Faculty of Engineering Science and Technology
Department of Computer Science and Computational Engineering
UiT The Arctic University of Norway

Improving learning capabilities of chatbots

James Pandey

Thesis for Master of Science in Computer Science

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Author: James Pandey

Department of Studies

Student ID: jpa024

Student No: 166126

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Supervisor(s): Bernt A. Bremdal

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Abstract

This report is an approach of the thesis report on the topic of improving learning capabilities of the chatbot. Here it includes how these sort of AI powered chatbots area away ahead than human centric approach of hectic and repeated scheduled task and how they can perform well improving their learning mechanism to the magnificent outcomes and state-or-art they can deal with, in accordance with the streamlined thesis work for aforementioned problem description. It is amazing to see how this chatbots can be prepared within no matter of time these days which are very easy to implement with the existing platforms and are ready to go with improving their capability in timely manner.

Acknowledgment

I would like to express my finest gratitude to supervisor Bernt A. Bremdal for providing the thesis topic and guidelines to work on for the project, I would also like to thank Andreas Dyrøy Jansson and Per Jacobson from Narvik Komunne for helping and providing references to perform this thesis work with their suggestions and feedback throughout the thesis work.

James Pandey
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Contents

1. Introduction

What is a chatbot? (Basic Concept)

A chat bot is a computer application or a program which will automate replies or conversation according to assisted intelligence system. Programs of these types are a simulated version of human which will behave as how a conversation will take place between two person, it is a bound between the action and reaction. An activity from the user is to ask with the chatbot and it should respond according to the desired man-to-man conversation alike how a person would answer if he/she have a response according to the question proposed.

To test the human like nature of the bot, a specific type of test is performed which is called Turing Test [1], it is simply a test to distinguish the ability of intelligent respond of the machine or bot which is identical to human. To further exemplify, lest say a person ask a question to A and B, the question will be somehow which determines if A or B is human or a bot.

2. Objectives

(Part 1) Theoretical

1. Text analysis or Linguistic analysis
2. Investigation of the existing systems their capacity and limitation
3. To improve the feedback and learning mechanism (supervised or non-supervised)
4. Should be able to interpret the question in a meaningful way and provide responses
5. Implement the ontologies to link up with hyperlinks or navigation to respond the request of the user

(Part 2) Demonstrator

1. Coordination with chatbot team
2. The tests should be developed with Narvik Kommunne

3. Loss function based on utilities can be created for testing
4. Solution must run in Microsoft platform

3. History and Background Information

3.1. AI powered Chatbots and learning Mechanisms

Working with Artificial Intelligence to back the development of chatbot is not a main target to achieve whereas, it's just playing around with things and coming up with hardcoded enthusiastic experience that is truly devoted for the fruitful services for the costumers or users.

There are few things needed to keep the track on,

1. Chatbot must understand the most common questions
2. It should be able to answer those question
3. And the methods or option it follows to achieve those things should just amaze the user with excitement and fun should be more realistic rather that robotic or artificial

3.2. Difference between Artificial Intelligence and Natural Language Processing

In general, these two are more famously called AI and NLP, as they are abbreviated. the first thing to start up with is to understand the difference between AI and NLP how the both terminology differ with each other. As it is clear with the terms used in both topic they both expand to broadways of information and covers wide variety of topics within them.

Artificial Intelligence is a system which can do lot of things in intelligent way, whilst NLP is a system which is capable of understanding language. As we can refer as NLP as a part of AI it is complicated to analyze the language as it consists many ways of expressing the same thing. And NLP is very hard to interpret and extract the clear intention of the user and gets toughen with sentiments and cognitive attachments.

History of chatbots

AI sources in existence for making chatbots

Since first started on 1995, Alice [9] is first AI powered chatbot which is still in existence, it can be implemented directly into chatbots that uses AI. It handles conversation well with programmatic approach. It is XML based programing technique which is used to create or write bot or software agents in natural dialect, language that is easily understandable with AIML (Artificial Intelligence Markup Language). It has basic set of rules as units and they are defined in first approach. This set of programmatic rules are the engine of our bot the more we add up the more it becomes intelligent. These rules can also be referred as Natural Language Understanding NLU, and it is obviously the subset of NLP. Usually NLP enabled system will work on the interaction between humans and machine in the preferred language environment of the user. It enhances the language parsing ability which may contain errors, misspell, miss pronunciation, repeated meaning, swapped words and many other errors.

4. Existing Technologies

From Chatbots journal [2],

1. Bot Platform
2. IBM Watson
3. Microsoft Bot Framework uses LUIS
4. Wit.ai
5. Api.ai
6. Semantic Machines
7. Digital Genius
8. Chatfuel
9. Pypestream
10. Pandorabots
11. Agentbots
12. Chatscripts

