Abstract

The article surveys a little of the history of the technology, sets out the main current theoretical approaches in brief, and discusses the on-going opposition between theoretical and empirical approaches. It illustrates the situation with some discussion of CONVERSE, a system that won the Loebner prize in 1997 and which displays features of both approaches.

1 Introduction

Practical and theoretical investigations into the nature and structure of human dialogue have been a topic of research in artificial intelligence and the more human areas of linguistics for decades: there has been much interesting work but no definitive or uncontroversial findings. The best performance overall in HMC (Human-machine conversation) has almost certainly been Colby’s PARRY program since its release on the (then ARPA) net around 1973. It was robust, never broke down, always had something to say and, because it was intended to model paranoid behaviour, its zanier misunderstandings could always be taken as further evidence of mental disturbance, rather than the processing failures they were. Colby actually carried out a version of the Turing test –usually taken to be the test of whether users can tell a human from a machine in a HMC environment–by getting psychiatrists to compare, blind, PARRY utterances with those of real paranoids and they were indeed unable to distinguish them. Indistinguishability results are never statistically watertight, but it was, nonetheless, a very striking demonstration and much longer ago than many now realise.

2 History

In theoretical terms, modelling conversation or dialogue comes within the division of linguistics that Morris called pragmatics–that which deals with the relationship of individual agents to symbols and the world–as opposed to syntax,
that deals with the relationship of symbols to each other, and semantics, that
deals with the relationship of symbols to the world. HMC is a pragmatic study,
but its history has involved many attempts to see it in syntactic and semantic
terms as well, since the more tractable areas of research and pragmatics was
often thought too hard.

If we look back at the HMC systems of the Seventies we see a clear division
of approach that persists to this day: on the one hand there were theoretically-
motivated models in the artificial intelligence tradition that emphasized rea-
soning and a deep understanding of language based on knowledge of the world
about which the conversation took place. The most famous was Winograd’s
program \[4\] that discussed a set of blocks on a table top, and more realistic
settings were Grosz’s \[5\] system that acted as a robot discussion of how to as-
semble a water pump.

If you said

"Attach the platform to the pump"

it could reply

"Where are the bolts?"

although no bolts had been mentioned because it knew from its knowledge struc-
ture that bolts were needed for assemblies. The most advanced system of its
generation was the Toronto train timetable system \[6\] that would reply to:

"The 6.15 to Vancouver?"

with

"Platform 6"

In some sense, it knew what was wanted by a person saying the first utterance,
which is just a noun phrase and not even a question. None of these systems had
very good performance and their vocabularies were a few dozen words at most;
they were never tested by being opened up to a public who could talk to them
in an unconstrained way–their systems of syntactic and semantic analysis were
far too fragile for that–if one word was differently placed they might understand
nothing at all.

A quite different kind of system was Colby’s PARRY, mentioned above–
and which was never as famous as its far far weaker contemporary ELIZA \[7\].
PARRY knew little of the world, had no syntax analysis and just worked by a
large set (about 6000) of patterns with which it matched any input. It appeared
to be a paranoid patient in a Veterans’ hospital and in reply to:
“Have you been hospitalized before”

it might say

“No, this is the first time”

The essence of PARRY was not in individual answers but in the fact that it could keep up a conversation like these for dozens of turns and appeared to have things it wanted to say, particularly stored resentments about the Mafia and bookies at the race track. It appeared to have a personality and many users (and it had thousands) refused to believe it was a computer at all.

This dichotomy between theory-driven models and performance driven models persists to this day. One could classify the different approaches to HMC roughly as follows.

3 The current state of play

One could argue that Human Machine Conversation (HMC) is now in a position like that of machine translation fifteen years ago: it is a real technology, coming into being in spite of scepticism, but with a huge gulf between busy practitioners getting on with the job, often within companies, and, on the other side, the researchers, in linguistics, artificial intelligence (AI) or whatever, whose papers fill the conferences. The rise of empirical linguistics has largely closed this gulf for machine translation and related arts, but not as yet, for HMC. First, let us set out historical trends in HMC, for if the HMC world is really as disparate as what follows it is hardly surprising there is so little consensus on how to progress.

