Human Communication 1
Lecture 3

Historical Setting for Cognitive Science (a)

The concept of a discipline, and taking an interdisciplinary approach are important for understanding how we are going to narrow down our perspective on communication.

– Cognitive science is an interdisciplinary approach born after World War II
– Artificial intelligence (AI), linguistics, neuroscience, philosophy, psychology are some ingredients

Philosophy -> Psychology

Initially intuition - armchair philosophy

The move to a need for more objectivity

Behaviorism - replacing subjective talk of mental experience with objectively observed regularities in behaviour

– stimulus -> response
– only observable behaviour of import
– empiricist approach: evidence + observation

Resulted in useful experimental techniques

Recent moves towards extracting knowledge by statistical treatment of data of experience

Psychology -> Cognitive Science

Information processing - move to need to demonstrate mental structure without giving up need for objective evidence

- Attention on level of description in terms of information
- Automata theory out of logic
- Computational abstractions e.g. Turing, Enigma
- Use to formally analyze Natural Language grammar (Chomsky, Montague)
- Computing happened when logic met electronics

Resulting in technology and the formal languages for analysing behaviour

Methods: Analysis and synthesis

To understand X:

Analytical approach:
- Observe X in context
- Take X to pieces and see how it works - (Psychology, Linguistics)

Synthetic approach:
- Build one and see how it behaves (AI, Computational Linguistics)
- May be ‘black box’: deduce the properties any X must have (Cog Psych)

Joke generation example uses both

Normative and Descriptive Stances

Normative: how something should behave
- How we ought (ideally) to communicate
- What rules give ‘correct’ analysis
- How ‘should’ we reason - what logics should describe this

Descriptive: how do things actually behave
- How do we communicate?
- How do we reason?

Science as Idealization

Science focusses on some phenomena and systematically ignores others

e.g. Galileo ignored friction for general theories of motion

Do the same in Linguistics and Psychology

- Do not include all variables
- Exclude some data

e.g. rules of grammar do not cover all cases and ignore errors (unless this is the focus)

Computers and Communication - goals:

1. Understanding how humans communicate, exploring human cognition by modelling linguistic abilities;
2. Building computer systems which are (more) useful because they use or process human language, or communicate, somehow;
3. Understanding the notion of communication in principle.

We will look at `classic' AI issues---how can we communicate with computers, via speech or text?

Natural Language Processing

Area of Artificial Intelligence, Cognitive Science, Computational Linguistics that focusses on modelling communication

- Requires effective computational deployment of knowledge.
- Knowledge may be explicit, e.g. a grammar of Portuguese, or tacit, e.g. knowledge of how to communicate emotions

Two related tasks in any application of NLP:

- Represent the knowledge in a computationally tractable form;
- Design and implement algorithms which effectively employ that knowledge so achieve communication goals

Many NLP tasks can be viewed as transforming one sort of representation (letters, sounds, words, syntactic structures, meanings) into another

Two Fundamental Problems for NLP

1. **Ambiguity:** the transformation from one representation to another is often one-to-many.
2. **Ellipsis:** At all levels, a lot is left out and must be supplied from context.

Solving the Problems:

- Each step in NLP system uses knowledge (the AI methodology) to reduce ambiguity and fill in gaps.
- Each step needs different knowledge: phonetic, orthographic, lexical, morphological, grammatical, semantical, pragmatic, common-sensical (crucial).

Providing a *common-sense filter* is not yet (generally) possible

Possible ways round this:

- Restrict scope of interaction
- Make semi-automatic (i.e. human in loop)

Using knowledge across levels: ArtCheck:

Some native languages do not include an article category, e.g. **Finnish** - definiteness and indefiniteness expressed in quite different ways (also Basque, Chinese, Russian)

Aims to help such non-native speakers of English use articles appropriately

Rules which determine correct article usage:

- how do you know whether you are talking about a specific object, or any old object?
- how do we choose the correct article to indicate the indefinite or definite property of the noun in an utterance?

Applying knowledge to user input, to **detect** when the incorrect article is used

Use rules as basis for generating explanations, customised to learner**,** to help them learn correct user

Artcheck *(Sentence, 1993)*

Indefinite **a/an,** eg *John is* **a teacher**

zero, eg *Do you take* **milk** *in* **coffee?**

Definite **the,** eg *He is* **the only teacher** *I like*

Example errors:

*I have visited__Tower of London

I have visited the Tower of London

*__ Aeroplane has revolutionised travel

The aeroplane has revolutionised travel

*We discussed our plans over the breakfast

We discussed our plans over breakfast

Determining correct article usage

Rules indicate whether article before noun should be:

1. the **definite article *the***
2. the **indefinite article *a/an***
3. no article at all, **(*the zero article*)**

Some are *fixed* rules: *the definite article should be used when the noun is modified by a superlative adjective,*
eg *the largest dog*

Other depend on context of use: *the indefinite article should be used to introduce new information.*

The sources of information used by the system:
the **lexicon**, the **parser,** the **morphological analyser,** and a **discourse history module.**

Note: you already know and can use all this information!

