1. Introduction

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Kyoto University
Prologue

Conversational Informatics: a field of study that centers on understanding and augmenting conversation
Conversation is everywhere in our life

At a marketplace

At a seminar room

Under cherry blossom
Long-term goal

Challenge: A robot that can participate in conversation
Challenge: Synthetic character who guides the user through the virtual world
What is AI?

- Artificial intelligence
- Artificial mind
- Example
  - *Enthiran (The Robot)*, 2010
<table>
<thead>
<tr>
<th>Year</th>
<th>Title</th>
<th>Who</th>
<th>Wikipedia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1968</td>
<td>2001: A Space Odyssey</td>
<td>HAL9000</td>
<td><a href="http://ja.wikipedia.org/wiki/2001%E5%B9%B4%E5%AE%87%E5%AE%99%E3%B1%AE%E6%97%85">http://ja.wikipedia.org/wiki/2001%E5%B9%B4%E5%AE%87%E5%AE%99%E3%B1%AE%E6%97%85</a></td>
</tr>
<tr>
<td>1977</td>
<td>Star Wars</td>
<td>C-3PO, R2-D2</td>
<td><a href="http://ja.wikipedia.org/wiki/%E3%82%B9%E3%82%BF%E3%83%BC%E3%83%BB%E3%82%A6%E3%82%A9%E3%83%BC%E3%82%BA">http://ja.wikipedia.org/wiki/%E3%82%B9%E3%82%BF%E3%83%BC%E3%83%BB%E3%82%A6%E3%82%A9%E3%83%BC%E3%82%BA</a></td>
</tr>
<tr>
<td>1982</td>
<td>Blade Runner</td>
<td>Replicants</td>
<td><a href="http://ja.wikipedia.org/wiki/%E3%83%96%E3%83%AC%E3%83%BC%E3%83%89%E3%83%A9%E3%83%B3%E3%83%8A%E3%83%BC">http://ja.wikipedia.org/wiki/%E3%83%96%E3%83%AC%E3%83%BC%E3%83%89%E3%83%A9%E3%83%B3%E3%83%8A%E3%83%BC</a></td>
</tr>
<tr>
<td>1984</td>
<td>The Terminator</td>
<td>The terminator</td>
<td><a href="http://ja.wikipedia.org/wiki/%E3%82%BF%E3%83%BC%E3%83%9F%E3%83%8D%E3%83%BC%E3%82%BF%E3%83%BC_(%E6%98%A0%E7%94%BB)">http://ja.wikipedia.org/wiki/%E3%82%BF%E3%83%BC%E3%83%9F%E3%83%8D%E3%83%BC%E3%82%BF%E3%83%BC_(%E6%98%A0%E7%94%BB)</a></td>
</tr>
<tr>
<td>1987</td>
<td>RoboCop</td>
<td>RoboCop (cyborg)</td>
<td><a href="http://ja.wikipedia.org/wiki/%E3%83%AD%E3%83%9C%E3%82%B3%E3%83%83%E3%83%97">http://ja.wikipedia.org/wiki/%E3%83%AD%E3%83%9C%E3%82%B3%E3%83%83%E3%83%97</a></td>
</tr>
<tr>
<td>1993</td>
<td>War Games</td>
<td>WOPR: War Operation Plan</td>
<td><a href="http://ja.wikipedia.org/wiki/%E3%82%A6%E3%82%A9%E3%83%BC%E3%83%BB%E3%82%B2%E3%83%BC%E3%83%A0_(%E6%98%A0%E7%94%BB)">http://ja.wikipedia.org/wiki/%E3%82%A6%E3%82%A9%E3%83%BC%E3%83%BB%E3%82%B2%E3%83%BC%E3%83%A0_(%E6%98%A0%E7%94%BB)</a></td>
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<tr>
<td>1994</td>
<td>Disclosure</td>
<td>Angel</td>
<td><a href="http://ja.wikipedia.org/wiki/%E3%83%97%E3%82%AA%E3%83%BC%E3%83%BB%E3%82%9B%E3%82%B9%E3%82%AF%E3%83%AD%E3%83%BC%E3%82%B8%E3%83%A3%E3%83%BC_(%E6%98%A0%E7%94%BB)">http://ja.wikipedia.org/wiki/%E3%83%97%E3%82%AA%E3%83%BC%E3%83%BB%E3%82%9B%E3%82%B9%E3%82%AF%E3%83%AD%E3%83%BC%E3%82%B8%E3%83%A3%E3%83%BC_(%E6%98%A0%E7%94%BB)</a></td>
</tr>
<tr>
<td>1998</td>
<td>Bicentennial Man</td>
<td>Andrew, a new NDR-114 robot</td>
<td><a href="http://ja.wikipedia.org/wiki/%E3%82%A2%E3%83%B3%E3%83%89%E3%83%AA%E3%83%A5%E3%83%BC%DR114">http://ja.wikipedia.org/wiki/%E3%82%A2%E3%83%B3%E3%83%89%E3%83%AA%E3%83%A5%E3%83%BC%DR114</a></td>
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<tr>
<td>1999</td>
<td>The Matrix</td>
<td>Computer</td>
<td><a href="http://ja.wikipedia.org/wiki/%E3%83%9E%E3%83%88%E3%83%AA%E3%83%83%E3%82%A4%E3%82%B9_%E6%98%A0%E7%94%BB">http://ja.wikipedia.org/wiki/%E3%83%9E%E3%83%88%E3%83%AA%E3%83%83%E3%82%A4%E3%82%B9_%E6%98%A0%E7%94%BB</a></td>
</tr>
<tr>
<td>2002</td>
<td>Minority Report</td>
<td>Insect robots (user interface is interesting, too)</td>
<td><a href="http://ja.wikipedia.org/wiki/%E3%83%9E%E3%83%86%E3%83%8E%E3%83%AA%E3%83%86%E3%82%A3%E3%83%BB%E3%83%AA%E3%83%9D%E3%83%BC%E3%83%88">http://ja.wikipedia.org/wiki/%E3%83%9E%E3%83%86%E3%83%8E%E3%83%AA%E3%83%86%E3%82%A3%E3%83%BB%E3%83%AA%E3%83%9D%E3%83%BC%E3%83%88</a></td>
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<td>2004</td>
<td>I, ROBOT</td>
<td>V.I.K.I., Sonny</td>
<td><a href="http://ja.wikipedia.org/wiki/%E3%82%A4%E3%82%A4%E3%83%9E%E3%83%9C%E3%83%83%E3%83%88">http://ja.wikipedia.org/wiki/%E3%82%A4%E3%82%A4%E3%83%9E%E3%83%9C%E3%83%83%E3%83%88</a></td>
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<td>2009</td>
<td>ATOM Astro boy</td>
<td>Astro boy</td>
<td><a href="http://ja.wikipedia.org/wiki/ATOM_+%E6%98%A0%E7%94%BB">http://ja.wikipedia.org/wiki/ATOM_+%E6%98%A0%E7%94%BB</a></td>
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<td>2009</td>
<td>Avatar</td>
<td>(tele-existence)</td>
<td><a href="http://ja.wikipedia.org/wiki/%E3%82%A2%E3%83%90%E3%82%BF%E3%83%BC">http://ja.wikipedia.org/wiki/%E3%82%A2%E3%83%90%E3%82%BF%E3%83%BC</a></td>
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<td>Surrogate</td>
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<tr>
<td>Year</td>
<td>AI</td>
<td>ICT</td>
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Successful Topics of AI

