May 2023

ENHANCED ENGAGEMENT AND PRODUCTIVITY IN ONLINE MEETING WITH INTELLIGENT REAL-TIME CONTENT-BASED QUESTION AUTO-GENERATOR

Doosan Jung

Claire Y Chour

Qihong Shao

ENHANCED ENGAGEMENT AND PRODUCTIVITY IN ONLINE MEETING WITH INTELLIGENT REAL-TIME CONTENT-BASED QUESTION AUTO-GENERATOR

AUTHORS:
Doosan Jung
Claire Y Chour
Qihong Shao

ABSTRACT

The host of an online meeting may frequently wonder if the meeting attendees understand the message that they are trying to deliver. Additionally, an attendee of an online meeting may be confused by the content of a meeting or a webinar and need clarification. Techniques are presented herein that support a real-time, intelligent, content-based automatic question generator that enhances meeting engagement and productivity. The presented techniques can perform all of the capabilities of the current question generator tools but, most importantly, they can also automatically generate and rank relevant questions during a meeting based on the content of that meeting. After receiving the results of their auto-generated quiz or poll, a host may check the attendees' understanding during a meeting and reiterate previous content if necessary. After a meeting ends, an automated message (including the generated quiz or poll questions, along with the correct answers) may be sent to all of the meeting attendees while a host may receive the meeting's statistics (so that they can pinpoint the key areas they need to emphasize in future meetings).

DETAILED DESCRIPTION

The host of an online meeting may frequently wonder if the meeting attendees understand the message that they are trying to deliver. Additionally, an attendee of an online meeting may be confused with the content of a meeting or a webinar and need clarification.

As remote work continues, it is important for a host of an online meeting to ensure that their audience fully understands the message that they are trying to deliver. That objective is particularly difficult to achieve when attendees have their cameras turned off

and they are muted. If an attendee does not ask questions or make comments, it is impossible for the host to gauge whether the audience understands.

Oftentimes, these types of questions may arise during an online meeting – "Are we on the same page?" "Are the next steps clear?," and "Are the attendees understanding my message?" Frequently, a meeting host may become tired of asking those types of questions or they may silently wonder about the above questions.

One common solution to the above-described problem calls for a host to manually create quizzes or polls. However, creating those types of questions, which are relevant to a meeting's topic, can be very time consuming. Additionally, the current automatic random question generators are not relevant to a meeting's topic.

Consequently, automating the above-described process of generating quizzes or polls, based on the content of a meeting, would be useful and efficient. For a meeting host, such an automation would replace their effort of manually generating quizzes prior to or during a meeting.

Such automated quizzes or polls can help attendees reinforce their understanding of a meeting and signal to a host whether everyone understands the contents of a meeting. For an attendee, during a quiz or poll they might not know the answer to some questions. This may encourage them to ask clarifying questions, as they might have missed or not understood some parts of the meeting. For a host, if a quiz or poll indicates poor results, this would show the host that the audience did not fully understand and is confused. Therefore, the host should probably go over the previous material again, instead of moving on to the next topic.

Techniques are presented herein that address the challenges that were described above. Aspects of the presented techniques enhance engagement and productivity during remote meetings by intelligently and automatically generating content-based questions in real time. Additionally, such questions are designed to be generated from both a "global view" and a "local view" of the content.

Since the automatically-generated questions are not in any particular order, further aspects of the presented techniques encompass the ranking of questions, which may order the questions based on customizable settings including a host's preference, the diversity of

the questions, the model's feedback loop, and, if needed, participant-specific information such as role and expertise.

After receiving the results of an automatically generated quiz or poll, under still further aspects of the presented techniques a host may check the attendees' understanding during a meeting and, if necessary, reiterate previous content. After a meeting ends, an automated message, including the automatically generated quiz or poll questions along with the correct answers, may be sent to all of the meeting attendees. Additionally, a host may receive the meeting's statistics so that they can pinpoint the key areas that they need to emphasize in future meetings.

Utilizing live polls and quizzes within a meeting to make meetings more interactive is well-established. For example, one online meeting platform has integrated a tool that supports "polls" and "quizzes." However, such solutions require quizzes to be manually created so that they are relevant to a meeting's topic. Alternatively, such solutions may create quizzes automatically from public information and, thus, they are most likely not relevant to the topic of a meeting.

Additionally, employing artificial intelligence (AI) to generate questions based on specific content is also well-established. For example, one AI-powered platform provides quality quizzes and assessments for people to use based on content submission, such as any text passage. Another AI-powered quiz generator automatically generates quiz questions based on text passages and a user's choice of question types (e.g., true or false, fill in the blank, multiple choice, etc.). Still another online tool can automatically generate funny and engaging icebreaker questions for hosts to use during meetings, as icebreaker questions can help to start conversations. However, those questions are not based on the content of a meeting but instead are random in the hope of brightening the atmosphere of a meeting.

As described above, one of the challenges of remote work is that it is difficult for the host of a meeting to gauge how well the meeting attendees are understanding the meeting's content. To address this problem, the techniques presented herein can automatically and intelligently generate questions based on the content of a meeting. Using such a method, a meeting host can easily and quickly launch a quiz or a poll to help determine whether they should stay on the same topic or move on to a different topic.

Figure 1, below, presents a high-level overview of a content-based question generator according to the techniques presented herein and reflective of the above discussion.