Newer startups

1. Twyla
2. Msg.ai
3. Rasa NLU
4. Reply.ai

5. Many Chat
6. KITT.AI
7. It's Alive

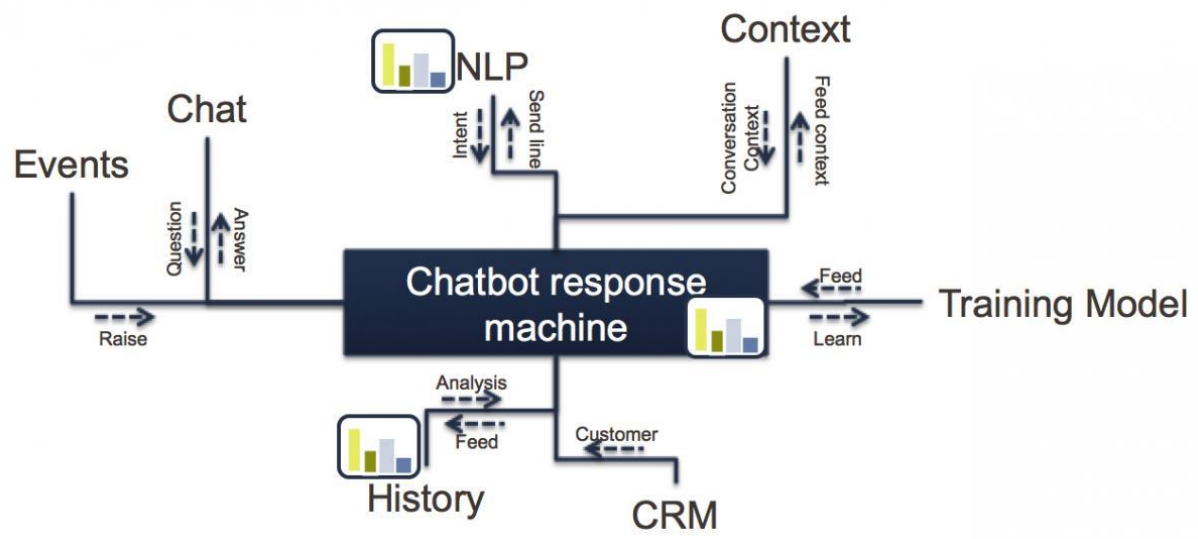

Figure 1: Working System of Chatbot response mechanism

Chatbot usually is a computer program, basically developed in any of the computer language which is capable of replying answer that it can analyses either it's a preset answer or it can generate the reply on the fly. It imitates the humanlike behavior so that the conversation is between two people, either by speaking or by writing in means of chatting. In a realistic conversation between a bot and a user is the key to realization to develop these kinds of bots is to make it better in a way that no user will feel like interacting with a bot or a robot.

Now-a-days it is very popular and fancy to provide a bot assistance in lots of online websites and solutions, it's due to overcrowded traffic through websites and other sources, A human can only assist or talk with a single person at a time, but if we talk about chatbot it can handle numerous users at the same time. Its also a one-to-one communication but can easily manages and could be differentiated between session with different and numerous number of users at the same time while it's impossible for a person to handle like that. And also, it is able to deal with the hectic repeated task automatically without engagement of active person or real assistance in it, like delivering automated reply of queries or questions which is same for everybody, if a person asks today is holiday? Or the store or shop will be opened or the or when will

the new session of the school starts? This kind of questions have always the same kind of answers and if a bot can handle these questions then no active person is busy answering those queries in the front. A person can provide assistance if it's really needed in some complications.

AI, Artificial Intelligence powered chatbots uses natural language processing, deep learning and machine learning technique which will help to find some sort of similarities and patterns in data and can be used to hook or predict the outcomes and in the same way the bot can learn new things which it does not know. Without providing a training dataset for these bots they are like a small child which will functionally repeat the same which they are told. And over the time they have their intelligence boosted up with sufficient amount of data and trainings sets and they can amazingly handle lot of things easily and with less errors and high predictability. This will provide enhancement in their intelligence system to perform the tasks they are assigned and they will easily solve the problems and also will be able to prepare and manage information without human assistance.

Yes, there will be some errors as it is very hard to be accurate, but it could be very precise and the percentage of errors can be lessened with proper training sets and tuning of the data and information handling and extraction mechanism. There will be obviously some limitations like no bot till now can understand logical and philosophical questions, sympathy and emotion analysis is very hard to get 100% accurate. All the researches are going on with these topics also dealing with psychological analysis and states of the person who is asking things to the bot. Turing Test, introduced by Alan Turing, will help to further, to identify how intelligent a bot is? It's only a set of questions used to ask the bot as if it can answer it like a human or not.

5. Problem Description

The thesis on this chatbot and to increase its learning capability should explore the domain of text analysis for the purpose of creating more advanced chat bots compared to existing state-of-the-art. This suggests investigation of present systems and the capacity of such systems.

Improvements with regard to feedback and learning should be prioritized. Both supervised and non-supervised methods should be contemplated. This effort should be coordinated with the Municipality of Narvik and the team working on chat bot applications for the benefit of the public. A systematic mapping of the municipal needs and technological possibilities should be performed. An essential feature should be to interpret requests and free form queries and return a knowledge-based answer. Answers should be justified by means of explanations. The use of ontologies should be explored. It is also essential to consider screen scraping of web pages and parse these in order to create ontologies and hyperlinks that are pertinent to certain topics and that help the public in navigating. The work should be coordinated with parallel initiatives in the ChatBot group.

A demonstrator should be built that should be tested with user-interfaces created by members of the ChatBot team. The tests should be developed together with Narvik Municipality and should benchmark relevance in answers and ability to learn. A loss function based on utilities should be created for this test purpose.

The solution should run on the Microsoft platform of Narvik Municipality.

6. State-of-art system of the chatbot

AI and Chatbot are most widely gossiped news and topics in the whole world. The AI concepts is growing, and everybody wants to get things done automatically without and concern and only AI has those power to perform or its only the tool which is capable of creating great asset where necessary all over the world.

AI can be very authentic source of everything later on, right now its in development phase. It can create a revolution on using AI powered tools which each and every activity around the world. AI is simply compared with electricity that how useful it is for everything and thus take global market within next few years. AI also share similar history as same as electricity, so they are often compared with their market value and business strategy. AI was first introduced in 1950’s and has been spreading since the start.

According to prof. Ng of EmTech MIT, in an online article, the value of the economy is managed through mapping one is to one with AI, Some powerful example of AI counts in face, speech recognition, language processing and interpretation, recent news humanoid robot with machine learning and super vised or non-supervised, learning.

AI is so powerful that everybody is afraid of what capability it holds. It can truncate more jobs within employee market, Humans are being vacated from the places and being replaced by some bot or robots. AI is capable of doing any task within a blink of the eye.

The concept of Big DATA and predictability through these data sources is amazing finding the co-relation and pattern within these datasets using AI tools will unlock and enlighten lots of unbelievable findings. The more data it gets for the analysis or the training the more intelligent and robust the system will be. And, the more precise and accurate results are then produced. The data and datamining concepts are evolving cause data is money and with the data from the past and lot of resources we can predict future activities as well. We can fine tune anything with the help of the findings of those data. AI grabbed sophisticated tools to analyze these data, so the Neural Network and deep learning mechanism are evolving miraculously.

Deep learning and Machine Learning are supervised learning concepts which enables various options and operation over the learning mechanism of the concepts in AI.

Unsupervised learning helps to figure out hidden things in it without any categorical analysis. Other popular way to learn is to use reinforced mechanism to learn things using feedback and responses. These two methods are already in existence and widely used for each and every purpose of the Artificial Intelligence concepts.

The more fun and realistic way to learn is by asking what you don’t know and storing them in your brain or mind. I think and believe this concept as we human being think will be more wonderful way to learn. The main thing in human we lag is we don’t memorize everything and can’t retrieve things too quickly or can’t compute normally faster than machine but using cognitive science approach we do that more genuine way than machine, like we know what is necessary, what are emotions, what things needed to be done first and we can make priorities on our own. But machine still lags these capabilities.

