

Creating a Chatbot for Radiation Safety Training in Radiotherapy

J. Chow^{1,2}, L. Sanders³ and K. Li³

¹Princess Margaret Cancer Centre, University Health Network, ON

²Department of Radiation Oncology, University of Toronto, ON

³York University, Toronto, ON

Aim

- The aim of this study is to create a Chatbot (Bot) that serves as a tool for radiation safety training for clinical staff working in a cancer centre/hospital.
- The Bot can provide effective knowledge transfer in radiation safety to the radiation staff for refreshment and update, so as to reduce the resources required to conduct in-person classwork.

Background

- Radiotherapy is a major nonsurgical method used to control and treat cancer, as approximately 50% of all cancer patients are treated with radiotherapy. Therefore, it is essential to safeguard radiation safety in radiotherapy, for radiation staff using ionizing radiation in cancer treatment in a hospital.
- The diversity of background, professions, and certification requirements among different staff bring about challenges to radiation safety protection that need to be addressed.

Background

- Radiation safety training is required for different staff working in the cancer hospital/centre. The staff include radiation therapist, radiation oncologist, neurosurgeon, medical physics staff, nursing, service staff, and supervisor/manager.
- There are many in-person training courses such as radiation safety orientation, initial radiation safety training, refresher training, update training, remedial training and so on.

Background

- During the pandemic period, it is difficult to deliver training courses in-person to staff for radiation safety. Online training is possible but is restricted virtually for PC.
- Radiation safety training on a mobile device or Internet-of-things is desired because the trainee does not need to present in the classroom or in front of a laptop/desktop.

Motivation

- We created an AI Chatbot for radiation safety training in radiotherapy. The Bot was for radiation oncologists, medical physicists and radiotherapists, working in a cancer center, so that they could learn and refresh their radiation safety knowledge without attending the classroom session in the centre. This is important in the pandemic period, when face-to-face communication between hospital staff should be kept to a minimum.

Motivation

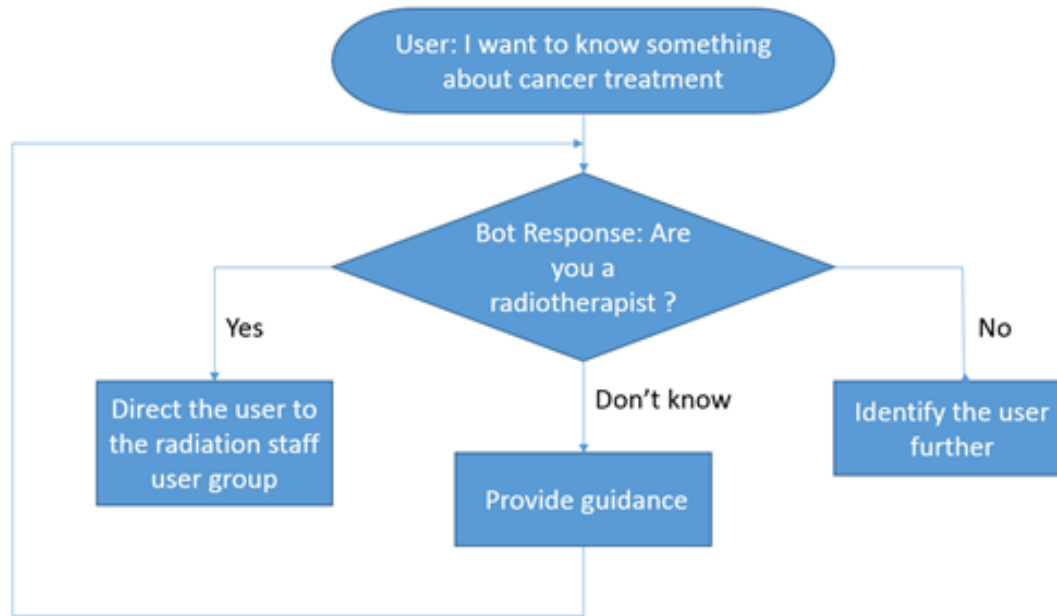
- The Bot is built on IBM's Watson Assistant platform because it provides a relatively easy way to use interface, along with simple but powerful integration tools that allow it to be used through different channels such as Webchat on any Internet-of-things

What is Chatbot?