- Large-scale Search
- Knowledge-based Systems
- Language, Speech, Vision
- Planning
- Machine Learning and Data Mining
- Using AI in Creating Works of Art

DeepBlue (1997)
http://www.research.ibm.com/deepblue/

IBM Watson (2011)


ALVINN （An Autonomous Land Vehicle in a Neural Network）on Navlab (1989)
http://dl.acm.org/citation.cfm?id=89891

Experiments in Musical Intelligence (1987)
http://arts.ucsc.edu/faculty/cope/
http://artsites.ucsc.edu/faculty/cope/mp3page.htm

AARON (1985)
http://www.kurzweilcyberart.com/
Grand Challenges in AI

Conceptual
- Turing Test (1950)

Autonomous Vehicles
- Lego Robots (1998-)
- European Land-Robot Trial (2006-)
- DARPA Urban Challenge (2007-)
- The Microtransat Challenge: a transatlantic race of fully autonomous sailing boats (2006-)
- Aerial Robotics (Sept. 28, 2011)

Chess (competition ended)
- Deep Blue defeated Gary Kasparov on May 11th, 1997

Education
- STEM Grand Challenge to develop adaptive, generalizable intelligent tutors (June 5, 2011)
- Hewlett Foundation: Improve Automated Scoring of Student Essays (Jan, 2012)

Face Recognition
- The Face Recognition Vendor test (FRVT) (2002-)

Go
- Entertainment and Cognitive Science, The University of Electro-Communication

