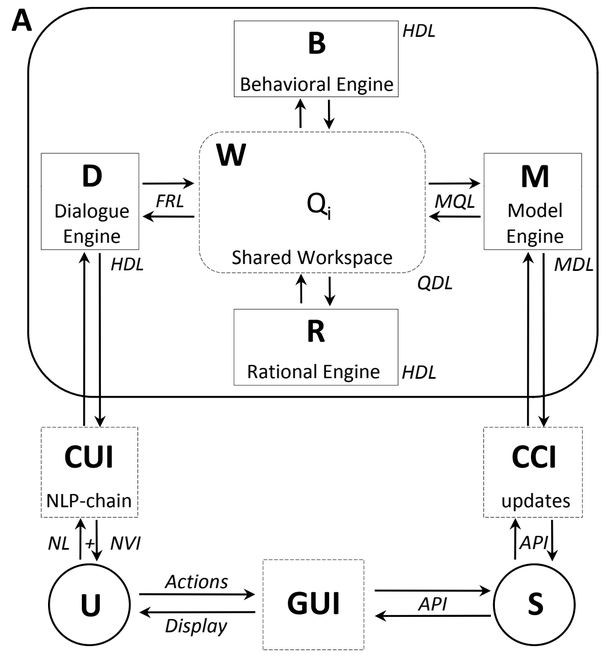
Objective: architecture with intertwined psychology and rationality.

The R&B Framework

U **User**
S **System**
A **Agent**
W **Workspace**
R **Rational Engine**
B **Behavioral Engine**
D **Dialogue Engine**
M **Model Engine**

GUI **Graphical user Interface**
CUI **Conversational User Interface**
CCI **Control/Command Interface**

NL Natural Language
NVI Non Verbal Interaction
FRL Formal Request Language
MDL Model Description Language
MQL Model Query Language
HDL Heuristic Description Language
QDL Query Description Language
API Application Programming Interface
Q_i Query objects
NLP-chain Natural Language Processing chain



- Rational and Behavioral architecture, based on:
  - **Principle of separation:** rational and behavioral heuristics are:
    - designed separately;
    - executed concurrently on separated engines R and B;
    - experimented separately or together.
  - **Principle of genericity:** a case study $\Leftrightarrow <$ *Policy*, *Situation* $>$:
    - *Policy* is related to:
      - the heuristic management in engines R and B,
      - the query management in the shared workspace W.
    - *Situation* depends on the user-agent (U-A) relationship
- Here, we consider Situation = "strict help agent",
  i.e. U interacts with S and A is ignored unless "things go wrong"
- In this situation, we have the following workflow:

$$\mathtt{U} \overset{NL}{\Rightarrow} \mathtt{CUI} \overset{NL+}{\rightarrow} \mathtt{D} \xrightarrow[[FRL]]{QDL} \left(\mathtt{B|R} \xrightarrow[[MQL]]{QDL} \mathtt{M} \xrightarrow[[MQL]]{QDL} \mathtt{B|R} \right)^{*} \xrightarrow[[FRL]]{QDL} \mathtt{D} \overset{NL}{\rightarrow} \mathtt{CUI} \overset{NL}{\Rightarrow} \mathtt{U}$$

with optional system updates: $\left(\mathtt{M} \xrightarrow{\text{API}} \mathtt{CCI} \Rightarrow \mathtt{S} \right)^{*}$

where $\xrightarrow[[X]]{QDL}$ = a request written in *X* is wrapped into a *QDL* query.

Query Description Language (QDL)

Query = element of W wrapping a *FRL* or *MQL* request + attributes.

$$Q_i = [\text{value}[\{r|\{r_i\}], \text{history}[\{\mathtt{D},\mathtt{R},\ldots\}], \text{to}[\mathtt{M}], \text{status}[+]]$$
$$= Q_i.\text{value}^{Q_i.\text{status}}_{Q_i.\text{history}|Q_i.\text{to}} = \{r_1,\ldots,r_n\}^{+}_{\{\mathtt{D},\mathtt{R},\ldots\}|\mathtt{M}} \quad \text{(shortened)}$$

- i $\in \mathbb{N}^+$ is the absolute identifier of the query in the session
- value contains one or several *FRL* | *MQL* requests
- history $\in \{\mathtt{D},\mathtt{R},\mathtt{B},\mathtt{M}\}^*$ is the stack of engines that handled Q_i
- to $\in \{\mathtt{D},\mathtt{R},\mathtt{B},\mathtt{M}\}$ is the next engine meant to retrieve Q_i
- status $\in [\emptyset,-,+]$ shows the success of the latest handling of Q_i

Heuristic Description Language (HDL)

Heuristic = definition of R or B reaction to a class of *QDL* requests.