1. Dialogue analysis based on models of individual agents’ beliefs and knowledge structures, usually presented within an AI-Derived theory of plans, inference and possibly speech/dialogue acts and truth maintenance, many using a “space” metaphor to represent individuals (e.g. Allen [8], Traum [9], Kobsa [10], Ballim and Wilks [11]).

2. AI-derived models of dialogue based on more linguistic notions and not primarily based on models of individuals; the representation is often in terms of partitioned semantic nets to represent domains but uses concepts of focus, failure, repair etc. (e.g. Grosz and Sidner [12], Webber [13]).

3. AI-derived models based largely on transitions in domain scripts, driving top-down inference but augmented by local inference rules representing quasi-plan etc., no models of individuals (e.g. Schank [14]).

4. Sociology/Ethnomethodology tradition of descriptive conversational analysis, usually based on local transition analysis types in actual dialogues, analysed non-statistically (e.g. Schegloff [15]).
5. Local AI theories of discourse, usually without models of individuals or domains, but with a taxonomy of speech/dialogue acts and inference rules applied bottom-up to utterances (Charniak [16], Bunt [17], Carletta [18]).

6. Transition network models of general discourse moves–apparently global but domain-independent scripts but largely dependent on local alternatives–a dialogue version of “text grammar” and in some ways a normalization of (4) above (e.g. Whittaker and Stanton [19]).

7. Empirical analysis of dialogue corpora to produce statistical measure of dialogue turn transitions based on a taxonomy of dialogue acts the first empirical pragmatics? In some ways, the provision of evidence for forms of (6) and so (4). (e.g. Maier and Reithinger [20, 21]). Pattern-matching approaches to bottom-up dialogue analysis, providing input to some higher representational form and rejecting the possibility of effective dialogue grammar (Colby [22, ATIS [23] and CONVERSE [24]).

8. Full treatment of empirical dialogue analysis, derived automatically from corpora, transducing from utterances to some form rich enough to support dialogue acts, whether in terms of some conventional grammatical representation or a fusion of taggers, lexical strings and pattern matcher outputs.

The themes and approaches in this list are probably not wholly independent and may not be exhaustive. Notice that, thirty years after PARRY, no real form of (9) exists, and the corpora from which it might be done (for English at least) have only very recently come into existence. An interesting question right now, is whether (9) can be done in a principled way, as an alternative to PARRY-like systems built up over long periods by hand, or many of the other types of systems above with trivial vocabularies and virtually no functionality. This was exactly the opposition in machine translation for many years: with SYSTRAN’s large hand-crafted functionality contrasted with a host of theoretical, published, acclaimed but non-functional systems. In Machine Translation, that opposition began to collapse with the arrival of IBM’s statistical MT system about 1990. The possibility of a meaningful empirical pragmatics could do the same for HMC.

One additional point should be made here: we have said nothing of computer recognition (and production) of speech in dialogue systems. Speech research has pursued its own agenda, separate from written text, and all the above systems communicated via screen typing. The chief speech problem was always decoding the signals into words, rather than the content of dialogue as we have described it above–researchers tended to assume that speech could be solved separately and then a dialogue model of one of the following types just bolted on, as it were. This agenda for research has had obvious defects, especially in that speech phenomena like pauses, stress, pitch etc. convey meaning as well–but basically there has been agreement on all sides until now to separate out the speech and language issues so as to progress.
4 The Loebner Prize

The Loebner Prize Medal is awarded annually to the designer of the computer system that best succeeds in passing a variant of the Turing Test, in which human judges communicate with a workstation and try to decide which of the systems in the competition is a program and which a person. The winning program is the one the judges are least able to distinguish from the human interlocutors taking part. Complex competition rules control typing speeds and so on, so that the machine entries do not give themselves away by typing too fast. The competition is overseen by the ACM, the main US organization for computer professionals, and for the last two years there has been no domain restriction on what can be talked about: programs entering must in principle be prepared to talk about anything at all. CONVERSE (the 1997 winner) had strong views on the lesbian couple Bill Clinton had welcomed to the White House the night before the competition, and of course on Clinton himself. It narrowly beat out the 1998 winner, an Australian program that claimed to be a 14-year-old girl marooned on a desert island and appealing for help over the World Wide Web.