Examples of rules

Article Usage Rules	Example	Information needed
The definite article can be used where the noun is modified by a relative claus e	*The* **man** *who I saw . . .*	Syntactic
The zero article can be used before plural count nouns	*Do you like* **eggs**	Morphological
The zero article can be used with proper nouns	*My dog is called* **Marcus**	Lexical
The indefinite article is used in some expressions of frequency	*I go running* **twice a day**	Idiomatic

Detecting article usage errors

1. Student answer **compared with expert model**
2. Incorrect article usage identified
3. **Uses *rule induction*** to learn rules from training instances
4. **Artcheck produce new rules**, based on the expert ones, describes what students doing i.e. identify the (incorrect) rules (**= *mal-rules***)
5. If the system can **determine a mal-rule** which represents the student's error, then this is **explained to the student**

Example dialogue

AC: Enter sentence:
Student: **I am doctor**

AC: ***doctor*** in ***I am doctor*** is incorrect.
[identify error]

AC: It should be: ***a doctor*** .
[correct error]

AC: Select: m more q quit explanation
[ask student for feedback]

Student: **m**
AC: The rule is: RULE 11
[state rule]
Use a or an before singular count nouns which come after the verb to be.

AC: Select: m more q quit explanation
[ask student for feedback]

Student: **m**

Dialogue, continued

AC: **I have noticed that you seem to use no article instead of a or an before a singular count and after the verb to be in the singular**
[explain mal-rule]

AC: Select: m more q quit explanation
[ask student for feedback]

Student **m**
AC: You also said: ***** Sandy is pig**
***** John is teacher**
which are similar errors.
[exemplify mal-rule]
Try one of these again: **Sandy is **** pig**
Choose the correct article:
1 a **2 an**
3 the **4 no article**

Student: **1**
AC: Well done. That is the correct answer.

Reading

Paper: Sentance, S. (1997), A Rule Network for English Article Usage within an Intelligent Language Tutoring System , Computer Assisted Language Learning, 10:2, 173 - 200
Available at:
http://www.informaworld.com/smpp/content~content=a746722517&db=all

Extract from notes on ArtCheck
http://www.cogsci.ed.ac.uk/~helen/humancomms/05artcheck.pdf

Practicalities

Tutorials start today after this lecture:

See course page for notes and tutorials:

http://www.inf.ed.ac.uk/teaching/courses/hc1/syllabus.and.slides/index.html

Tutorial 1 (week 2) Analysing Humour

Consider the video shown in the lecture:

Comic Relief - Catherine Tate & David Tennant, © 2009 YouTube

http://www.youtube.com/watch?v=WxB1gB6K-2A

Your task is to analyse and describe the various incidents of humour in the video.

See tutorial assignment

http://www.inf.ed.ac.uk/admin/itodb/mgroups/stus/hc1.html

Imitating Communication: Eliza

Joseph Weizenbaum (1964): fancy linguistic analysis not needed to give the appearance of intelligent conversation.

- simple pattern matching produces responses to typed input
- people have been fooled by Eliza and similar programmes
- program is very simple but surprisingly deceptive.

Following is dialogue that supposedly took place between a sales executive of a computing company, who wanted to use the computer, and ELIZA.

The story goes that the executive (SE) believed that he was talking to the computer operator and did not realise that he was, in fact, on-line to ELIZA.

Talking to Eliza

SE: Do you think that I can use the computer this morning?

El: Why do you ask?

SE: I might be able to make some additional telecomp sales.

El: Why aren't you sure?

SE: My prospective customers have never seen a demonstration of the system.

El: Does this mean very much to you?

SE: Of course it does.

El: You seem very positive about that.

SE: This is ridiculous.

El: What do you mean this is ridiculous.

SE: Is there any reason why I can't use the computer now?

El: Tell me more about your prospective customers.

SE: Please dial me up on 491-1850

The outcome….

After this last line there was no response (SE forgot full stop)

The story goes SE telephoned operator he thought he had been talking to, and the exchange went something like this:

SE: Why are you being so snotty to me?

Op: What do you mean, why am I being so snotty to you?

rest censored...

Seems that ELIZA could fool people into believing that they were talking to another person....

Weizenbaum very carefully choose the domain so ELIZA could demonstrate its power.

General domain is Rogerian (non- directive) therapy

- clinician draws out the patient, get him to talk more about himself and his problems, without being directive.
- the program acts as the clinician.

