Instructional design and natural language processing in dialogue-based CALL

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How do we practice speaking in a MOOC?
How do we practice speaking in a MOOC?

Record your answer to a written prompt

Upload it for peer assessment
In many learning environments, learners lack speaking in interaction.

### Online learning environments
- MOOCs, apps & websites for autonomous language learning
- Synchronous computer-mediated communication (SCMC) - whether audio, video or text chat - is difficult to supervise and does not scale well.

### Foreign language instruction contexts
- No L2 outside the classroom
- Large classes in developing countries
- Limited teacher-student interaction
- Very rare peer interaction
- No opportunities outside the class

Lack opportunities for spontaneous interactive practice of the L2.
Dialogue-based CALL refers to any application or system allowing to maintain a dialogue [immediate, synchronous interaction] [written or spoken] with an automated agent [tutorial CALL (≠ CMC)] for language learning purposes.
Designing dialogue-based CALL systems to allow for interactive and meaningful practice

Instructional design  Technological approach

Learning outcomes  Dialogue modelling
Task to accomplish  Initiative management
Learning principle  Natural language understanding
Degree of interactivity  Adaptivity and user modelling
Scaffolding
Instructional design and natural language processing in dialogue-based CALL

Previous research & existing systems
A research synthesis from 1982 to 2015

Instructional design & technological challenges
A typology of dialogue-based CALL systems

Natural language processing approaches to dialogue systems
From handcrafted rules to machine learning
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Corpus of studies

146 papers
80 different systems
(67 designed for lang. learning)
Co-citation network of Authors
Co-citation network of Systems

Chatbots

(AI/...)

Intelligent tutoring systems (CALL)

focus on corrective feedback

Spoken dialogue systems (Speech/NLP)

focus on dialogue management

Communicative CALL + ICALL

ICALL

Others

SDS/CA

Chatbots

ICALL

Others

SDS/CA

Intelligent tutoring systems (CALL)

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Spoken dialogue systems (Speech/NLP)

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Communicative CALL + ICALL
Intelligent tutoring system

Map task  (Wilske, 2014)
Spoken dialogue system

SCILL (Seneff et al, 2007)
Chatbot
Leslie Linguo

Leslie Linguo

You:

Leslie: Hello, my name is Leslie. I am an ESL oriented chat bot. I can talk about different topics in English, define words, provide synonyms and antonyms, translate my responses into over thirty languages, explain grammar, and finally conjugate nouns, adjectives and verbs, both in writing and orally. What can I do for you today?

| SAY |

Your input:

Spelling mistakes:

Translation: You must register to get translations of Leslie's answers into your language. Registration is free and easy. Click here for more information, or here to login.
Dialogue simulations in a virtual world
Tactical Language and Culture Training System (Johnson et al, 2005)
Limitations

Almost none of the 80 systems studied have made it to the general public.

We know very little about their effectiveness on language learning.
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Need for an instructional design approach of dialogue-based CALL

Available technology is not enough

“Free conversation” with an all-purpose “question answering” chatbot: ineffective, aimless, vapid.

Various learning goals ⇔ various technologies

Bottom-up typology of dialogue-based CALL
Instructional design framework for dialogue-based CALL

- Learning objectives
- Dialogue task design
- Task(s) to accomplish
- Scaffolding and progression
  - Input and system prompts
  - In-system task modeling
- Feedback provision
Learning principles

Form-focused practice
- Focus-on-forms
  - Gap filling exercise
  - Pronunciation training exercise

Interactive input
- Focus-on-meaning
- Branching dialogue (point-and-click)
- Branching paths (fully predictable)

Output & interaction
- Focus-on-form + Focus-on-meaning
- Interactive dialogue
- Dialogue management

Talking to Avatars (Cerezo, 2010)
GenieTutor (Kwon et al, 2015)
ARTUR (Engwall et al, 2014)
FASOP (Cucchiarini et al, 2014)

VILTS (Rypa & Price, 1999)
Let’s Chat (Stewart & File, 2007)
Mentira (Holden & Sykes, 2011)
## Dialogue task design for interactive dialogue management