- A Chatbot is a form of a computer system that lets humans use natural human language to interact with computers.
- The idea of a Chatbot was not new but was first introduced in 1950 when Alan Turing proposed the question, “Can machines think?”.

Turing AM. *The world of mathematics*. 1956;4:2099-123.

Simple Workflow of Chatbot



Chatbot and Machine Learning

- Machine learning plays a key role in the context of IBM's Watson Assistant. The objective of machine learning is to analyze the user-inputted text to obtain rules and recognize patterns. This in turn means that the Chatbot converts the user's input into a structured format, one that follows a hierarchy.

Chatbot and Machine Learning

- Natural Language Processing is a tool for machine learning in Chatbot. These include pattern matching and linguistic analysis.
- IBM Watson Assistant specifically recognizes keywords in the user input and assesses them to determine the intent of the sentence. This is then cross-referenced with the database of intents to evaluate the response that the Chatbot should provide.

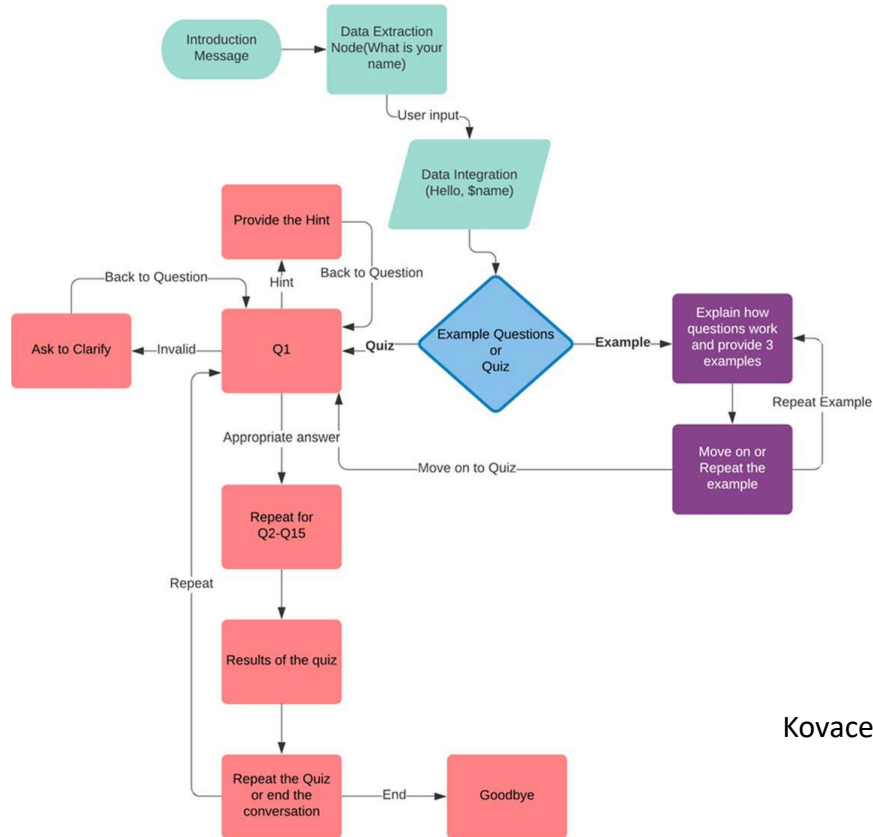
Siddique S, Chow JCL. *Encyclopedia*. 2021, **1**, 220-239

Create a Chatbot

- The Bot was created on the IBM Watson Assistant Cloud platform. For a human-like communication between the Bot and the user, machine learning feature such as Natural Language Processing provided by the tool of Intent in the Watson platform, was used to determine the specific intent of the user's input.
- The Bot contained fifteen radiation safety questions, which could be customized according to training needs and timed to fit into the attention span of the end-user.