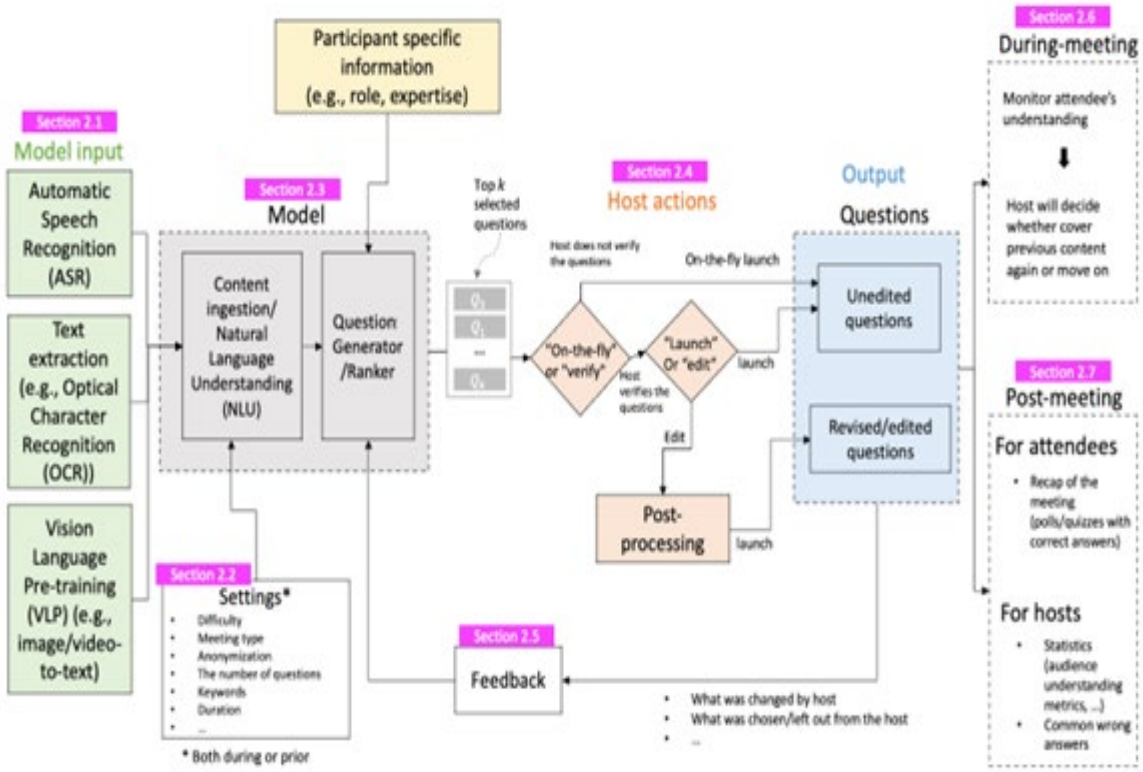


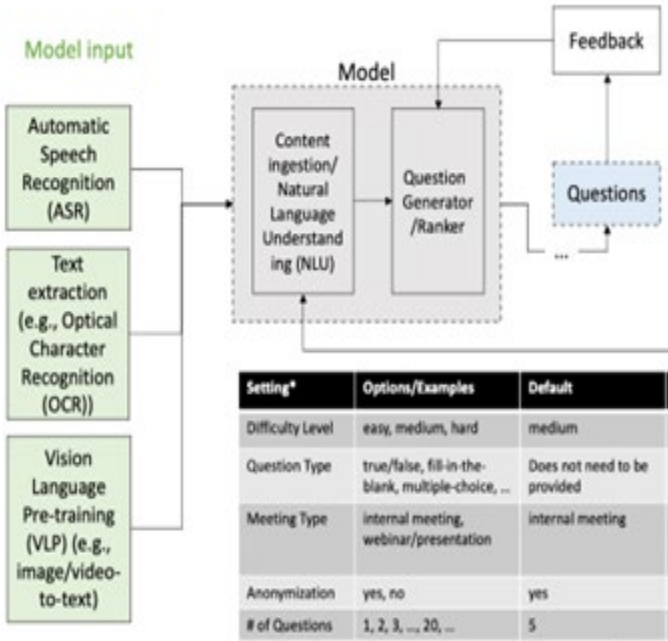
Figure 1: High-level Overview of Content-based Question Generator

The next sections of the instant narrative discuss in detail the different steps that are involved in the generation of questions, and which are labeled in Figure 1, above, as Section 2.1, Section 2.2, through Section 2.7.

As depicted in Figure 1, above, under Section 2.1, the techniques presented herein encompass a number of model inputs. In order for the instant system to generate questions based on the content of a meeting in real time, the system must learn the contents of the meeting. At the core of the instant approach is a natural language model that, first, must input contents as text. This can take place either prior to a meeting (through, for example, the insertion of documents, slides, or any other format of text) or during a meeting (through, for example, a capture of what was said by whom).

The model inputs may take the form of automatic speech recognition (ASR) with, for example, an association between a participant and their voice-to-text mapping to record who uttered a sentence. Other input forms may be based on text extraction through, for example, optical character recognition (OCR) and vision-language pre-training (VLP) facilities supporting image-to-text and video-to-text.

As depicted in Figure 1, above, under Section 2.2, the techniques presented herein encompass a range of settings. In order to drive a more engaging meeting experience, by generating a more controlled environment with tailored questions, the presented techniques accept various settings from a host. As shown in Figure 2, below, while the model inputs are being processed as text the different hyperparameters may be established.