Language Learning and Understanding
- Loebner Prize (1990-)
- IBM Watson

Lunar Robotics
- NASA Prize for Digging Moon Dirt (September 20, 2005)
- Google Lunar X Prize (2007-)

Medical Diagnosis and Monitoring
- Nokia Sensing X Challenge (May 24, 2012)

Rescue Operations
- Robocup Rescue (2001-)

Robotics
- The DARPA Robotics Challenge (October 2012-)

Japanese Chess (Shogi)
- World Computer Shogi Championship, IPSJ Computer Shogi Project

Shredder Challenge
- DARPA Shredder Challenge (October 27th-December 2nd, 2011, solved)

Soccer
- Robocup (1997-)

Entrance examination of the University of Tokyo
- NII Artificial Brain Project: “U Tokyo Robot”

Adapted from AAAI>AITopics>Grand Challenges in AI
Recent Trends

Landmarks

1997: Deep Blue defeated G. Kasparov
   ... Source: IBM Deep Blue, wikipedia
1997: Official opening of Robocup (H. Kitano)
   ... Source: robocup.org, robocup.or.jp, Wikipedia
1997: Mars Pathfinder
   ... Source: NASA Mars Pathfinder, Wikipedia
1999: Robot pet SONY AIBO
   ... Source: SONY AIBO, Wikipedia
1999: OpenCV Project
   ... Source: OpenCVWiki, wikipedia
2000: Honda ASIMO
   ... Source: Honda ASIMO, Wikipedia
2004: Mars Exploration Rovers
   ... Source: NASA-JPL
2010: Google Driverless Car
   ... Source: Wikipedia, Sebastian Thrun’s home page, 3P
2010: Kinect
   ... Source: xbox.com, Wikipedia
2011: IBM Watson defeated two Jeopardy! champions
   ... Source: IBM Watson, Wikipedia
2011: iPhone Siri
   ... Source: Apple, Wikipedia
2011: Google Voice Search
   ... Source: Google
2012: Zen Takemiya Masaki with 4 stones
   ... Source: Sig ECS, UEC
2012: Google Glass Project
   ... Source: Project Glass
2012: NTT DOCOMO’s Shabette Concier
   ... NTT DOCOMO
Other: Smarter than You Think (New York Times)

- From philosophy to science-technology
- Toy problems to the real world
- Powerful tools
- Grand challenges and competitions
Traditional AI

Dark side of super intelligence

- Technology abuse
- Responsibility flaw
- Moral in crisis
- Over-dependency on technology
(Technological) singularity

- The day when machine intelligence surpasses human intelligence.

- IEEE Spectrum June 2008 issue
  [http://spectrum.ieee.org/biomedical/ethics/signs-of-the-singularity](http://spectrum.ieee.org/biomedical/ethics/signs-of-the-singularity)
  - “The AI Scenario: We create superhuman artificial intelligence (AI) in computers.”
  - “The IA Scenario: We enhance human intelligence through human-to-computer interfaces--that is, we achieve intelligence amplification (IA).”

- The fear of utopia
So what?

- Dismiss as nonsense.
- Neo-Luddism.
- Invent a better solution.
- Endow AI with empathic capabilities.
Communicative Intelligence for Bridging People and CI

- Computational Intelligence
- People

Communicative Intelligence
Towards Empathic Agents

Glad to stay with you!

- Service
- Presence
- Empathy

Embedding AI in the society
Traditional AI:
High competence

DeepBlue

IBM Watson

Siri

(AI that can pass entrance exam)

Future AI:
High empathy

Entertain with a game

Entertain with a game

Conversation partner

Effective and affective tutor
Empathy

The ability to understand others’ emotions and/or perspectives and, often, to resonate with others’ emotional states.

or ...

An affective response that is identical, or very similar, to what the other person is feeling or might be expected to feel given the context: a response stemming from an understanding of another’s emotional state or condition.

[Eisenberg 2010]
Sharing hypothesis

The more common ground is shared, the more empathy will be gained.

... the universe of discourse, first-person view, knowledge and skills, the communication style and rituals, the value system, ...

[Nishida 2013]
Towards Empathic Agents
Conversation is a complex business

Trust

Conviviality

Social networks

Asking

Proposing

Negotiating

Eye gaze

Para linguistic

Hand gesture

Posture
A context-of-use study of Open Hand Prone gestures suggests that they all share the semantic theme of stopping or interrupting a line of action that is in progress.

Index Finger Extended Supine (palm down).

Size-shape-specifier gesture serving as a referent for the deictic pronoun ‘that’.

[Kendon 2004]
Adam: Sit down here [pointing at a chair] would you
Bart: ...