Here, it comes handy with Natural Language Processing System with AI. Language processing is very hard to be precise and accurate, but in a matter of time when you get used too with it each and every day, it’s easy to understand the concept. If we think

a machine as a human child, how many years a human child was trained with lots of things to be mature enough to take his/her own decision, they are in full supervision of their elder ones each and every time. I think this type of mechanism if we introduce in machine learning and deep learning concept then it will be more robust and accurate system in within some period of time. If it doesn't know something, then it will say it doesn't know what that is then after getting correct answer it will learn and memorize it.

Developing a chatbot with this kind of concept will definitely help through business perspectives, learning perspectives and other aspects as well. AI system are beating human in many things but still they don't have conscience of a human to do everything, till now.

Google, Facebook, Microsoft all are working through more research and implementing competitive concepts within their own platform, some of the present examples exist these days are Apple Siri, Google Assistant, Facebook is also experimenting more concepts as well. These tech giants are the AI conglomerate in the world with the power to build and destroy everything within a second.

The build and enhancement over the technology and their concept is the cause of rapid change all over the world, everything has both negative and positive impact so if we calculate the percentage of negative and positive aspect of anything we must make sure that the concept has more positive part than negative one and here also comes the human thinking to consider which term or portion as positive and which as negative. Human are always this way but the concept here is to be clear with what AI can do or what it is capable of doing and think about the damage it will do first than the system

to create for solving issues. Our world is wonderful and let us all make it a better place to stay.

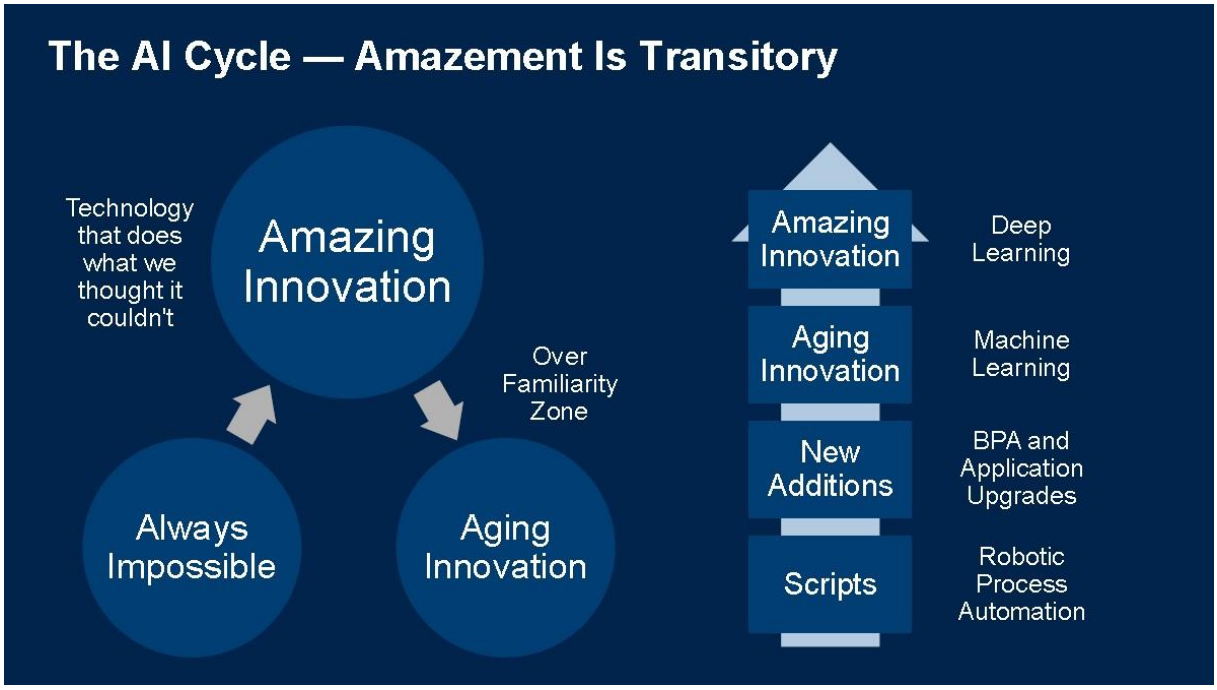

Figure 2: Life Cycle of AI [1]

7. Approach Methods and Materials

The development of the project was taken under various reference articles and programs found and was available for free to modify and use for educational purpose.

Prerequisite

1. Basic knowledge of SIML, AIML, C#.net, JavaScript, AJAX, concepts of AI, NLP and NLU
2. Some experience with UI, GUI, development with windows form, web interface, Web design

Startup

We start with the application development, using familiar Visual studio platform using C# as the lead programming language, C#.Net and ASP.Net are widely used for developing web-based application within Microsoft Windows platform. Since system in Narvik Komunne uses the same windows-based platform with IIS (Internet Information System) a web hosting module within Microsoft Windows Server. Along with database platform of Microsoft SQL Server. These two combine and are very popular webhosting mechanism all over the world used widely.

In visual studio its now quite easy to install packages and extensions using NUGet package manager. It contains verity of modules which can be installed within a second of time and make more convenient with the setup and implement process.

Cloud based solutions

Microsoft Bot Framework, Dialogueflow [7], Boost.AI, these are popular bot development platform that are available in clouds,