Setting*	Options/Examples	Default	Description	Required?
Difficulty Level	easy, medium, hard	medium	Quizzes/polls can be set to easy, medium, or hard.	yes
Question Type	true/false, fill-in-the-blank, multiple-choice, ...	Does not need to be provided	Hosts can set the type of questions in their quiz/poll.	no
Meeting Type	internal meeting, webinar/presentation	internal meeting	If the meeting type is webinar/presentation, make quiz/poll results anonymous; if it is internal meeting, make them known.	yes
Anonymization	yes, no	yes	Yes if host would like anonymous quiz/poll results, no if not.	no
# of Questions	1, 2, 3, ..., 20, ...	5	Host can set the number of questions per quiz/poll.	yes
Keywords Input	a, b, c, ...	Does not need to be provided	Host can input keywords that the model should prioritize.	no
Duration (sec.)	10, 20, ..., 50, ...	30	Host can set the duration of how long to take on each question.	yes

Figure 2: Hyperparameters Setting

As depicted in Figure 2, above, each hyperparameter has a default setting, but that setting may not be the most optimal option for a host's meeting. Some of the hyperparameters, which may also be referred as "settings," that are possible under the techniques presented herein are described below. It is important to note that a host can modify a setting both prior to and during a meeting. For example, based on the attendees'

participation or reaction during a meeting, a host may want to adjust their previously established settings.

Figure 2, above, identified a number of settings (including difficulty level, question type, etc.) that are possible according to the techniques presented herein. Each of those settings will be briefly described below.

A difficulty level hyperparameter may have a default setting of "medium." A host may determine whether they want their quizzes or polls to be easy, medium, or hard. Based on the difficulty level, the instant model can generate different types of questions. For instance, an "easy" quiz may include true or false questions, whereas a "hard" quiz may consist of multiple-choice questions or even open-ended questions.

A question type hyperparameter may not have a default setting. A host may set the type of questions that they would like to have in their quiz or poll (e.g., true or false, fill in the blank, multiple choice, etc.). If they do not set the question type, the instant model may generate randomized question types based on the specified difficulty level.

A meeting type hyperparameter may have a default setting of "internal meeting." A host will usually schedule a meeting for two reasons – to have an internal meeting or to hold a webinar or presentation. A meeting often consists of a smaller group of people, where everyone participates in the conversation, whereas a webinar or presentation includes a larger group of people, where only a subset of the people speaks. Furthermore, depending upon the meeting type, the participants of a quiz or poll may want to remain anonymous. If the meeting type is an internal meeting, the quiz or poll results will not be anonymous; on the other hand, if the meeting type is a webinar or presentation, the quiz or poll results will be anonymous, as participants may not want to reveal their name in a webinar or presentation in case they get a question wrong. Anonymous results in a webinar or presentation should not affect the outcome, as a host simply needs to gauge what percentage of the audience understands their content.

An anonymization hyperparameter may have a default setting of "yes." Such a hyperparameter may be a binary (i.e., yes or no) value and may override the meeting type parameter in the case where the host would like to manually set whether they want the results of a quiz or poll to be anonymous.

A number of questions hyperparameter may have a default setting of "5." Through this value a host can establish the number of questions that they would like to include in their quiz or poll.

A keywords hyperparameter may not have a default setting. In addition to keywords that are identified by the instant model as being related to the main idea of a meeting, a host can input certain keywords that they would like the model to prioritize or include when generating questions.

A duration of a quiz or poll hyperparameter may have a default setting of "30 seconds." A host may specify the maximum duration time for attendees to answer each question.

The above-described settings allow the techniques presented herein to create a more controlled question and answer setup (such as the number of questions, duration, and anonymization) and to generate more tailored questions according to a host's preference (such as difficulty level, keywords, etc.).

Figure 3, below, presents elements of an exemplary question generator module that is possible according to the techniques presented herein.

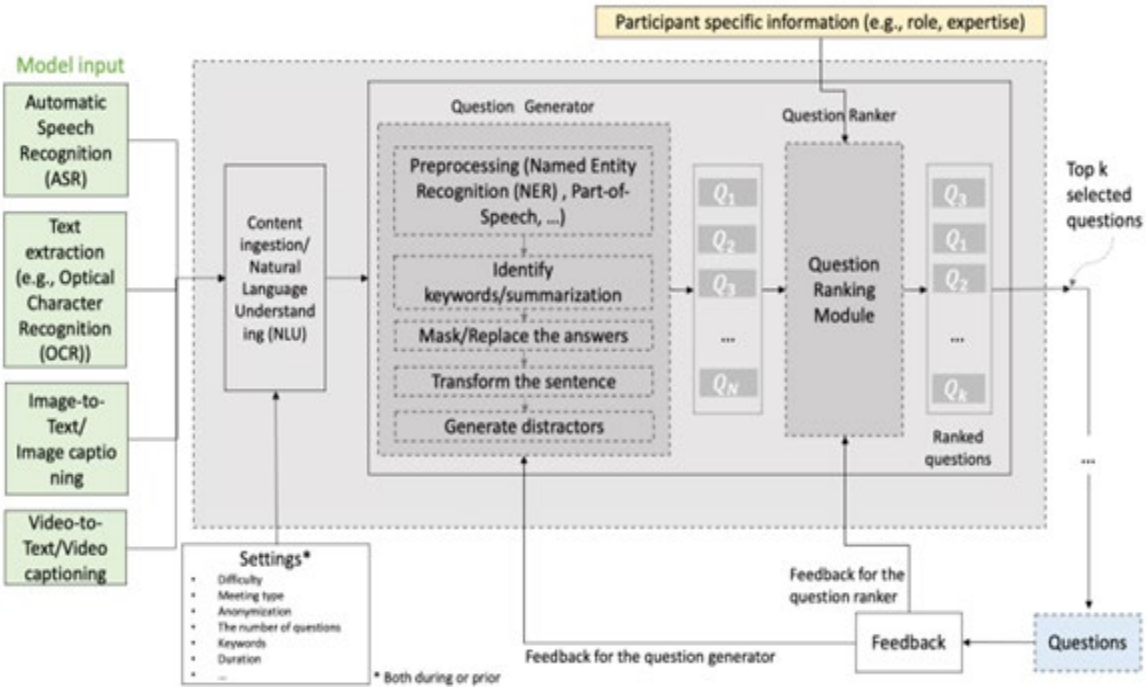


Figure 3: Question Generator Module

As shown in the Figure 3, above, the instant model may generate k questions based on the model inputs and the hyperparameters. Two key components within that process include a question generator and a question ranker, each of which will be described below.

