Automatic Question Generation from KeyBERT-indexed Handwritten Lecture Notes on

T5-TrOCR Pipeline

Rommel John Ronduen1, Jan Adrian Manzanero2, Analyn Yumang3

1,2,3School of Electrical, Electronics and Computer Engineering, Mapua University  
Mapua University, Manila, Philippines, 1002

1rjhronduen@mymail.mapua.edu.ph

2jacmanzanero@mymail.mapua.edu.ph

3anyumang@mapua.edu.ph

Abstract— In this research, a system equipped with optical character recognition (OCR) technology and automatic question generation (AQG) capabilities allowed for the intake of single-column, diagram-free, and equation-free handwritten lecture notes for the generation of factoid-type questions using the Transformer-based Optical Character Recognition (TrOCR) model with context completion and text correction using Gemini 1.5 Pro, and a fine-tuned variant of the Text-to-Text (T5) Transformer on the Stanford Question Answering Dataset (SQuADv1.1). In terms of evaluation dataset, 70 handwritten lecture notes were obtained from undergraduate classes on computer networks and cybersecurity, and 25 questions from the students. OCR evaluation was done using the word error rate (WER), word overlap error rate (WOER), and confusion matrices for the top three most common keywords. On the other hand, AQG was evaluated using the Recall-Oriented Understudy for Gisting Evaluation (ROUGE) and the Bilingual Language Understudy Evaluation (BLEU).

## Index Terms— Handwritten lecture notes, Optical Character Recognition, Raspberry Pi, Large Language Model, Automatic Question Generation

1. Introduction

Handwritten lecture notes have been the usual tool acquainted with learning. These learning artifacts contain elements of the learner’s development of learning in various topics. With the advent of artificial intelligence (AI) applications on education, more possibilities were realized. One important possibility is the generation of learning materials. An example of learning material are questions in the form of quizzes, flashcards, and reviewers. Learners are enforced with existing learning through the challenge that is provided through the answering of such questions. AI has paved the way for the generation of these questions through a process called automatic question generation (AQG).

Despite successful applications of AQG, these systems lack the capability to directly capture and extract information directly from handwritten lecture notes as a basis for AQG. In fact, it was emphasized that there is a need for AQG systems that can handle from different kinds of media sources [1]. Literature suggested that AQG systems are categorized based on the creation of the question from a given source [1]. For instance, an AQG system for extracting from digital text was created using the Bidirectional Auto-Regressive Transformer (BART) with text summarization achieving an F-score of about 89.4 [2]. Moreover, an approach was adapted to rule based AQG to provide review questions from programming source codes [3]. Review questions for learning the English language [4] were made using AQG based on statistical techniques that allowed for the precision of about 75%. Another use case involved the use of audio as a source for information in AQG that attained an accuracy of about 89% [5]. Another study analyzed the use of keywords using the Bidirectional Encoder Representation for Transformers (BERT) [6] leading to 73 to 85 percent accuracy.

1. Materials and Methods

An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it.

1. Page Layout

Your paper must use a page size corresponding to A4 which is 210mm (8.27") wide and 297mm (11.69") long. The margins must be set as follows:

* Top = 19mm (0.75")
* Bottom = 43mm (1.69")
* Left = Right = 14.32mm (0.56")

Your paper must be in two column format with a space of 4.22mm (0.17") between columns.

1. Page Style

All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

1. Text Font of Entire Document

The entire document should be in Times New Roman or Times font. Type 3 fonts must not be used. Other font types may be used if needed for special purposes.

Recommended font sizes are shown in Table 1.

1. Title and Author Details

Title must be in 24 pt Regular font. Author name must be in 11 pt Regular font. Author affiliation must be in 10 pt Italic. Email address must be in 9 pt Courier Regular font.