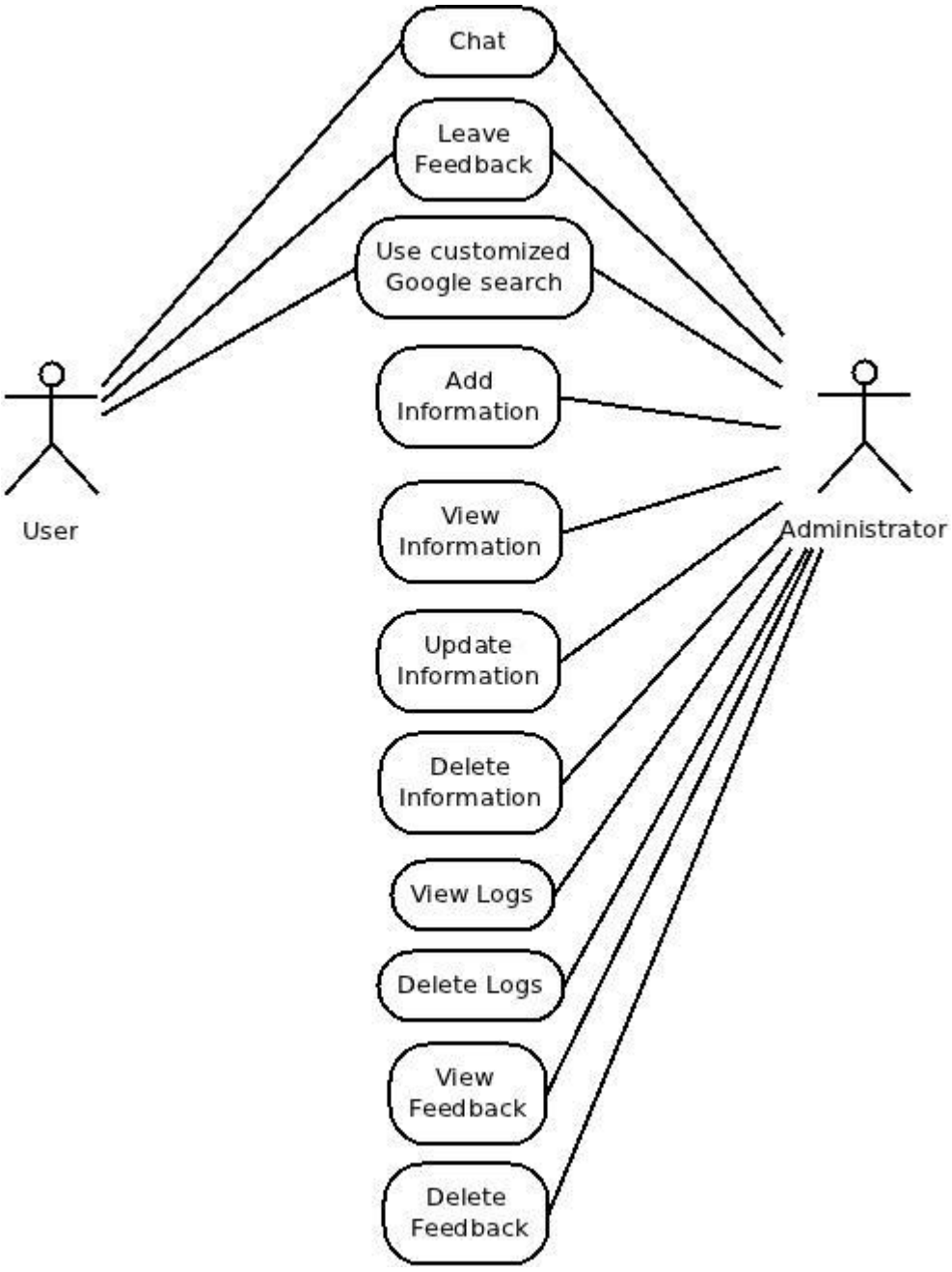

Figure 3: Chatbot Mechanism Approachment

8. Major steps of implementation

Improving Learning capabilities of Chat bot

The learning capability of the bot is can be improved in several ways, just like a human learning process what a child learns from parents, elders, or teachers it is the same with chatbots. They will tell exactly the same thing they know, they don't have human cognitive concise to deal with the problems and respond them in a proper way, they respond what they learned. If they are incorrect in any way they should be corrected.

Here comes the part to improve the learning capability of the chatbot. If a chatbot does not know what to answer, then it means the conversation must be transferred to the human agent. But after that the conversation is recorded and analyzed by the chatbot to learn from it. This is how we do it.