Competitions have included American, Canadian and Australian programs and it is the first time it has been won by a non-US team. David Levy, Director of Intelligent Research, claimed that in twenty years people will be falling in love with these programs, and they are certainly more stimulating than Tamagotchi pets, and of a far higher standard than the Chatterbots currently available on the Web. The example below simply repeats exactly the kind of limited paraphrase, masquerading as chat, that was to be found in Schank’s programs in the early 1970’s. More details on past and future competitions and full transcripts of the 1997 Loebner competition can be found on the Web site: [http://acm.org/~loebner/loebner-prize.html](http://acm.org/~loebner/loebner-prize.html). A sample of CONVERSE’s 1997 performance is at the end of this article.

5 CONVERSE

The CONVERSE program was not intended to be based on any scientific research but on hunches about how to do it, while taking advantage of some recent methodological shifts in computational linguistics towards empiricism and the use of real data. The main hunch was derived directly from PARRY’s impressiveness when compared with its passive contemporaries like ELIZA. (Weizenbaum, 1976) PARRY had something to say, just as people do, and did not simply react to what you said to it. It could be said to rest on the hunch that a sufficient condition for humanness in conversation may be what Searle calls intensionality: the apparent desire to act and affect surroundings through the conversation, which is a strong version of what we are calling “having something to say”, since a computer program without prostheses can only create such effects through speech acts and not real acts on physical objects. The extension of this hunch as far as Turing test situations are concerned – i.e. fooling people that the
system is human—is that if the computer can get to say enough, to keep control of the conversation, as it were, through being interesting or demanding so that the human plays along, then there is correspondingly less opportunity for the human interlocutor to ask questions or get responses to an unconstrained range of utterances that will show up the system for what it is. Naturally enough, this hunch must be tempered in practice since a system that will not listen at all, and which will not be diverted from its script no matter what is said, is again inevitably shown up. The hunch is simply that, and translatable as: be as active and controlling in the conversation as RACTER, PARRY’s only real rival (as regards interestingness) over the last 30 years, worked on the principle of being so interesting and zany that many humans did not want to interrupt it so as to intrude new topics or demands of their own. Others were less charmed of course, but it was one very effective strategy for operating this key hunch, and one not involving clinical madness, as PARRY did.

The original features of CONVERSE are as follows:

1. top down control of conversation by means of a range of scripts, plus an active bottom up module seeking to answer questions etc. using a set of data bases on individuals.

2. control and interaction of these features in (1) by means of a weighting system between modules that could be set so as to increase the likelihood of one or another of these modules "gaining control" at any given point in the conversation.

3. the use of large scale linguistic data bases such as thesaurus networks giving conceptual connectivity—for dealing with synonyms—and large proper name inventories (Collins’ dictionary proper names in our case) that allowed CONVERSE to appear to know about a large range of people and things not otherwise in the scripts, the data bases, or the semantic nets, though this dictionary information was formally mapped to the structures of the semantic network and the databases.

4. a commercial and very impressive text parser, based on trained corpus statistics. This however had been trained for prose rather than dialogue which meant that much of its output had to be modified by us before being used. We also made use of large scale patterns of dialogue use derived from an extensive corpus of British dialogue that has recently been made available.