TABLE I  
Font Sizes for Papers

|  |  |  |  |
| --- | --- | --- | --- |
| Font Size | Appearance (in Time New Roman or Times) | | |
| Regular | Bold | Italic |
| 8 | table caption (in Small Caps),  figure caption,  reference item |  | reference item (partial) |
| 9 | author email address (in Courier),  cell in a table | abstract body | abstract heading (also in Bold) |
| 10 | level-1 heading (in Small Caps),  paragraph |  | level-2 heading,  level-3 heading,  author affiliation |
| 11 | author name |  |  |
| 24 | title |  |  |

All title and author details must be in single-column format and must be centered.

Every word in a title must be capitalized except for short minor words such as “a”, “an”, “and”, “as”, “at”, “by”, “for”, “from”, “if”, “in”, “into”, “on”, “or”, “of”, “the”, “to”, “with”.

Author details must not show any professional title (e.g. Managing Director), any academic title (e.g. Dr.) or any membership of any professional organization (e.g. Senior Member IEEE).

To avoid confusion, the family name must be written as the last part of each author name (e.g. John A.K. Smith).

Each affiliation must include, at the very least, the name of the company and the name of the country where the author is based (e.g. Causal Productions Pty Ltd, Australia).

Email address is compulsory for the corresponding author.

1. Section Headings

No more than 3 levels of headings should be used. All headings must be in 10pt font. Every word in a heading must be capitalized except for short minor words as listed in Section III-B.

1. Level-1 Heading: A level-1 heading must be in Small Caps, centered and numbered using uppercase Roman numerals. For example, see heading “III. Page Style” of this document. The two level-1 headings which must not be numbered are “Acknowledgment” and “References”.
2. Level-2 Heading: A level-2 heading must be in Italic, left-justified and numbered using an uppercase alphabetic letter followed by a period. For example, see heading “C. Section Headings” above.
3. Level-3 Heading: A level-3 heading must be indented, in Italic and numbered with an Arabic numeral followed by a right parenthesis. The level-3 heading must end with a colon. The body of the level-3 section immediately follows the level-3 heading in the same paragraph. For example, this paragraph begins with a level-3 heading.
4. Figures and Tables

Figures and tables must be centered in the column. Large figures and tables may span across both columns. Any table or figure that takes up more than 1 column width must be positioned either at the top or at the bottom of the page.

Graphics may be full color. All colors will be retained on the CDROM. Graphics must not use stipple fill patterns because they may not be reproduced properly. Please use only *SOLID FILL* colors which contrast well both on screen and on a black-and-white hardcopy, as shown in Fig. 1.



Fig. A sample line graph using colors which contrast well both on screen and on a black-and-white hardcopy

Fig. 2 shows an example of a low-resolution image which would not be acceptable, whereas Fig. 3 shows an example of an image with adequate resolution. Check that the resolution is adequate to reveal the important detail in the figure.

Please check all figures in your paper both on screen and on a black-and-white hardcopy. When you check your paper on a black-and-white hardcopy, please ensure that:

* the colors used in each figure contrast well,
* the image used in each figure is clear,
* all text labels in each figure are legible.

1. Figure Captions

Figures must be numbered using Arabic numerals. Figure captions must be in 8 pt Regular font. Captions of a single line (e.g. Fig. 2) must be centered whereas multi-line captions must be justified (e.g. Fig. 1). Captions with figure numbers must be placed after their associated figures, as shown in Fig. 1.

[](http://www.freedigitalphotos.net/images/Television_Video_and_g178-TV_p11679.html)

Fig. Example of an unacceptable low-resolution image

[](http://www.freedigitalphotos.net/images/Television_Video_and_g178-TV_p11678.html)

Fig. Example of an image with acceptable resolution

1. Table Captions

Tables must be numbered using uppercase Roman numerals. Table captions must be centred and in 8 pt Regular font with Small Caps. Every word in a table caption must be capitalized except for short minor words as listed in Section III-B. Captions with table numbers must be placed before their associated tables, as shown in Table 1.

1. Page Numbers, Headers and Footers

Page numbers, headers and footers must not be used.