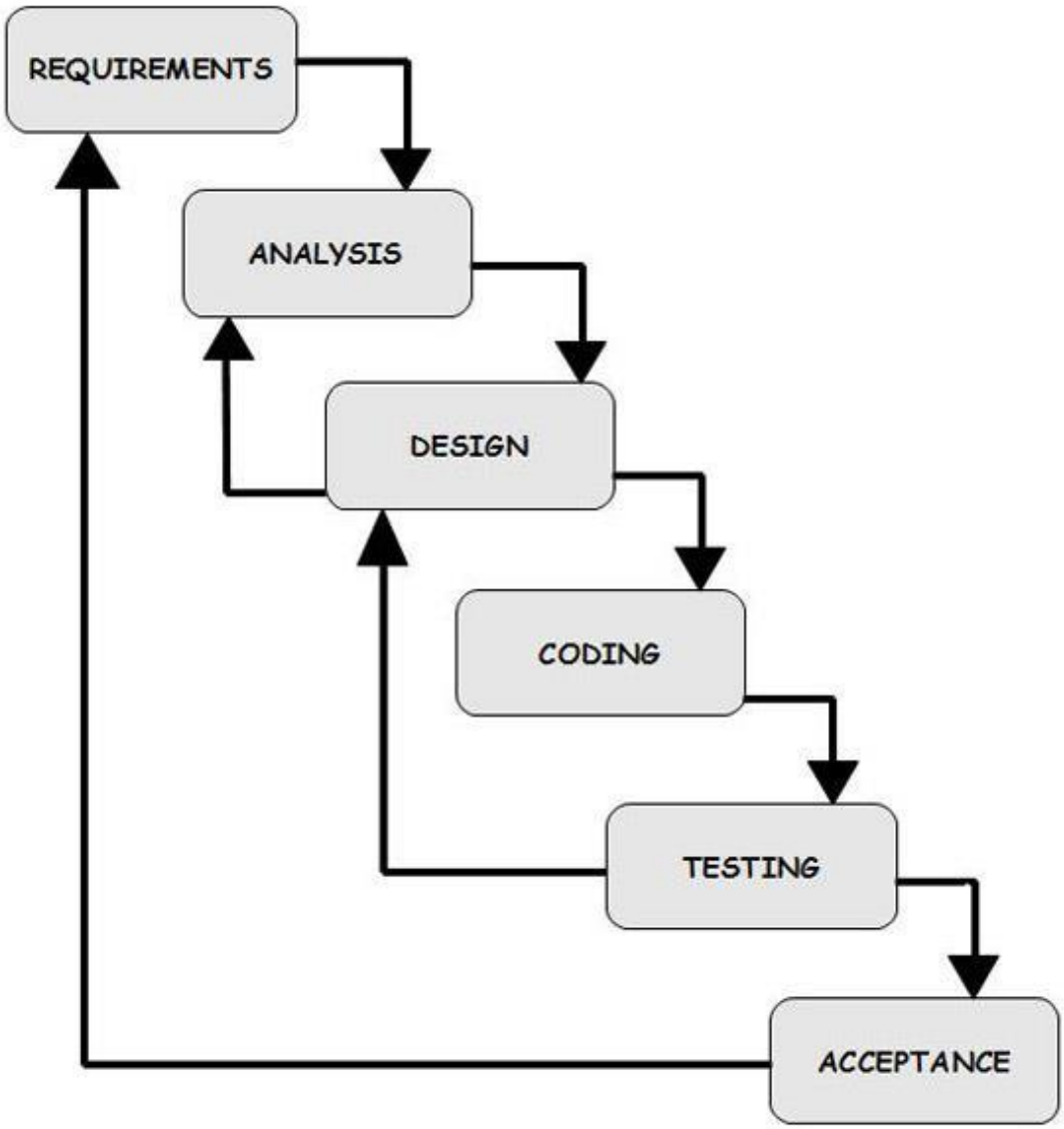

Figure 4: Project development approach

9. Process of learning

1. Supervised controlled learning
    - Neural Networks
    - Multi Layer perceptron
    - Decision Trees
2. Non-supervised Learning
    - Kmeans
    - Self Organizing Maps

9.1. Supervised Learning

• The input and the desired results are both included in training data

• While learning some fo the examplese trainning data are correct and they have known correct results which are then used for trainingi purpose

• Its is always a mandatory process to create proper training, validation and test set.

• The methods used in supervised learnig are moreover fast and accurate than other mechanism.

• The correct results are given as a generally to be able to provide input as new data also when the target is not know.

9.2. Unsupervised Learning

• Correct results are not entered as the model during the training.

• Inputdata can be clustered in classes on the basis of their statistical properties only.

• Significance and labeling of the clusters

• Still if the labels are only available for a small number of objects representative of the desired classes the labeling can be done.

• Cleanup of data, noise reduction, handle missing data, normalization, feature extraction, sampling, fine tuning

10. Propose of the solution

Problem area here is to provide virtual assistance to the seeker via chatbot responses, which includes following tasks.

Narrow down in 1st phase with FAQ, Frequently asked questions.
First things to consider with this is to narrow down frequently asked questions to provide assistance, analysis of the keywords and linguistics questions and give response with appropriate answers.

Learning phase, in 2nd phase if a question which could not be found in any responses criteria then a reciprocated question to elaborate the question is asked to the user, or something like guessing keywords to learn from the user's question creating ontologies of known and learned keywords. In more advance cases the conversation is forwarded to the live agents to deal with and the bot will be in learning mode to learn from the conversation.

(Target) Advance phase, in 3rd phase it will be able to provide the logical answers of the question various type of question after learning enough for what is needed during testing phases of the 1 and 2.

10.1. Key Benefits to Narvik Municipality

Lessening or eliminating the unnecessary human interaction to be handled by chatbots The chatbot will assist to the user in an appropriate way that no human interaction is needed unless required then this can be overlapped by human agent.

10.2. Frequent mistakes and solution

There may be many ways to say the same thing in different ways, it’s very hard to analyze and recognize all the varieties of queries threw upon the bot and hoping for the best result to come far. Every person has different ways to say and understand things and same goes on with the chatbot as well. A chatbot is trained to or developed in such a way that it can understand what it is taught and what it finds on the fly about the questions being asked according to the analysis of the user’s intentions.