Conversation is a complex business

<table>
<thead>
<tr>
<th>Level</th>
<th>A’s actions in progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>A is proposing to B that B sit here for A.</td>
</tr>
<tr>
<td>3</td>
<td>A is asking B to sit here.</td>
</tr>
<tr>
<td>2</td>
<td>A is presenting to B a signal composed of “here” plus pointing at the chair.</td>
</tr>
<tr>
<td>1</td>
<td>A is executing for B’s perception the articulation of “here” and the movement of his arm.</td>
</tr>
</tbody>
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<table>
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<tr>
<th>Level</th>
<th>A+’s actions in progress</th>
</tr>
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<tbody>
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<td>4</td>
<td>A is proposing joint project w to B</td>
</tr>
<tr>
<td>3</td>
<td>A is signaling that p for B</td>
</tr>
<tr>
<td>2</td>
<td>A is presenting signal s to B</td>
</tr>
<tr>
<td>1</td>
<td>A is executing behavior t for B</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level</th>
<th>Speaker A’s actions</th>
<th>Addressee B’s actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>A is proposing joint project w to B</td>
<td>B is considering A’s proposal of w</td>
</tr>
<tr>
<td>3</td>
<td>A is signaling that p for B</td>
<td>B is recognizing that p from A</td>
</tr>
<tr>
<td>2</td>
<td>A is presenting signal s to B</td>
<td>B is identifying signal s from A</td>
</tr>
<tr>
<td>1</td>
<td>A is executing behavior t for B</td>
<td>B is attending to behavior t from A</td>
</tr>
</tbody>
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<tr>
<th>Level</th>
<th>B’s actions in progress</th>
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<tbody>
<tr>
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<td>B is considering A’s proposal that B sit here for A.</td>
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<td>B is recognizing A’s request for B to sit here.</td>
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<td>B is identifying A’s signal as composed of “here” plus pointing at the chair.</td>
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<td>B is attending to A’s articulation of “here” and the movement of A’s arm.</td>
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[Clark 1996]
Conversation is a complex business
The Architecture of Empathic Agent?

Cultural

Social

Interactive

Mind
- Self
  - Consciousness
- Language
- Judgment
- Memory
- Imagination
- Internal theater

Perception

Embodiment
- Sensors
- Motors

Learning skills

Evolutional system
History of conversational systems development

Natural language dialogue systems

Speech dialogue systems

Story Understanding systems

Conversation Analysis

Discourse Analysis

The Knowledge Navigator

Multi-modal dialogue systems

Embodied Conversational Agents
Intelligent Virtual Human

Interactional systems

Transactional systems

Conversational Informatics

Timeline:
- 1970
- 1980
- 1990
- 2000
- 2010
Our approach

Application

Content production

Model building

Platform

Analysis

Measurement

Conversational interactions

Evaluation

Theory
Our approach: Building a Primordial Soup of Conversation

- Content provision
  - Training data

- Acquired content

Conversation management
- Conversation environment management
- Sensing human behaviors
- Controlling agents

Partially mechanized humans & Partially humanized machines live together and converse with each other.
The Idea of Conversation Quantization

[Diagram showing a conversational situation with 'a conversational situation' and 'another conversational situation', indicating 'materialization', 'conversion / spatialization', and 'dematerialization'.]

[Nishida DNIS 2005]
Augmented Conversation Environment
We aim at building a smart environment that integrates conversation in physical and virtual spaces.

Conversation in the physical world

Conversation in the virtual world

Augmented Conversation Environment
We aim at building a smart environment that integrates conversation in physical and virtual spaces.

Conversation in the physical environment
Conversation in the virtual environment

Platform for supporting cyber-physical conversation
IMADE: Interaction Measurement, Analysis, and Design Environment

- A conversation robot
- Cameras for varying purposes
- A computer vision and a cluster computer (to be installed)
IMADE: Interaction Measurement, Analysis, and Design Environment

- SmartInFill
- Cluster computer
- Polygraph
- Multiparty conversation recorder
- Eye tracker
- Eye tracker (wearable)
- Optical motion capture systems
IMADE: Interaction Measurement, Analysis, and Design Environment

- Experiment profiles
- Timeline
- Motion data
- Visual data
- Audio data (PCM)

- Experiment record
- Recording operation

- Conversation field

- Camera system
  - Data streams

- Audio capture system
  - 8ch preamp

- Motion data server

- Wearable sensors
  - Wireless head set microphones
  - Eye mark recorders
  - Motion capture devices
  - Biological sensors