After the model inputs are ingested and the hyperparameters are set, the instant model may, through a question generator, automatically generate a set of questions.

There can be various types and levels of questions based on a meeting, and the level of required complexity of the underlying natural language model can vary as well. For example, if a question requires a deeper understanding of the meeting content it will require a model to be highly capable of natural-language understanding (NLU). Questions that might require a more capable and complex model may include “What are the actions items discussed in this meeting? Choose all that apply,” “Which of the following sentences is discussed/not discussed as next steps in the meeting?” and “Which of the following sentences describes well what was discussed as benefits in this meeting?”

For the existing solutions (as described above), once those models acquire and process the meeting contents, they are capable of “abstracting,” or summarizing, the contents to produce key highlights. It is crucial that the abstracted text can be seen as “processed meeting contents” and can be fed into a question generator. In this way, questions may be generated using the model’s understanding (i.e., a “global view”) of the meeting content.

In contrast, the techniques presented herein can generate questions based solely on what was ingested without a deeper understanding. For example, the presented techniques can choose a certain paragraph without understanding the full picture of the meeting (i.e., a "local view”).

Figure 4, below, shows elements of a content hierarchy, where both of the above-described views may be fed to a question generator.

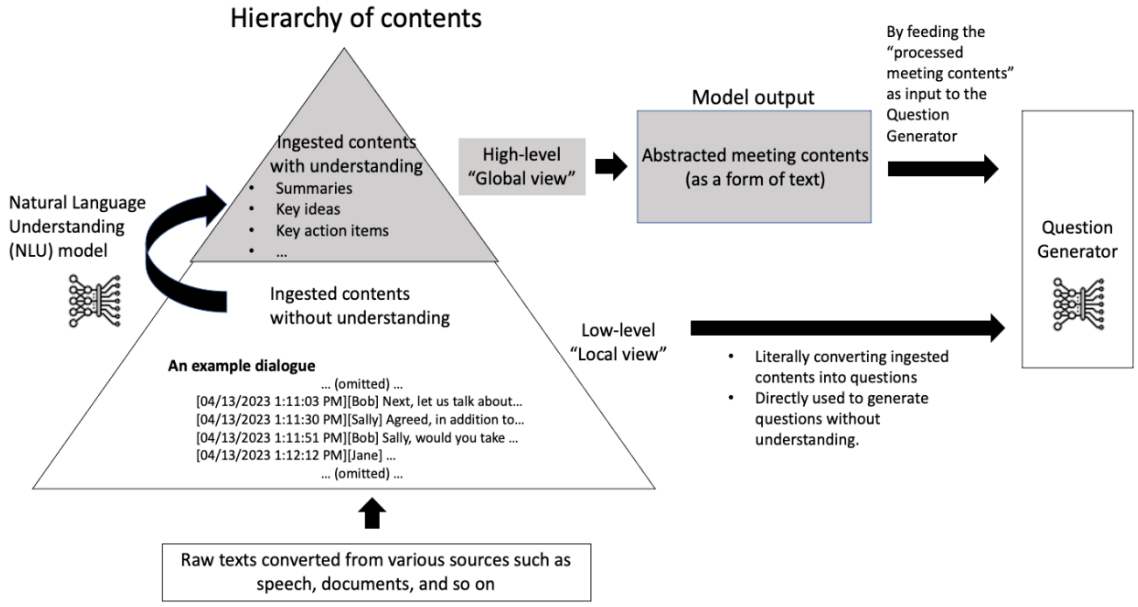


Figure 4: Hierarchy of Contents Used in Generating Questions

As indicated in Figure 4, above, both the ingested contents without an understanding and the abstracted meeting contents may be fed as input to a question generator. Such a question generator may, according to the techniques presented herein, encompass a number of steps.

During a preprocessing step, the model inputs may be cleaned (if needed), named entities must be recognized, etc. During a keyword identification step, the instant model may extract from the text important keywords regarding a meeting's main idea and use the same as answers to questions.

During a masking step, the model may mask or replace the answer to a question with a blank space. During a transformation step, the model may transform the sentences with the blank spaces into questions. During a distractor generation step, the model may, depending upon the type of question, generate distractors. For example, if a question is multiple choice, the model may generate words or phrases that are synonymous with the correct answer.

As indicated in Figure 3, above, an element of the question generation process includes the ranking of questions. The automatically generated questions may be ranked in order of preference or importance so that more favored and tailored questions can be asked

first. For example, if a host wants to generate five questions in a quiz, then the top five questions may be outputted.

A question generator, according to the techniques presented herein and as described and illustrated above, is capable of automatically generating any number of questions. Therefore, it is important to regulate the output questions in terms of their alignment to the objective and the quality of the automatically generated questions. Settings from a host also play a role in guiding the question ranking according to the objectives that a host has planned. Figure 5, below, depicts elements of such a question ranking module.