<table>
<thead>
<tr>
<th>Goal-orientation</th>
<th>Initiative</th>
<th>Interactivity</th>
<th>Dialogue control</th>
<th>Information extracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open-ended</td>
<td>High</td>
<td>Pre-scripted interaction</td>
<td>Pattern matching</td>
<td>Keywords</td>
</tr>
<tr>
<td>User-initiated open-ended practice</td>
<td>Low</td>
<td>Goal</td>
<td>Graph</td>
<td>Entities</td>
</tr>
<tr>
<td>User-initiated open-ended practice</td>
<td>High</td>
<td>System</td>
<td>Frame</td>
<td>Intent + Entities</td>
</tr>
<tr>
<td>Open-ended</td>
<td>Low</td>
<td>Mixed</td>
<td>Graph</td>
<td>Entities</td>
</tr>
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<td>High</td>
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<tr>
<td>Pre-scripted interaction</td>
<td>Goal</td>
<td>Mixed</td>
<td>Frame</td>
<td>Entities</td>
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<tr>
<td>Interaction in fixed task</td>
<td>Goal</td>
<td>Mixed</td>
<td>Frame</td>
<td>Entities</td>
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<tr>
<td>Interaction in multiple task</td>
<td>Goal</td>
<td>Mixed</td>
<td>Frame</td>
<td>Entities</td>
</tr>
</tbody>
</table>

- **Chatbots CSIEC (Jia, 2009)**
- **Subarashii (Ehsani et al, 1997)**
- **Kaitito (Vlugter et al, 2009)**
- **Let’s Go (Raux et al, 2003)**
- **SPELL (Morton et al, 2011)**
- **POMY (Lee et al, 2014)**
A short detour by Modalities (spoken vs. written)

Dialogue-based CALL systems (n = 80)

Primary modality of input from user
- Spoken
- Written

Systems started each year

- Spoken
- Written
Spoken or written
Beyond the modality dichotomy

Not so much of an issue today.

Speech recognition (ASR) and speech synthesis (TTS) as services (SaaS) can be implemented into any system to enable speech capabilities.

Spontaneous output vs. prepared output (synchronous, interactive) × (asynchronous, monologic) as a more relevant distinction, with major consequences on L2 acquisition.
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## Dominant dialogue management paradigms and frameworks

<table>
<thead>
<tr>
<th>Paradigm</th>
<th>Chatbot</th>
<th>Frame-based dialogue system</th>
<th>Deep learning</th>
<th>Probabilistic rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dialogue control on</td>
<td>Normalized utterance</td>
<td>Slot-value pairs</td>
<td>Internal neural network representation</td>
<td>Intent &amp; entities recognition</td>
</tr>
<tr>
<td>Frameworks</td>
<td>ChatScript</td>
<td>VoiceXML</td>
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<td>OpenDial</td>
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<td>AIMA (see Pandorabots)</td>
<td>CSLU Toolkit</td>
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<td>Wit.ai</td>
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<td>Rivescript</td>
<td>CMU Olympus</td>
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<td>BotEngine</td>
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<td>Api.ai</td>
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<td>Recast.ai</td>
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<td>IBM Watson</td>
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<td>Microsoft LUIS</td>
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<td>Note: requires extremely large corpus</td>
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Why probabilistic approaches to dialogue management?

Chatbots

Some systems with 250,000 rules!
And still dramatically limited, using massive avoidance strategies.

Deterministic rules cannot describe all cases.

Ambiguity pervades language.

Deep learning techniques have obtained good results, but require huge corpora (Mesnil et al, 2013; Vinyals & Le, 2015; Shang et al, 2015)

Probabilistic rules offer the best of both worlds: statistical, data-driven techniques possible with small corpora.
Intent and entities recognition with Wit.ai Bot Engine

Try out an expression
Test out and train how well your app can extract entities.

I would like to buy a medium-sized shirt

- **intent**: buy
- **item**: shirt
- **w/it/number**: a
- **size**: medium

Add a new entity
Dialogue-based CALL
Summarizing

Need for spontaneous interaction

Previous research & systems
Scattered field, between ICALL, spoken dialogue systems and chatbots

Instructional design framework
Towards goal-oriented, mixed initiative interactions

NLP approaches to dialogue
From handcrafted rules to probabilistic rules for intent recognition and dialogue control
Thank you for your attention! Do you have any questions?

<table>
<thead>
<tr>
<th>addressee</th>
<th>you</th>
</tr>
</thead>
<tbody>
<tr>
<td>intent</td>
<td>ask-if-questions</td>
</tr>
<tr>
<td>intent</td>
<td>inquiry</td>
</tr>
<tr>
<td>wit/quantity</td>
<td>any</td>
</tr>
<tr>
<td>reason</td>
<td>your attention</td>
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