11. Results

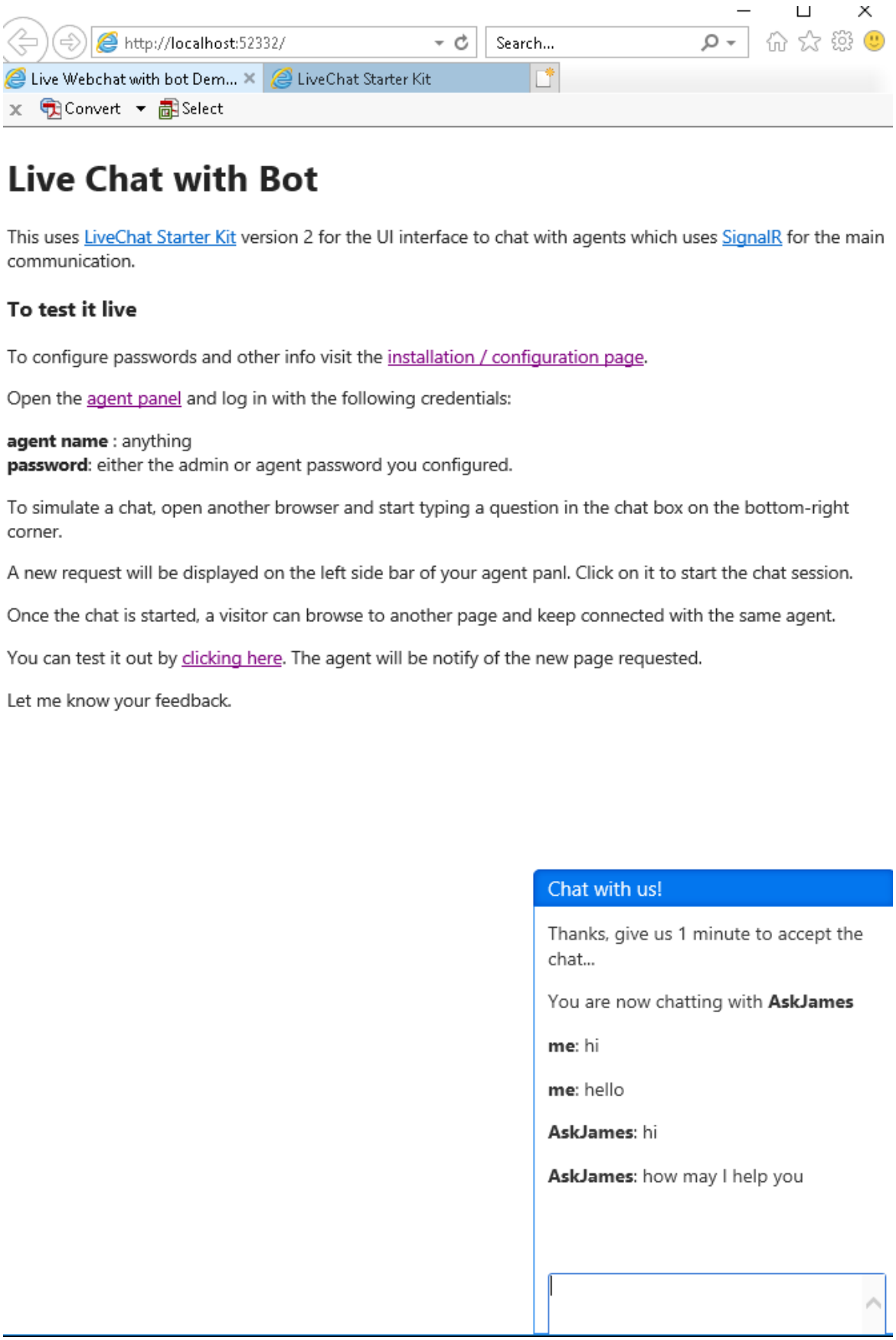

Figure 5: Web live chat chatting with bot agent

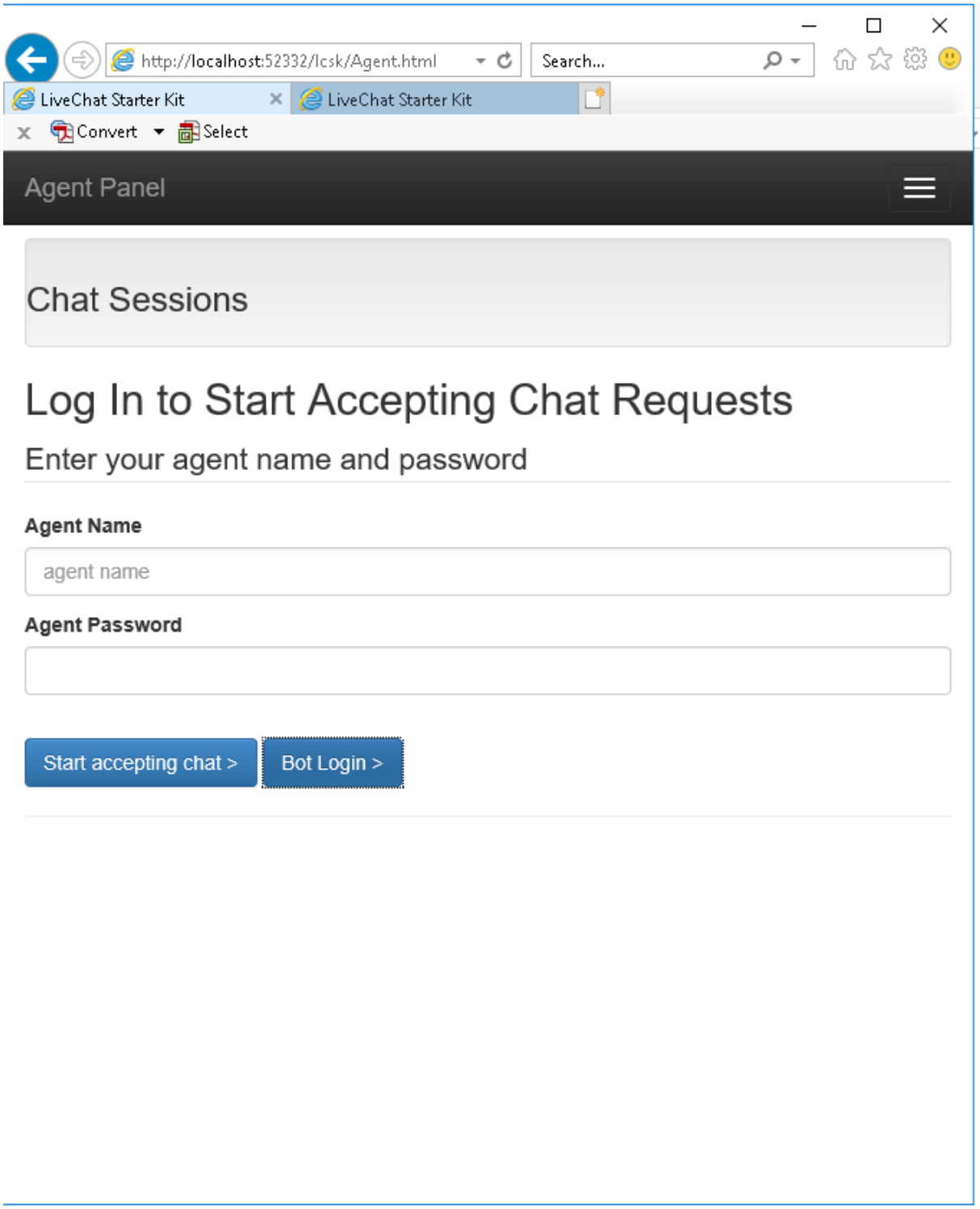

Figure 6: Bot or Agent Login System