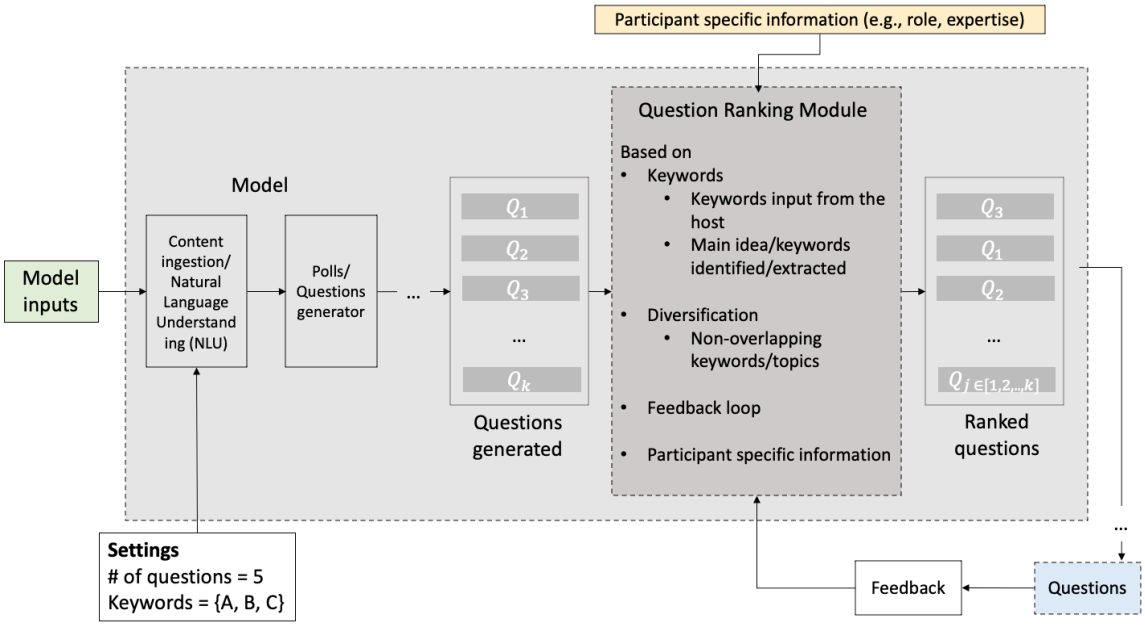


Figure 5: Question Ranking Module

As indicated in Figure 5, above, the operation of a ranking module may reflect a number of different criteria. A first criteria encompasses keywords. For example, the instant model may prioritize questions that are related to the main idea of a meeting and a host's keyword inputs. A second criteria encompasses diversification. For example, the generated questions may be diversified, meaning that the focus of each question may be on different keywords or topics. A third criteria encompasses a feedback loop such that each time that a host launches a quiz or poll, a feedback loop may leverage past questions to better rank new questions. A fourth criteria encompasses meeting participant such that, as an extension to the instant model, if there is a group of people in a meeting with different

roles or expertise (e.g., as one might encounter in a cross-functional meeting), a host may want to customize role- or expertise-specific questions for each attendee group (such as, for example, a group of data scientists, a group of software engineers, a group of user interface (UI) and user experience (UX) designers, etc.). Accordingly, the instant model may rank questions based on the attendees' role or expertise. By default, there may be no ranking that is based on a participant's role or expertise.

Figure 6A, below, depicts elements of the first criteria of the above-described ranking model – i.e., when keywords are provided by a host.

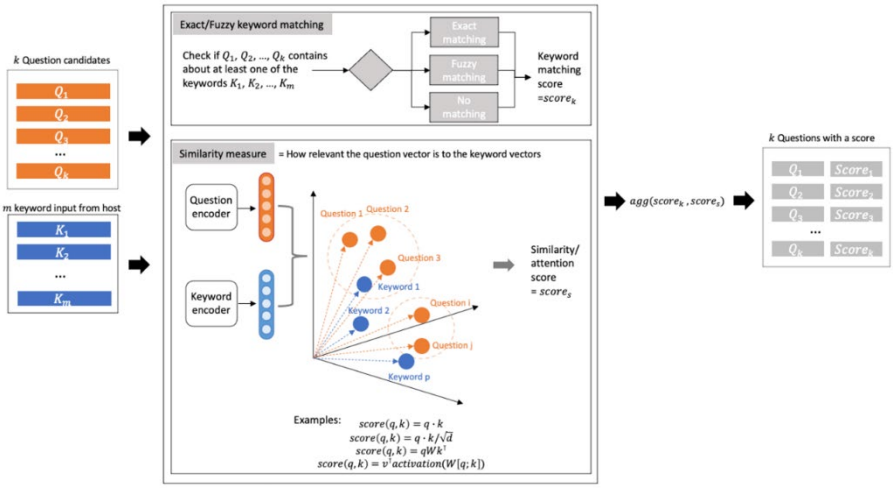


Figure 6A: Keyword-based Ranking

As shown in Figure 6A, above, if keywords are provided by a host, then the instant model may assign a higher rank to questions that are related to those keywords. A host may provide keywords to the techniques presented herein to reflect the main message of the host's meeting.

Figure 6B, below, depicts elements of the second criteria of the above-described ranking model – i.e., ranking questions based on their topic to achieve diversification.