- Web server
  - Experiment record
  - Recording operation

- Database
  - Experiment profiles
  - Timeline
  - Motion data

- Storage
  - Visual data
  - Audio data (PCM)

- NTP server
  - Time stamps

- Ethernet
- Wireless
- Camera
- Microphone
- Motion capture tag

[Sumi]
3D conversation capture
3D conversation capture – from first person view

[Yano 2011]
3D conversation capture – from first person view
3D conversation capture – over the shoulder
ICIE: Immersive Collaborative Interaction Environment

[Ohashi 2011]
Immersive Interaction Environment

https://www.youtube.com/watch?v=V-9SKpcMrzk
Projecting the real world into the virtual world

Photos

System of Constructing Virtual Space

Structure from Motion
- camera parameter

Multi view Stereo
- CMVS Patches

Creating Panorama
- panorama image
- panorama depth map

Segmentation
- segmented image

Creating Depth Map
- depth map

Interpolation
- interpolated image

Use previous work

Show a Immersive Virtual Space

[Mori 2011]
Virtualized physical world
ICIE: Immersive Collaborative Interaction Environment

Projecting operator’s behavior on a robot [Saiga 2012]
ICIE: Immersive Collaborative Interaction Environment

iDEAL: a software platform for ICIE

[Ohmoto 2012]
Immersive WOZ environment

- Tele-operated robot
- Feedback generation
- Motion mapping
- User motion sensing
- Head recognition
- Gesture recognition
- Face model
- Human body model

WOZ operator
- Camera
- IR range sensors
- Microphone
- Surround speakers
- Floor sensor
- 360-degree vision

ICIE Control PC

The conversation place

WOZ operating environment

[Ohmoto, Ohashi, Saiga]
Immersive WOZ environment

The user in ICIE is asking for a clerk in the remote shop to explain a product.

http://www.youtube.com/watch?v=YTVYwwZcGhU

[Saiga 2011]
ICIE: Immersive Collaborative Interaction Environment

[Ohmoto 2011]
Interactions from observation

Observation/measurement of human-human interactions

Realizing autonomous robot with estimated parameters
Analysis using annotation tool (iCorpusStudio)

North conversation field shifts South

scene 1 scene 2 scene 3 scene 4

[Sumi, Bono, Kijima]
Conversation visualizer
Learning by imitation

1. Watch
   - Operator
   - Learner
   - Model
   - Commands
   - Feedback

2. Learn
   - Command stream
   - Action stream
   - Discovery Phase
   - Discrete Commands
   - Discrete Actions
   - Association Phase
   - Behavior Generation Model
   - Controller Generation

3. Act
   - Operator
   - Learner
   - Induced Model
   - Commands
   - Feedback
   - Actions

[Mohammad 2009]
The problem formulation

Gesture stream

Action stream
Learning by imitation

Learning Interaction Protocols using Augmented Bayesian Networks Applied to Guided Navigation

Yasser Mohammad and Toyoaki Nishida

IEEE IROS 2010
Fluid Learning

(Mohammad 2013)
Virtual Basketball

[Lala 2013]
Corneal Image Capture

[Nakazawa Nitschke 2013]
1. This course centers on conversations.
2. Why conversations?
   -> Foundation of thought and communication
3. Why do people converse with each other?
   -> As a part of social interaction, for creating and maintaining stories, for fun.
4. The complexity of conversations:
   -> Multi-level, multi-layered, polysemy, polymorphism, coordination of multi-modality.
5. People are not only proficient in expressing ideas but also skillful in interpreting utterances, thereby they learn from each other.
6. Building a conversationally intelligent agents helps people effectively communicate with each other by conversations.
7. Conversational intelligence can be counted as an important branch of artificial intelligence.
8. We will integrate the engineering and scientific approached to conversation.
Credits:
Will be awarded based on one or more reports on subjects given at the class.

Calendar (tentative)

1. Introduction (October 2nd)
2. History of Conversational System Development (October 9th)
3. Smart space for conversation and the analysis (October 16th)
4. Mark Up Language (October 23rd)
5. Corpus Based Approach (October 30th)
7. Affective Computing (November 13th)
8. Motif Discovery (November 20th)
9. Gesture (December 4th)
10. Computer Vision (December 11th)
11. Language Use - 1 (December 18th)
12. Language Use - 2 (December 25th)
13. Cognitive Design (January 8th)
14. Speaking Turn Taking System (January 22nd)
15. Cognitive Process (January 29th)
References


http://dx.doi.org/10.1241/johokanri.55.461


http://dx.doi.org/10.1007/978-3-642-37134-9_18