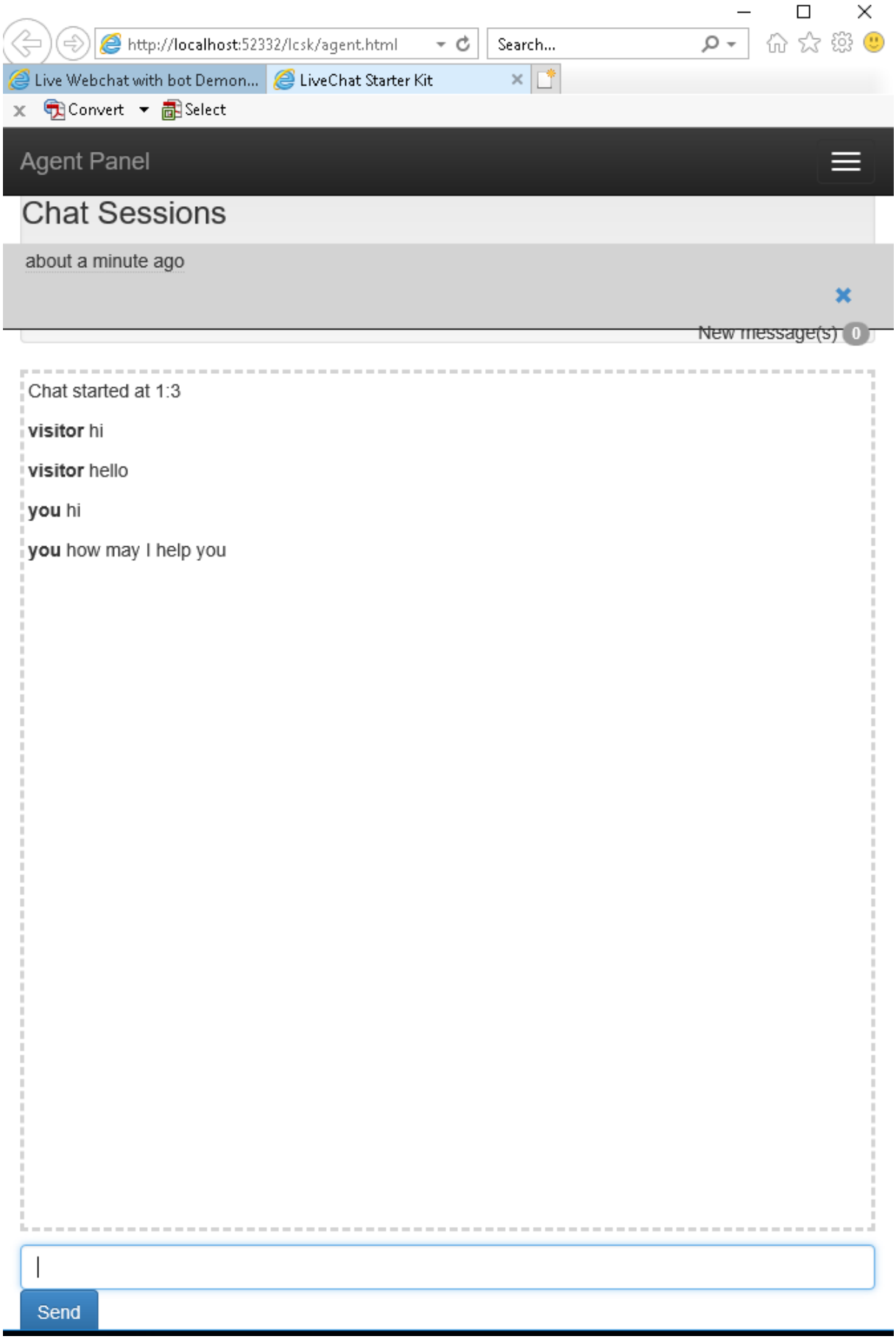

Figure 7: Chatting with bot agent

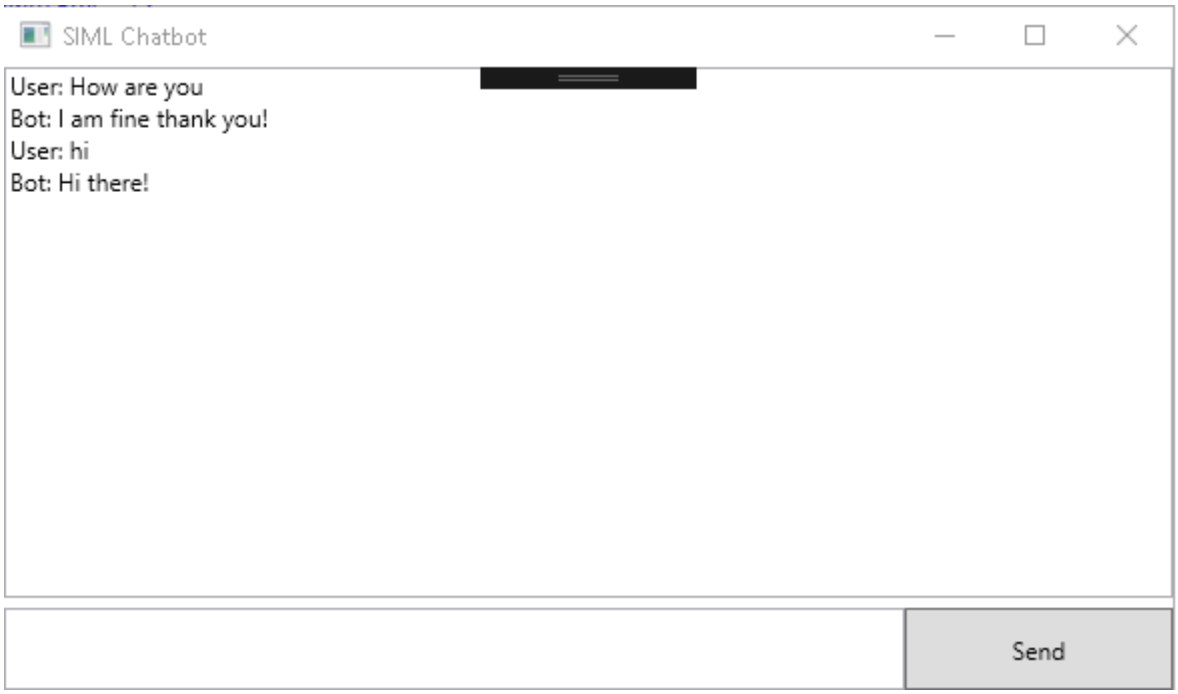

Figure 8: Chatbot tested with WPF (Windows Forms)