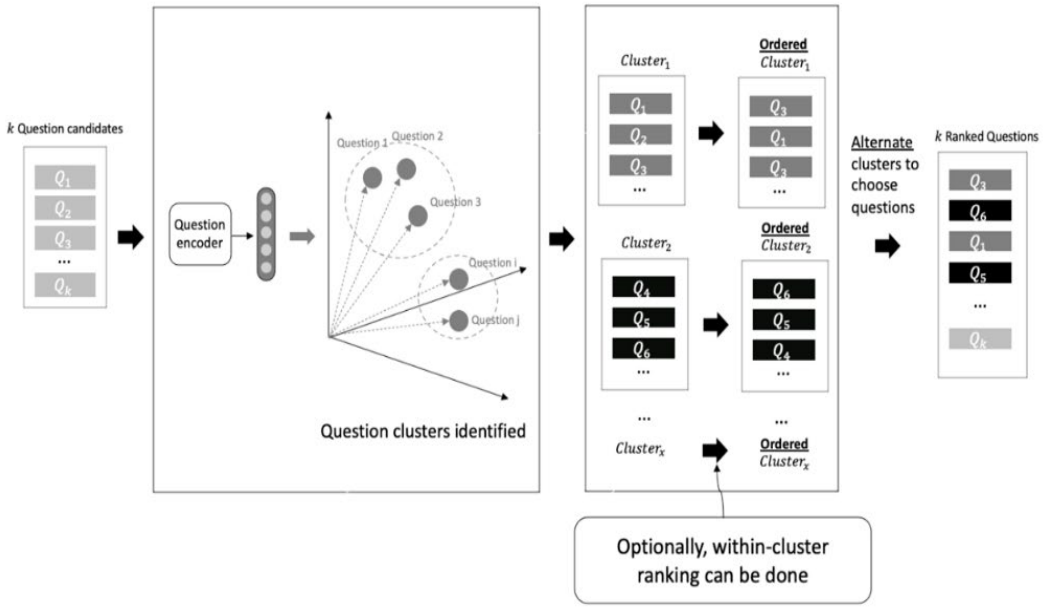


Figure 6B: Diversified Questions

As shown in Figure 6B, above, in order to cover the different topics and key ideas that were discussed during a meeting, the instant model may diversify the questions based on the topics. For example, if topics A, B, and C were discussed during a meeting, the questions may also be distributed to those three topics to avoid a case where all of the generated questions cover only one topic and ignore the remaining two topics.

Figure 6C, below, depicts elements of the third criteria of the above-described ranking model – i.e., the use of a feedback loop.

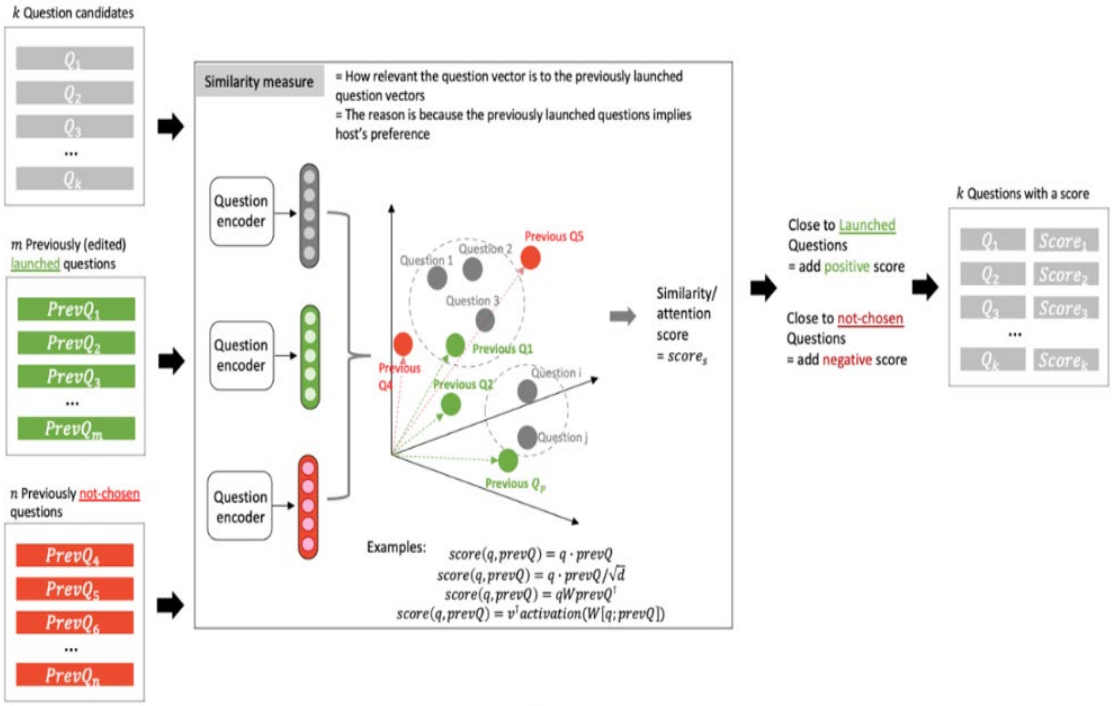


Figure 6C: Feedback-based Ranking

As shown in Figure 6C, above, in order to incorporate a real-time feedback loop, the techniques presented herein introduce a measure for the similarity of a launched question and the generated questions. A question may be launched with or without a host's edit and the fact that the question is launched with or without edits implicitly encodes a host's preferences. In short, the instant model strives to ensure that new questions are as good as the launched questions.

Figures 6A–6C, above, show how the different criteria, according to the techniques presented herein, may achieve the above-described main objectives. It is important to note that one criterion may be used in conjunction with other criteria. For example, it is possible that a host may provide keywords and still want diverse questions from other topics.

As depicted in Figure 1, above, under Section 2.4, the techniques presented herein encompass various host actions. In order to maintain the quality and validity of the automatically generated questions, as a gate keeper the presented techniques incorporate a human meeting host in this stage. Both question generation and ranking would be the target for model validation. In particular, the hallucination phenomenon, which may arise under a NLU approach, is still not completely understood or controlled. After the instant model

automatically generates a quiz or poll, a host must take action. As one example, the host must determine whether they want to quickly launch a quiz or poll without checking the questions. If they do, then the quiz or poll may be immediately launched to the meeting attendees. If they do not, then the host may verify the questions before launching the quiz or poll. In the case where a host elects to verify the questions, they have the option to immediately launch the quiz or poll or edit it (through post-processing) and then launch the quiz or poll.

As depicted in Figure 1, above, under Section 2.5, the techniques presented herein encompass a variety of outputs and feedback. Depending upon a host's actions, the instant model may output either an unedited or a revised poll or quiz. To ensure that the process of generating and ranking the different questions remains on track, the techniques presented herein include a feedback loop module. The output of the above-described process may be fed into a feedback loop consisting of five different types of feedback.