How ELIZA works…

Uses **key-phrase matching**: It stores a set of key phrases and words and looks to match these to the sentences input.

If input *I hate you* and '*hate*' is keyword, response:

Why do you hate me?

Large set of stimulus-response rules used.

- input matched to stimulus, corresponding response given
- variables: used in stimulus to allow more flexible matching
- whatever matched variable in input replaces it in response

e.g. input: ***I am sick.***

Matching to the rule:

stimulus: ***I am X***.

response: ***How long have you been X***?

with *X* matching to '*sick*', resulting in the response:

response: ***How long have you been sick?***

The program..

1. Takes the input as stimulus.
2. Matches it to a pattern in the table.
3. Gives values to variables, by matching.
4. Substitutes variables for values in the response.
5. Outputs the response.

If input had been ***I am sick of you*** the response ***How long have you been sick of you?*** would not be appropriate.

To deal with this, program also ***exchanges pronoun*** immediately after the sentence is input

So ***you*** would be exchanged for ***me*** and response would be

How long have you been sick of me?

Some example patterns

1a. **I am hungry.** **1b.** **I am only joking.**
2a. **I want you to give me some chocolate.**
2b. **I want you to give me a drink.**
3a. **I feel very happy.** **3b.** **I feel awfully tired.**

The patterns here are:
- 1a. and 1b. ***I am X.***
- 2a. and 2b. ***I want you to give me X.***
- 3a. and 3b. ***I feel X.***

The ***X*** is a variable and can match to any piece of text.
To match to more variables, use different variable names.

I feel X and I want Y.

Matches: **I feel cold and I want a nap.**
I feel hot and I want a long cold drink.
I feel like going home and I want a lift.

But not: **I feel tired and need to sleep.**
because ***and I want*** will not match with **and need.**

General criticisms of ELIZA

* Lack of memory: there is no relation between the current response and any previous stimulus or response;
* The program is inflexible;
* There is no knowledge of the structure of the stimulus:
  if nonsense is input then nonsense results;
* The program has no world knowledge.

Program uses the technique of keyphrase-matching:
- an example of pattern-matching (very important)

Significance of this can be exaggerated, but the issue of the ***Turing Test*** makes it necessary to think carefully.

For further discussion of ELIZA (and other examples) see:

Boden, M. 1987, *AI and Natural Man*. Chapters 5 and 6, 1st Edition (Harvester Press, 1987) or 2nd Edition (MIT Press).

The Turing Test

Alan Turing:
- one of founders of Computer Science
- codebreaking work at Bletchly Park in 2nd World War
- major contributions to developing 1st digital computers

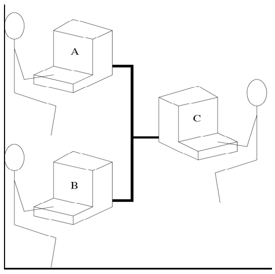
Among the many areas of modern computing he foresaw, AI was one.

He wrote a famous paper, ***Computing Machinery and Intelligence*** in 1950, discussing the potential of computers to be or seem intelligent, in which he proposed his test

On-line copy of the Turing's original article on the web:
http://www.loebner.net/Prizef/TuringArticle.html

Turing Test

The investigator (C) does not know if A and B is man or woman. Tries to determine this by asking questions. Man tries to fool the C, the woman tries to help (or vice versa).



Turing's test: if a computer could take the man's or woman's part, and not significantly change the investigator's success rate, the computer would have to be judged intelligent.

Simpler version

A person Q connected to two others, A and B, through computer.
- Q interacts verbally with A and B
- One of A/B is another human, the other is a computer program.

The test is whether the person can distinguish A and B, and correctly detect which is the computer program:
- if they cannot, the program has passed the Turing test.

Neither A nor B have to tell the truth: may deliberately mislead Q, e.g.

Q. Please write me a sonnet on the subject of the Forth Bridge
A. Count me out on this one. I never could write poetry.
Q. Add 34957 to 70764
A. (pause for about 30 seconds) 105621
Q. Do you play chess?
A. Yes
Q. I have K at my K1 and no other pieces. You have only K at K6 and R at R1. It is your move. What do you play?
A. (pause of 15 seconds) R - R8

The Loebner Prize

More modern ELIZAs developed in response to challenges of the Turing Test.

The ***Loebner Prize*** Competition established in 1990 by Hugh Loebner and the Cambridge (Massachusetts) Center for Behavioral Studies.

Awarded annually to the designer of the computer system that best succeeds in passing a variant of the Turing Test.

For more information on the Loebner prize see:

http://www.loebner.net/Prizef/loebner-prize.html

We will look at examples of these later in the course