

## BusTUC – a savant level intelligent bus oracle

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### Abstract

A natural language bus route expert system has been developed during the last 12 years. It is bilingual and has up to now answered millions of questions about the bus departures in Trondheim. What it seems is that the system has reached a level of a savant. This claim is discussed in the paper, drawing some lines into its future development.

## BusTUC – a natural language bus oracle

A natural language bus route expert system has been developed during the last 12 years. The so-called bus oracle BusTUC (Bratseth 1997), (BusTUC, 1998) was installed in 1998 at the bus company Team Trafikk's website (Team Trafikk, 1998) and has been in daily use since then. It has answered more than 3 million queries so far, in Norwegian and English, and there are no reports of any system with similar capabilities.

Route information systems exist all over the country. They are characterized by a small set of fixed format entries like

Buran Dragvoll 1545 (*'from Buran to Dragvoll arriving before 1545'*)  
Buran 1545 Dragvoll (*'from Buran to Dragvoll departing after 1545'*)

This is also allowed for the bus oracle, but the oracle allows a nearly unlimited variety of natural language sentences. According to its own requirement specification, everything that is understandable shall be understood - with some reasonable limitations. One example is given below.

(*Although the oracle is bilingual, all examples are translated from authentic Norwegian examples.*)

: How can I get from Buran to Prof. Brochs street on bus 20?

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Bus 20 passes by Buran at 11:11am, at 11:41am and at 12:11pm and arrives at Professor Brochs gate, 23 minutes later .

The times indicate the earliest passing times.  
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It may be that the ordinary keyword input formulation is adequate in most cases, and given that a natural language is hard to achieve, the public may live with "primitive" systems for a while, but once it is functioning for one place, it is only an administrative problem to make it run in any place.

## Savant level – a specification

A savant (Treffert, 2009) is the term for a person that has certain social disabilities, but has some extraordinary skills when it comes to memory or speed of calculations (or

*This paper was presented at the NAIS 2009 conference. For more information see <http://events.idi.no/nais2009>*

music or drawing for that matter). They understand natural language, but generally on a very naïve level, except in their very narrow domains of expertise.

With the level of natural language input follows the expectation of a system to understand everyday questions and respond in a human like manner. This opens up the challenge to implement a kind of restricted intelligence that is pleasant to communicate with. Sentences like

How are you?  
 Can you help me to come to Skistua on Wednesday?  
 Do you know what time it is?

are all questions that imply that a response is expected as if from a human. On the other hand, questions like

How many bus stops does route 52 pass between Hotel Britannia and Yggdrasilvegen 9c, 7033 Trondheim after 3:45 pm on Nov 25, 2009.

How many days are there until 21 of April 2012 ?

Which day of week is Easter day 2012.

are not expected to be answered correctly by a human operator without a savant level of knowledge. A savant level intelligence also seems sufficient because all questions that a human operator is not supposed to answer, as well could be answered by superficial and boring responses like

“I cannot answer that”  
 “That is not possible”  
 “Unknown word ‘sex’ “  
 etc.

It is tempting to allow a bus oracle to answer funny questions just for entertainment like

Are you intelligent?  
 What is the meaning of life?  
 Would you be able to pass the Turing test?

but from the bus company’s point of view, it is not desirable to let the system be more than factual except for serving the need for a pleasant conversation. The information has to appear trustworthy, and there is little room for humour.

Artificial Intelligence in the strict Turing test sense (Russell et al,2003) means that the system cannot be distinguished from a human in general conversation. In other words, it is assessed by its ability to fool the customer to the lie that it is a human. In a strict sense, the system would fail the Turing test if it answered quickly on the questions like

How many days are there until 21 of April 2012?

The latter question is of a sort typical for savants. A time and date calculator is a necessary ingredient in a time-base information system, and is also a showpiece of savants. On the other hand, also a savant will most certainly reveal his limitations in

ordinary conversation very quickly, and fail the challenge of classical AI, but that is not considered to be the goal.

In this context, a savant level intelligence is meant as a -golden mean- between a proper artificial intelligent agent, and a computer information system. The savant level intelligence is in most cases seen as an optimal level for a natural language information system.

## Oracle guardian level

The smooth running of a bus oracle demands some human assistance. At the bus company, the traffic planner is in charge of informing the administrator of the bus oracle of all matters of the route information. The role of the bus oracle administrator could aptly be called a bus oracle guardian.