A first type of feedback is question specific. If a host is not immediately using the questions that are generated by the instant model and are electing to heavily edit them, the model may need to be retrained to generate better questions. A second type of feedback is ranking specific. As described above in connection with Section 2.3, if a host is not using the instant model's highly ranked questions and is, rather, using lower-rank questions, this will indicate to the model that it may not be properly ranking the questions.

A third type of feedback is general. The instant model may learn about the majority of hosts (such as X, Y, Z, etc.) and perhaps change the default hyperparameter settings. For example, if a host rarely uses open-ended questions in their quizzes or polls, the model may spend less time improving itself for those type of questions and instead it may prioritize the providing of more popular types of questions, such as true and false, to future hosts.

A fourth type of feedback is host specific. For each host, the instant model may learn what each host likes and dislikes and in the future be able to customize better questions based on a host's preferences. A fifth type of feedback is setting specific. The different hyperparameters (as described and illustrated above) may encompass a default setting, which can be changed by a host. Based on past meetings data, such a default setting may be modified to match the common selections for each hyperparameter. For instance,

based on past meeting data, the instant model may suggest a common or appropriate duration time that meeting attendees should have to answer each question.

As depicted in Figure 1, above, under Section 2.6, the techniques presented herein encompasses checking for an understanding during a meeting. After receiving the results of their launched quiz or poll, a host may check the attendees' understanding during their meeting. If the majority of attendees scored well on the quiz or poll, this would verify to the host that they have successfully delivered the content of the meeting. A host may reiterate topics that are associated with questions that are commonly answered incorrectly, as the attendees may not have understood that part of a meeting.

As depicted in Figure 1, above, under Section 2.7, the techniques presented herein encompass an automated message being sent following a meeting. This functionality helps to maximize the benefit of the presented techniques. After participants answer a host's quiz or poll and a meeting ends, the host(s) and the participants may receive an automated message (e.g., through email, etc.). That message differs depending upon whether a recipient is a host or an attendee, but it includes not only a meeting summary but also the questions that were asked and the correct answer for each question. Additionally, a host may also receive information on how well the audience understood the presented material.

For a meeting attendee, they may receive a recap of the meeting as well as the launched poll or quiz with the correct answers. A host may review the same before sending out such an automated post-meeting message. Such an automated message may also be customized depending upon the role or expertise of the meeting attendees.

For a host, they may receive various statistics that are related to the meeting, such as audience understanding metrics. Such a message may also include common wrong answers to a launched poll or quiz to help the host better prepare for a future meeting.

The use of the techniques presented herein offers a number of benefits. With the assistance of the automatic generation of intelligent questions, a meeting host may save time that would otherwise be spent on tedious tasks such as having to manually create a quiz or poll before a meeting. If the results of a quiz or poll are poor (e.g., the majority of a meeting's attendees incorrectly answered questions) this may be a sign to a host that people are confused, and the host may need to reexplain the meeting content. Such automated quizzes or polls can roughly gauge how well a host's message is being delivered.

The techniques presented herein may be further explicated with reference to an illustrative real-world example. Figure 7, below, presents elements of such an example.