H : id[QDL pattern]:–{GuardedScript$_1$, ..., GuardedScript$_n$}
GuardedScript $\equiv$ {Guard$_1$ $\rightarrow$ Script$_1$, ..., Guard$_n$ $\rightarrow$ Script$_n$}
Guard$_i$ $\equiv$ Logical expr | $\emptyset$ ($\emptyset$ = True)
Script$_i$ $\equiv$ Instruction | {Instruction$_1$, ..., Instruction$_n$}
Instruction$_i$ $\equiv$ Basic operation | Query call | GuardedScript
Query call $\equiv$ *Q*[Query id, {*FRL* req | *MQL* req}]

Heuristic Scheduler (HS)

HS defines coroutining *Policy* of the different heuristics:

- within a heuristic *H*, priority between GuardedScripts:
  - guards overlap $\Rightarrow$ execution policies
  - guard remains active $\Rightarrow$ repetition policies
- within a case study, priority between heuristics and engines:
  - several heuristic can match a $Q_i \in \mathtt{W} \Rightarrow$ heuristic policies
  - several $Q_i \in \mathtt{W}$ can be matched $\Rightarrow$ query policies

Examples of heuristics for a help agent

Rational: *"What is your age?"* $\Rightarrow Q_1 = \{\text{ASK}_u[\text{agent.age}]\}^{\emptyset}_{\{\mathtt{D}\}|R}$

H_{R1} : ask-agent-attribute[{ASK$_u$[agent.x_]}$^-_{\_|\_}$] :=
$\rightarrow Q[i, \mathtt{GET}\,[\,\text{x\_}\,]]$,
$Q_i^+ \rightarrow Q[j, \text{TELL}_a[\text{agent.x\_}, Q_i.\text{value}]]$,
$Q_i^- \rightarrow Q[j, \{\text{UNKNOWN}_a[\text{agent.x\_}], \text{TELL}_a[Q_i.\text{value}]\}]$
$Q_i^{\neg\emptyset} \rightarrow Q^+_{\text{this}}$

Behavioral: *"I'm not satisfied"* $\Rightarrow Q_2 = \{\text{DISLIKE}_u[\text{agent}\}^{\emptyset}_{\{\mathtt{D}\}|R}$

H_{B2} : dislike-agent[{DISLIKE$_u$[agent]}$^-_{\_|\_}$] :=
$\rightarrow \{\quad Q[i, \mathtt{MAP}\,[\,\text{energy}, \lambda\, x.x * 0.9\,]]$,
$Q[j, \mathtt{MAP}\,[\,\text{confidence}, \lambda\, x.x * 0.9\,]]$,
$Q[k, \mathtt{MAP}\,[\,\text{cooperation}, \lambda\, x.x * 0.9\,]] \quad \}$
$Q_i^+ \wedge Q_i.\text{value} < -0.5 \rightarrow Q[l, \text{TELL}_a[\text{energy}, \text{"tired"}]]$
$Q_j^+ \wedge Q_j.\text{value} < -0.5 \rightarrow Q[l, \text{TELL}_a[\text{confidence}, \text{"depressed"}]]$

Conclusion and perspectives

Implemented R&B framework relies on state-of-the-art for rationality (decision tree and plans) and psychology (model of mind) models.
Next works will involve:

- Defining software tools for heuristics manipulation
- Developing larger case studies
- Experimenting policies impact on perceived personality

LIMSI-CNRS – Université Paris-Sud 11
BP 133, 91403 Orsay Cedex, France

Web: www.limsi.fr/~jps/research/rnb/rnb.htm
Mail: {jps,bouchet}@limsi.fr