The task for the oracle guardian is to receive updates of the route database, make corrections to errors, add new words to the dictionary and give them a meaning in the system's semantic concept base, extend the grammar to new wordings and make additions to the knowledge base of a type that is not implied by the route database.

Much of the work is initiated by the oracle guardian by studying the logs of the user traffic. However, there is also communication with the bus company by E-mail. Thus, we get a new scenario for intelligent dialog, raised from the oracle savant level to the oracle guardian level.

## Handling of errors

The bus oracle has been in use for quite a while, and performs well as a rule based system. However, there may be errors in the knowledge base, as the following inquiry from a customer via the traffic planner shows.

```
Hi,  
I wonder about a thing regarding the bus oracle.  
Earlier, it was so that one could ask to know which bus one could take  
in order to come e.g. from Buran to Samfundet within a certain time,  
and the bus oracle would show routes that passes through the centre.  
Now, one cannot do that, because if one tries, one gets only an  
overview of ring routes that makes a detour by Jakobsli or  
Valentinlyst, but no routes through the center. Is it possible to do  
anything about that? It is a problem for me who lives on the other  
side of the center, if I want routes to Samfundet or other bus stops  
that (also) belongs to a ring route, for in that case, I only get the  
ring routes as answer, and these alternatives are often longer and  
more time consuming, and they don't depart as many times per hour as  
the routes through the center. For example, I know that I can take bus  
number 7 from my nearest bus stop, through the centre, and to Prof.  
Brochs street, but the bus oracle only proposes bus 20 or bus 36,  
which makes a tremendous detour. If it had been possible to solve this  
problem, it would certainly be of great pleasure for many!  
Regards.
```

In short, it is a complaint that the bus oracle preferred to give information about long routes around the city, instead of the obvious shorter routes through the city centre.

The traffic planner forwarded the inquiry the oracle guardian, who responded:

Thanks for the error report.  
 The error is caused by the fact that Bus 7 has concealed bus exchanges in the center.

```
Vikåsen --> Center M2 --> Flatåsen
Flatåsen --> Center M2 --> Vikåsen
```

This fact was not registered in the bus oracle, so the bus oracle until now operated as if the exchange in the center was explicit.

Because the bus oracle in general proposes direct routes in preference to routes with exchange, more time consuming (but direct) ring routes were proposed. The error is corrected, and will be incorporated into the bus oracle within a short time.

## Levels of knowledge and intelligence

This response was made by an intelligent person who had deep knowledge about the domain as well as the bus oracle itself. This puts the concepts of knowledge and intelligence into perspective. The error was partly resolved by a combination of world knowledge about concealed bus chances of shuttle routes, how people exchange buses, how they prefer not to exchange buses explicitly, and how the preferences were implemented in the bus oracle.

A step in the direction to increase the understanding level of the bus oracle is to adapt the bus oracle to be able to read E-mails from the traffic planner and other customers. The bus oracle was only able to understand the inquiry superficially, but it shows some of the natural language capabilities of the system. It is also noteworthy to observe how savant-like the responses are.

```
: Hi
-----
Hello
-----

: I wonder about a thing regarding the bus oracle.
-----
OK.
-----

: Earlier, it was so that one could ask to know which bus one could
take in order to come e.g. from Buran to Studentersamfundet within a
certain time, and the bus oracle would show routes that passes through
the centre.
-----
I cannot answer for so many places at a time!
-----

: Now, one cannot do that, because if one tries, one gets only an
overview of ring routes that make a detour by Jakobsli or
Valentinlyst, but no routes through the center.
-----
I can only answer one question at a time.
-----

: Is it possible to do anything about that?
-----
```

I cannot answer that.

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: It is a problem for me who lives on the other side of the center, if I want routes to Professor Brochs street or other bus stops that (also) belongs to a ring route, for in that case, I only get the ring routes as answer, and these alternatives are often longer and more time consuming, and they don't depart as many times per hour as the routes through the center.

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I have no information about ring routes.  
I can only answer one thing at a time.  
Team Trafikk has webadresse <http://www.team-trafikk.no>

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: For example, I know that I can take bus number 7 from my nearest bus stop, through the centre, and to Prof. Brochs street, but the bus oracle only proposes bus 20 or bus 36, which makes a tremendous detour.