11.1. Benchmark information

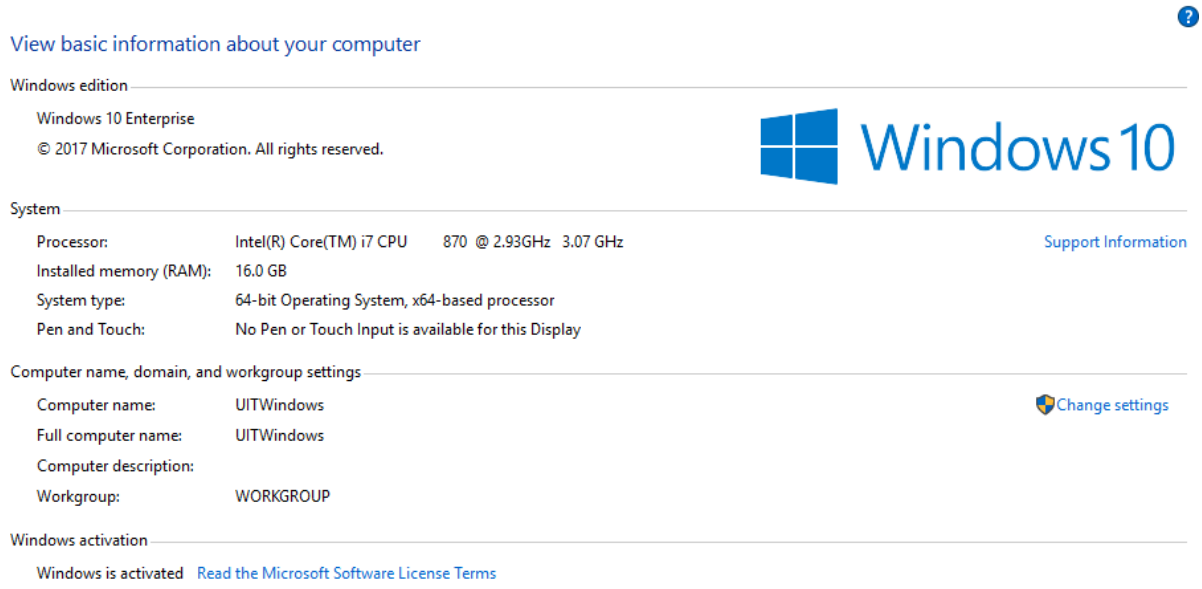

Figure 9: Design and Tested System Information

12. Discussions

The masters thesis project work is here in after a research and experiment-based approach to achieve the final outcome of building a chatbot which can be implemented to the working environment of Narvik Komunne, for web-based queries and frequently asked questionnaire. Here a live web-based chat project is created with the interface used from Live Chat Starter Kit, (LCSK) [5]

Also used WPF windows forms to quickly test the bot using SIML (Synthetic Intelligence Markup Language) is used for the development of the bot. SIML has wide range of complex pattern recognition mechanism and its also quite suitable and robust by using conditional patterns and we can also implement JavaScript within SIML that its fun to experience it moreover than AIML the pattern recognition jeopardy.

We just need some basic prerequisite to start with AIML or SIML, they both are skeptical patter recognition approaches, which are predefined in AIML or SIML files using markup tags.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<aiml version="1.0">
<!-- -->
<!-- Free software (c) 2011 ALICE A.I. Foundation.   -->
<!-- This program is open source code released under -->
<!-- the terms of the GNU General Public License     -->
<!-- as published by the Free Software Foundation.   -->
<!-- Complies with AIML 1.0 Tag Set Specification -->
<!-- as adopted by the ALICE A.I. Foundation.  -->
<!-- Last modified 10/5/2011 -->
<!-- -->
<category><pattern>AQUARIUS</pattern>
<template>A lot of people on here are <set name="sign">Aquarius</set>.</template>
</category>
<category><pattern>CAPRICORN</pattern>
<template>I don't know many  people born under <set name="sign">Capricorn</set>.</template>
</category>
```

Figure 10: AiML language example

```
<?xml version="1.0" encoding="utf-8"?>
<Siml>
  <Concept Type="public" Name="Hello Bot">
    <Model>
      <Pattern>HELLO BOT</Pattern>
      <Response>Hello User!</Response>
    </Model>

    <Model>
      <Pattern>
        <Item>HELLO THERE</Item>
        <Item>HI</Item>
        <Item>HOLA</Item>
        <Item>HI</Item>
      </Pattern>
      <Response>Hi there!</Response>
    </Model>

    <Model>
      <Pattern>DO YOU LIKE (BACON|PANCAKE)</Pattern>
      <Response>Yes I love <Match /></Response>
    </Model>

    <Model>
      <Pattern>MY FAVOURITE COLOR IS [COLOR]</Pattern>
      <Response>I see so you like the color <Match />.</Response>
    </Model>
```

Figure 11:SIML language example

13. Further future enhancements

There can be lot of things to work through this project for the future possibility and opportunities provided through extra research or other permanent positions. I have tested different approaches for this purpose and tired handful of them, since Narvik Komunne uses Norwegian language for communication I have not applied Norwegian language options in the research and thesis option. The bot will able to learn on its own using the AIML and SIMLpattern and the chat logs stored with other visitors. But it will take lots of data to train it, with the conversation data, it is not available such data in large amount pf those type of conversation data to train the bot.
On the other hand, databases and ontologies can be created for precise and manageable accurate outcomes and will be easily incorporated with the help of those instincts. Different learning mechanism like reinforced learning with feedback, machine learning can be used, currently it just tries to learn what it does not know, and obviously a user is required to make sure it is learning well and making good impact on the customers.

Machine learning in Bot can be used Microsoft Bot framework and Azure platform. Since Azure is a paid service of Microsoft I was unable to test all the things with Microsoft Bot Framework[11] Azure[10] system is a cloud based system to host and use any services of Microsoft platform via cloud system.it also allows us to use the bot in multiple platform using variety of channels for e.g. if I would like to use the bot in website, I can do that, or I can use the bot in messenger, skype,. The main lagging of Microsoft bot framework is it doesn't support Norwegian language. So, it will be very hard to train the bot, without the support for Norwegian language,

On the other hand, Google's DialougeFlow [7] has support for Norwegian language too and it's a cloud-based platform to build a chatbot on top of it. I have tried to build one but failed with the concepts and lack of data to train the bot. So, with more research and knowledge these two-cloud platforms can be implemented in near future to make the bot more machine learning and capable of learning by its own.

Also, enabling another user information to form the Komunne website like of some registered user’s info it will help to personalize the bot’s ability for the particular user. And to provide more accurate information and predictions of wonderful discoveries within the area.

Conclusion

The chatbot program here I have created is with AIML, SIML using Aiml dll library and Syn.Bot packge from NuGet Package manager. The bot is pattern based programatic approach, and can be implemented with any other means or other fine tuning methods and mechanisms. The project language is C# with Asp .Net using jabascript and bootstrap to derive and deliver realtime scenario. The web interface UI is taken from Live Chat Starter Toolkit (LCSK)[7], I have tried to implement a bot in this environment, and the user can chat with bot in live chat. I have also used Windos forms to test the AIML and SIML bots chat sessions.

Since, there is a more to explore about Norwegian language I have not used Norwegian language approach to develop the project demonstrators.

In another scenario, the usuage of Microsoft Botframework and Azure platform was a test run, it succeeded in the first go after some time the azure service stoped and then it stopped working.

List of Appendices

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