The last takes advantage of recent trends in natural language processing: the use of very large resources in language processing and intermediate results obtained from such resources, like the dialogue patterns. It meant that CONVERSE was actually far larger than any previous Loebner entry, and that much of our effort had gone into making such resources rapidly available in a PC environment. So, although not based on specific research, CONVERSE was making far more use of the tools and methods of current language processing research than most
such systems. Its slogan at this level was “big data, small program” which is
much more the current trend in language processing and artificial intelligence
generally than the opposite slogan, one which had ruled for decades and seen
all such simulations as forms of complex reasoning, rather than the assembly
of a vast array of cases and data. CONVERSE, although, it has some of the
spirit of PARRY, does in fact have data bases and learns and stores facts, which
PARRY never did, and will allow us in the future to expand its explicit reasoning
capacity. The weighting system would in principle allow great flexibility in the
system and could be trained, as Connectionist and neural network systems are
trained, to give the best value of the weightings in terms of actual performance.
We will continue to investigate this, and whether weightings in fact provide a
good model of conversation—as opposed to purely deterministic systems that,
say, always answer a question in the same way when it is posed. In the end,
as so often, this may turn out to be a question of the application desired: a
computer companion might be more functionally appropriate if weighted, since
we seem to like our companions, spouses and pets to be a little unpredictable,
even fractious. On the other hand, a computer model functioning as a counselor
or advisor in a health care situation, advising on the risks of a certain operation
or test, might well be more deterministic, always answering a question and
always telling all it knew about a subject when asked.

The CONVERSE Personality
The apparent character of CONVERSE is Catherine, a 26 year-old female editor
for a magazine like Vanity Fair, who was born in the UK, but currently lives
in New York. The contents of Catherine’s character are stored in a database of
features and values, known as the Person database (PDB). The kinds of things
that we store about Catherine are the details of her physical appearance, her
birthday, astrological sign, some of her likes and dislikes, whether she has a
boyfriend, where she works, etc. For the most part, things in the PDB are all
related to facts about Catherine. We can also store information about other
people in the PDB, in particular people that are related to Catherine in some
way: her mother, father, friend, boss, etc. Scripts are the driving force of the
program and whenever possible, we aim to keep control of the conversation, by
posing a question at the end of a system utterance. The scripts cover a range
of 80 topics, but this can be easily extended (within the limits of the hardware)
with a graphical script editing interface. Currently, some of the topics covered
are crime, racism, religion, the Simpsons, mobile phones, abortion, travel, food
and violence. These are only differences of topic not of genre or style. The
method for acquiring the scripts is done in a two stage process: first, a script
writer sketches out the script on paper and secondly, the scripts are entered into
the system via a semi-automatic script editor. The script editor establishes the
flow of control through the script based on the user’s responses to each script
utterance.

Amongst the recreational applications which are foreseen for CONVERSE,
foremost is the idea of using it as a virtual friend. CONVERSE’s Person Data
Base can be augmented with data for different personalities, enabling the user to talk, on one day, to a virtual elderly English gentleman and on another occasion to a virtual 20-year-old punk music fan from the Bronx. Eventually the user should be able to describe the personality with whom he wishes to talk, and there would then be a module to create a suitable Person DataBase conforming to the user’s specification.

**Extending CONVERSE**

CONVERSE was based on quite simple intuitions: that conversational skill is a compromise between two tendencies. First, there is the active, top-down, intentional driver with something to say (the feature that Colby’s PARRY (Colby 1971) had and Weizenbaum’s ELIZA (Weizenbaum 1967) so clearly lacked).

Secondly, there was the passive, bottom-up, listener aspect which meant understanding what was said to it and react appropriately, by answering questions or even changing the topic. This, as all researchers know, is much harder because it requires understanding. Humans who lack it are conspicuously bad conversationalists but this is normally attributed to not listening rather than not understanding what is said. We could call the simple CONVERSE architecture (Figure 1) Pushmepullyou (after Dr Doolittle) to convey the tension between the two elements.

What we are now engaged in is an attempt to move both the push and pull sides to a higher level. For the latter we hope to use a model of individual agents beliefs and intentions we have worked on (in Sheffield and New Mexico) for some years, called ViewGen [26], it is a well-developed method (with several iterations of Prolog programs) of creating and manipulating the beliefs, goals etc. of individual spaces for inference we call environments, all controlled by an overall default process called ascription that propagates beliefs etc. from space to space with minimum effort so the system can model the states of other agents it is communicating with.

It is based on the general assumption that a communicating agent must model the internal states of its interlocutor agents as best it can, not just by storing their features, like age and size, but their own states. This system is much stronger than the rather elementary Person DataBase in CONVERSE but we intend to strengthen that with aspects of ViewGen so as to increase its functionality substantially.