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I cannot answer for so many places at a time.  
Next bus, number 7 passes Munkegata, M2 at 4:32 pm  
and arrives at Professor Brochs street at 4:32 pm.  
Last bus, number 7 passes Munkegata M2 kl. 11:48 pm  
and arrives at Professor Brochs street at 11:53 pm.

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: If it had been possible to solve this problem, it would certainly be of great pleasure for many!

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OK.

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## Introspective understanding issues

Although it is almost impossible for any system to explain the errors of its own reasoning, it should be a requirement for a reasoning system to explain its actual reasoning, i.e. answering so called WHY-questions. That ability has been a part of rule based systems since the day of the early MYCIN expert system (Buchanan et al, 1984). In this context, that would be comparable to answering the questions

Question: Why didn't you propose bus 7 from Buran?

Answer: Because bus 7 would have to change bus in the centre, and I assumed that you would prefer a direct route instead.

This kind of explanations is not implemented but is within the possibilities, and would have been a natural extension to the intelligence of a system.

Also, an autonomous system should ideally be able to be told new knowledge by the traffic planner, who could tell the oracle guardian that

1. Bus 7 is a shuttle route that don't need explicit bus change in the centre
2. Direct routes are not to be preferred if the time for the direct route exceeds the time with the indirect route by more than 15 minutes.

The ideal system should be complete in the following sense: It should not be necessary to reprogram it, but should be able to accept changes to its knowledge base, and this updating can be done by an authorized person in common natural language without intervention of a human expert.

## The automation of an oracle guardian

Until now, the oracle guardian has been an elderly man Albert Moe, who has put his efforts and soul into building a savant level intelligent oracle. The success of the system would also be a proof of concept that natural language information system could be made as a preferable system platform. The requirement for precision in the answers has been absolute – a system that gives wrong answers or major misunderstandings would be intolerable and fall out of use. So far, the system has been successful, as evidenced by the following authentic words of appreciation in an E-mail from the traffic planner.

```
: I look forward to a future cooperation in 2009 and I must say that I
am proud of helping with the operations of the bus oracle which I
personally regard to be best system in Norway for public information
of public transport.
```

When this was put through the bus oracle, the response was

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You must specify a date in such questions
-----
```

When years have passed, the system has grown in complexity and sophistication, but the problem of a continuing operation of the bus oracle has become a concern over its vulnerability. When Moe retires, it is difficult to find another expert to take over. As it seems, it will be mandatory to automate the operation of the oracle guardian. At what level that could be done is a matter of an advanced research project, but it is an exciting challenge. Such an automated system would be an electronic agent online representative.

This is a matter for Artificial Intelligence, but on a higher level. Also, the Turing test issue arises again. So far, the traffic planner has communicated with Albert Moe only through E-mail, which is a communication neutral medium. If Albert Moe was replaced by an autonomous system without the traffic planner noticing it, it would be a successful version of a Turing test. However, this is far from any goal! A realistic goal would be if the traffic planner accepted to communicate with the agent online representative as if it was a human. Albert Moe would assure the traffic planner that the communication (route updates, new stations, route topology changes and error reports) would be supervised – until the day of reckoning.

## Epilogue

*We could imagine that the day of reckoning has come at some future date. The electronic agent representative, ElTagore has been smoothly running to the bus*

*company's satisfaction, and other public transport companies have joined. All they do is to send route updates to ElTagore, and give all extraneous information via E-mail. Albert Moe has retired, and got increasingly senile. He was suffering from a savant retardation syndrome that is characteristic for train spotters. Their sole interest is when buses (or trains) pass, and his reading materials were limited to route tables. His conversations degraded to the level of the bus oracle, and eventually he passed away. But long before that, he left behind an alter ego hidden inside ElTagore. He had literally put his soul into ElTagore, and would respond if one addressed him with the name AlterEgo. With this system you could write (or even talk), and it would respond in similar ways as Albert Moe would have done, if you wanted a friendly talk. If the traffic planner told him*

: I look forward to a future cooperation in 2045 and I must say that I am proud of helping with the operations of the bus oracle which I personally regard to be best system in Norway for public information of public transport.

*he would answer*

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Thank you.  
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