Xu L, Sanders L, Li K, Chow JCL. *JMIR Cancers*. 2021, **7(4)**, e27850

Workflow



Kovacek D, Chow JCL. *IOP SciNotes*. 2021, 2, 034002

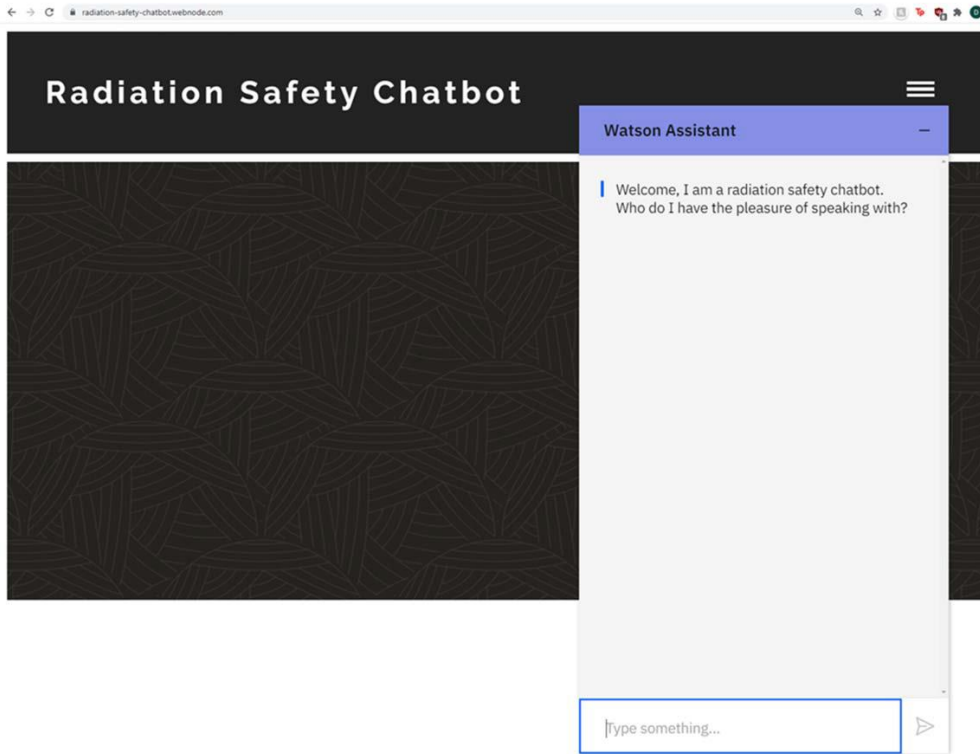
Design of Bot

As this work provides radiation safety education using a question-and-answer method, the focus for logical arguments is on intents, which work perfectly with the dialogue that is intended for the Bot. For example, the logic behind a true-or-false question can be described as follows:

Design of Bot

- (1) Bot displays the question, and the user replies with an input.
- (2) If the Bot recognize 'True' intent, it will initiate the 'Question-True' child node.
- (3) If the Bot does not recognize 'True', it will check if it can recognize 'False'.
- (4) If the Bot does not recognize 'False', it will check if it can recognize 'Hint'.
- (5) If the Bot does not recognize 'Hint', it will ask the user to clarify as his/her answer is not recognized as appropriate.

Results



The Bot was built and embedded to a website with the following link:
<https://radiation-safety-chatbot.webnode.com>.

Kovacek D, Chow JCL. *IOP SciNotes*. 2021, **2**, 034002

Results

Watson Assistant

Hi, I am a radiation safety chatbot. What can I call you?