The more immediately challenging move is to replace the push-me or parsing side of CONVERSE, which was based on a statistical parser of general English prose with a shell of what we called microqueries which adapted it to dialogue from normal prose.

We are currently working on a robust parser of English conversation, which is to say, a transducer from sentences to a set of dialogue acts plausible for any domain. Now is a perfect moment to do this since corpora of English dialogue (like the British National Corpus or BNC) have now become available so that this task can be seen as an extension of contemporary empirical computational linguistics into the field of pragmatics itself, the last bastion. The chief diffi-
Figure 1: The CONVERSE Architecture
culty, suffered by all researchers in this tradition, is that although the BNC is available for unsupervised training, there is very little dialogue corpus (Apart from Edinburgh’s MAPTASK [27], Rochester’s TRAINS and a corpus at Verb-Mobil) which is marked with a set of dialogue acts for supervised training and evaluation. There is currently an international initiative (DAMSL) [28] in this area but as yet few signs of progress. The next key step in empirical linguistics, one not yet achieved anywhere, will be such a robust model of English dialogue structure, probably using machine learning methods, a task so far only attempted for speech interfaces in very narrow domains.

6 Conclusion

It is worth emphasizing again how surprising it is that only recently, and within the Loebner competition, have levels of performance in HMC got back to the PARRY levels of nearly thirty years ago, in spite of all the theoretical activity since then—it has not led to much robust conversational performance. Even now if you check out the Chatterbots on the web they are of astonishingly low quality, far, far below that of the Loebner winners. A recent one, Peedy, chosen at random, told a user that:

Just type in a sentence like:

\[ \text{John gave Mary a book because it was her birthday} \]

and then you can ask the corresponding questions:

\[ \text{Did you give Mary a book} \]
\[ \text{What did John give Mary} \]
\[ \text{Who gave Mary a book} \]

and so on.

Those who look back at Schank’s inference system of 1970 will see that the example comes straight from there which is yet further proof, if it were needed, of how little movement there has been in some theoretical and empirical areas. In spite of its brusque approach to a complex technology, only the Loebner competition has been able to refocus R&D on robust and realistic performance, avoiding both the traps of theory without performance, and the performance trivialities like Chatterbot just quoted.
7 Appendix: CONVERSE Output from Loebner Competition

PROGRAM[10:18:04] Hi, my name is Catherine, what's yours?
JUDGE04[10:18:32] My name is Elliott.
PROGRAM[10:18:34] Well, it's nice to meet you, Elliott.
PROGRAM[10:18:48] Did you see that story on CNN last night about the lesbian couple who came out at a White House party on Sunday?
JUDGE04[10:19:55] Yes, I did. I think it may all be a publicity stunt for Ellen.
PROGRAM[10:20:01] Ellen Degeneres was one of them - she was kissing her lover in front of Bill Clinton. Do you think he was very embarrassed?
JUDGE04[10:21:00] I think he wants the gay vote. He will do anything to get it and keep it.
JUDGE04[10:21:15] He does not have a conservative base.
PROGRAM[10:21:21] Are you still a Friend of Bill Clinton?
JUDGE04[10:22:20] I am not sure if he has any real friends. He has achieved a lot and has left a lot of people behind.
PROGRAM[10:22:35] You really don't like the guy--well, at least that's definite--I thought most people were just indifferent or numb by now.
JUDGE04[10:23:34] I think we could have a more honest and dynamic leader. One able to face the real dangers facing the country and address them with courage and intelligence. Rather then listening to public opinion polls.
PROGRAM[10:24:30] I guess that means you really think there's serious behind Whitewater, the Special prosecutor and all that stuff?
JUDGE04[10:25:58] We have two dead people, Brown and guy who committed suicide, we have lost papers. And we have Clintons people willing to tell all. I think that Hillary will be found guilty of something.
PROGRAM[10:26:58] But how do you actually feel about him, now in the number two term?
PROGRAM[10:27:09]
He is too smart to get caught. He deserved to named hotel manager of the year. OK, but what happens now--does it all drift on, with everyone waiting to see how much his friends have said about him under threat of lots and lots of jail—or will something dramatic actually happen?

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