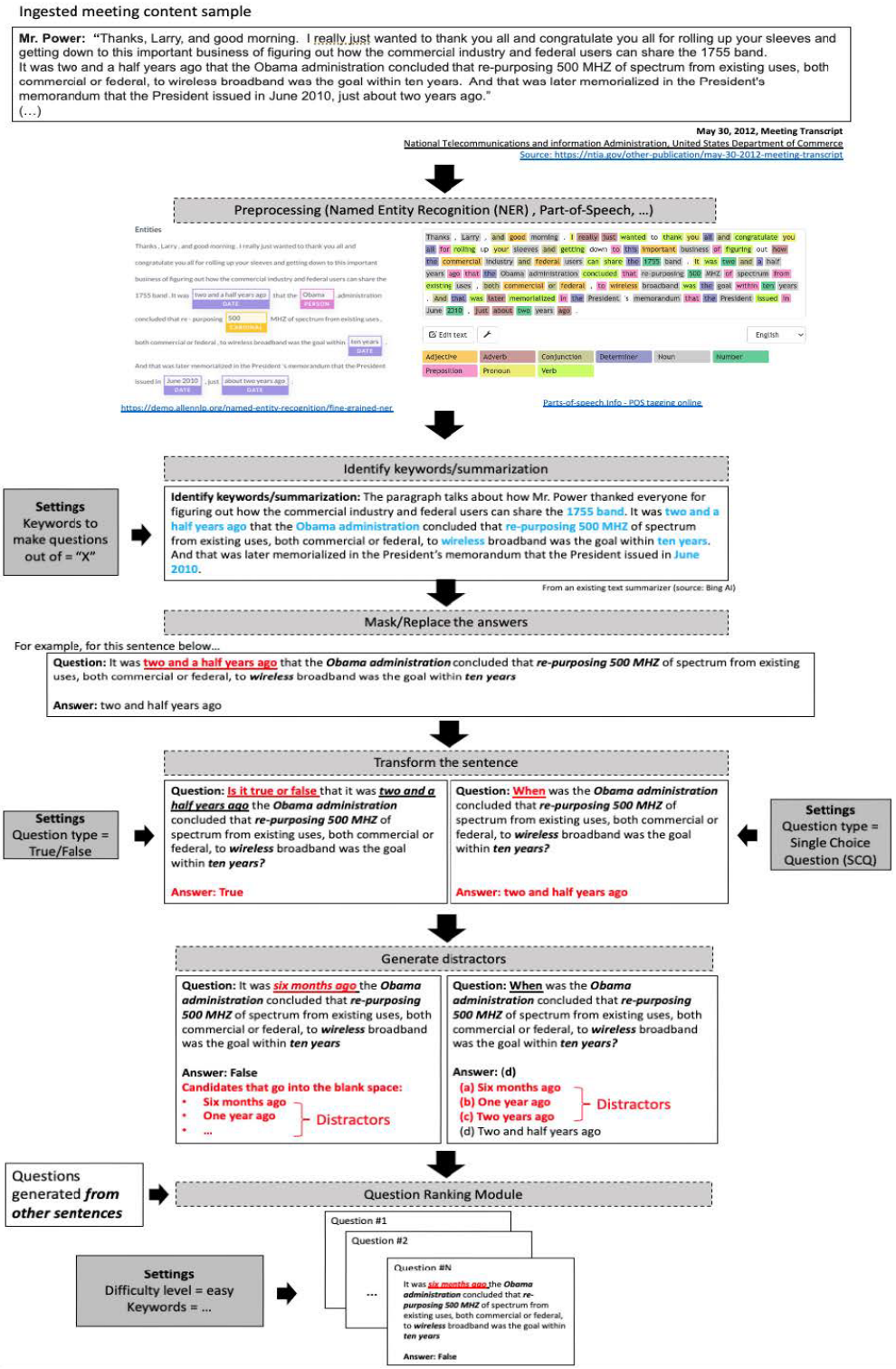


Figure 7: Example of Real-world Question Generation

The real-world example that is depicted in Figure 7, above, is taken from a publicly available meeting transcript and helps to illustrate the above-described steps. As shown in the figure, a body of text is first acquired from an ASR facility for a meeting. The example then follows the different steps that were described and illustrated above. It is important to note that text input is not abstracted by any NLU model, which means the question generator will attempt to generate questions based solely on the ingested text itself without any high-level understanding of the meeting.

The techniques presented herein may be further explicated with reference to two illustrative use cases. Consider a first use case involving a large-scale webinar in which a host, Mark, is hosting a webinar about a new licensing model for approximately 100 people. Prior to or during the meeting, Mark is able to set various parameters such as the difficulty level of the questions, the keywords that he would like the instant model to emphasize when generating questions for the audience, and whether the listeners can answer anonymously. After finishing an overview section of his webinar, Mark wonders if the audience understands the new licensing model. In this case, the instant model will automatically generate questions according to Mark's settings and then launch the questions to the audience upon Mark's approval. Before launching the questions, Mark may choose to check the questions and make any necessary edits to a question and its answer. Based on how heavily Mark curates the automatically generated questions, the model's feedback loop may take into account Mark's preferences regarding how he likes to create questions. The audience's answers may then be recorded anonymously and used to measure how well the content is being understood.

After seeing poor results from his launched quiz or poll, Mark may decide to either reiterate key points or take questions. After the meeting, a message may be sent to Mark and the audience, including the question and correct answer pairs in addition to the webinar highlights. The audience can verify their understanding of the content, Mark will know how well the audience understood the content, and Mark may even compare the results with previous audience groups.

Next, consider a user case involving a small internal meeting during which another host, Bob, talks about the requirements for a new feature in an online meeting, and he wonders whether the meeting participants understand what he has talked about thus far.

Bob has his requirement spreadsheet shared through his screen, but for each item that is shown on the screen he has spoken in greater detail. The instant model may capture information from both the shared screen (through, for example, an image-to-text conversion or OCR) and from what Bob has said about those items. Depending upon Bob's setting, the techniques presented herein may automatically generate questions which are related to the new feature requirements.

Once Bob approves sending the questions to the participants, they will have a chance to clarify their understanding and Bob will have a chance to check if his explanation of the new feature requirements has or has not been well delivered. After the meeting, a message may be sent to Bob and the meeting participants, including the question and correct answer pairs in addition to the meeting highlights.

As described and illustrated above, the techniques presented herein enhance engagement and productivity during remote meetings by intelligently and automatically generating content-based questions in real time. Such questions are designed to be generated from both a "global view" and a "local view" of a meeting's content. Since the automatically generated questions are not in any particular order, aspects of the presented techniques encompass the customizable ranking of questions, which may order the questions based on a host's preference, the diversity of the questions, the model's feedback loop, and, if needed, participant-specific information such as role and expertise. After receiving the results of an automatically generated quiz or poll, under further aspects of the presented techniques a host may check the attendees' understanding during a meeting and, if necessary, reiterate previous content. After a meeting ends, an automated message, including the automatically generated quiz or poll questions along with the correct answers, may be sent to all of the meeting attendees. Additionally, a host may receive the meeting's statistics so that they can pinpoint the key areas that they need to emphasize in future meetings.

As described above, NLP models can effectively answer questions based on documents. Using that knowledge, the techniques presented herein are able to direct NLP models to ask "us" questions. To be specific, the content that is shared and discussed during a meeting serves as the source of the automatically generated questions. As described and illustrated above, during or prior to a meeting the instant model ingests multimodal content,

converts the same to text using existing techniques, and then processes that text to embed the model's understanding of the text. Based on various settings (as described above in connection with the discussion of Section 2.2) the model may automatically generate and rank a set of questions (as described above in connection with the discussion of Section 2.3).

In summary, techniques have been presented herein that support a real-time, intelligent, content-based automatic question generator that enhances meeting engagement and productivity. The presented techniques can perform all of the capabilities of the current question generator tools but, most importantly, they can also automatically generate and rank relevant questions during a meeting based on the content of that meeting. After receiving the results of their auto-generated quiz or poll, a host may check the attendees' understanding during a meeting and reiterate previous content if necessary. After a meeting ends, an automated message (including the generated quiz or poll questions, along with the correct answers) may be sent to all of the meeting attendees while a host may receive the meeting's statistics (so that they can pinpoint the key areas they need to emphasize in future meetings).