Type something...

Watson Assistant

Hi, I am a radiation safety chatbot. What can I call you?

David

It's nice to meet you David. I hope you are doing well.

Would you like to go through a few example questions, or move on to the quiz?

Kovacek D, Chow JCL. *IOP SciNotes*. 2021, **2**, 034002

Results

Watson Assistant	Watson Assistant
Mike, whenever you are ready let me know.	Perfect, we will start with the first question.
<p>no</p>	It takes more lead to stop neutron than x-rays with the same energy in the Linear Accelerator? (T or F)
Mike, could you clarify?	<p>i need a hint please</p>
<p>no</p>	HVL of Lead for 4MeV Neutron is around 6.8 cm HVL of Lead for 4MeV X-ray is around 16 cm. Does that make the following statement True or False:
Mike, whenever you are ready let me know by typing "ready".	It takes more lead to stop neutron than x-rays with the same energy in the Linear Accelerator? (T or F)
<p>Ready</p>	<p>False</p>
Perfect, we will start with the first question.	Correct. It takes more lead to stop an X-ray than a Neutron with same Energy.
It takes more lead to stop neutron than x-rays with the same energy in the Linear Accelerator? (T or F)	Let's move on.

Kovacek D, Chow JCL. *IOP SciNotes*. 2021, 2, 034002

Results

Watson Assistant	Watson Assistant
<p>I'm sorry but that is incorrect. b) was the right answer</p> <p>You've completed the quiz Adam. Here are your results:</p> <p>Question 1: Correct Question 2: Incorrect Question 3: Incorrect Question 4: Correct Question 5: Correct Question 6: Incorrect Question 7: Correct Question 8: Correct Question 9: Incorrect Question 10: Correct Question 11: Incorrect Question 12: Incorrect Question 13: Correct Question 14: Correct Question 15: Incorrect</p> <p>One last thing Adam. Would you like to retake quiz?</p>	<p>Question 4: Incorrect Question 5: Incorrect Question 6: Incorrect Question 7: Incorrect Question 8: Correct Question 9: Correct Question 10: Correct Question 11: Incorrect Question 12: Incorrect Question 13: Correct Question 14: Correct Question 15: Correct</p> <p>One last thing Chell. Would you like to retake quiz?</p> <p>no</p> <p>That will be it then, Chell. Just remember: The cake is a lie</p>

Kovacek D, Chow JCL. *IOP SciNotes*. 2021, 2, 034002

Discussion

- One limitation in creating the Bot was the lack of global ability to restart the conversations freely, once the Bot is published on a website.
- Lack of ability to perform mathematical operations with the context variables. This was discovered when the Bot was originally designed to provide the user with either a letter grade ('A'–'F') or a percentage ('0'–'100%') result.
- For implementing the Bot, this work was presented to the radiation staff/colleagues and students in a scientific meeting and workshop so that potential users had the pre-bot experience baselines. Feedback from them will be used to fine-tune the Bot. It is seen that constructing a Bot is a continuous learning process for the developers.

Conclusion

- It is concluded that an AI-assisted radiation safety Chatbot can help the radiation staff to gain radiation safety knowledge in radiotherapy.
- The Bot with character supported by machine learning can provide information regarding radiation safety to the radiation staff working in the cancer hospital/centre more efficiently at their own pace.
- The Bot is particularly useful for courses on radiation safety protocol and can be revised continuously based on the feedback from the users.

Acknowledgments

- We are grateful to the Canadian Institute of Health Research Planning and Dissemination Grants – Institute Community Support program (Grant number: CIHR PCS-168296) for funding this project.
- We would like to thank David Kovacek, Sarkar Siddique, Lucy Xu, Syed Ali and Nathanael Rebelo from the Ryerson University and University of Toronto for assisting in this project.



CIHR IRSC



Canadian Institutes of Health Research
Instituts de recherche en santé du Canada

Thank you very much