1. Links and Bookmarks

All hypertext links and section bookmarks will be removed from papers during the processing of papers for publication. If you need to refer to an Internet email address or URL in your paper, you must type out the address or URL fully in Regular font.

1. References

The heading of the References section must not be numbered. All reference items must be in 8 pt font. Please use Regular and Italic styles to distinguish different fields as shown in the References section. Number the reference items consecutively in square brackets (e.g. [1]).

When referring to a reference item, please simply use the reference number, as in [2]. Do not use “Ref. [3]” or “Reference [3]” except at the beginning of a sentence, e.g. “Reference [3] shows …”. Multiple references are each numbered with separate brackets (e.g. [2], [3], [4]–[6]).

Examples of reference items of different categories shown in the References section include:

* example of a book in [1]
* example of a book in a series in [2]
* example of a journal article in [3]
* example of a conference paper in [4]
* example of a patent in [5]
* example of a website in [6]
* example of a web page in [7]
* example of a databook as a manual in [8]
* example of a datasheet in [9]
* example of a master’s thesis in [10]
* example of a technical report in [11]
* example of a standard in [12]

1. Conclusions

The version of this template is V2. Most of the formatting instructions in this document have been compiled by Causal Productions from the IEEE LaTeX style files. Causal Productions offers both A4 templates and US Letter templates for LaTeX and Microsoft Word. The LaTeX templates depend on the official IEEEtran.cls and IEEEtran.bst files, whereas the Microsoft Word templates are self-contained. Causal Productions has used its best efforts to ensure that the templates have the same appearance.

1. Acknowledgment

The heading of the Acknowledgment section and the References section must not be numbered.

Causal Productions wishes to acknowledge Michael Shell and other contributors for developing and maintaining the IEEE LaTeX style files which have been used in the preparation of this template. To see the list of contributors, please refer to the top of file IEEETran.cls in the IEEE LaTeX distribution.

1. References
2. S. M. Metev and V. P. Veiko, *Laser Assisted Microtechnology*, 2nd ed., R. M. Osgood, Jr., Ed. Berlin, Germany: Springer-Verlag, 1998.
3. J. Breckling, Ed., *The Analysis of Directional Time Series: Applications to Wind Speed and Direction*, ser. Lecture Notes in Statistics. Berlin, Germany: Springer, 1989, vol. 61.
4. S. Zhang, C. Zhu, J. K. O. Sin, and P. K. T. Mok, “A novel ultrathin elevated channel low-temperature poly-Si TFT,” *IEEE Electron Device Lett.*, vol. 20, pp. 569–571, Nov. 1999.
5. M. Wegmuller, J. P. von der Weid, P. Oberson, and N. Gisin, “High resolution fiber distributed measurements with coherent OFDR,” in *Proc. ECOC’00*, 2000, paper 11.3.4, p. 109.
6. R. E. Sorace, V. S. Reinhardt, and S. A. Vaughn, “High-speed digital-to-RF converter,” U.S. Patent 5 668 842, Sept. 16, 1997.
7. (2002) The IEEE website. [Online]. Available: http://www.ieee.org/
8. M. Shell. (2002) IEEEtran homepage on CTAN. [Online]. Available: http://www.ctan.org/tex-archive/macros/latex/contrib/supported/IEEEtran/
9. FLEXChip Signal Processor (MC68175/D), Motorola, 1996.
10. “PDCA12-70 data sheet,” Opto Speed SA, Mezzovico, Switzerland.
11. A. Karnik, “Performance of TCP congestion control with rate feedback: TCP/ABR and rate adaptive TCP/IP,” M. Eng. thesis, Indian Institute of Science, Bangalore, India, Jan. 1999.
12. J. Padhye, V. Firoiu, and D. Towsley, “A stochastic model of TCP Reno congestion avoidance and control,” Univ. of Massachusetts, Amherst, MA, CMPSCI Tech. Rep. 99-02, 1999.
13. Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification, IEEE Std. 802.11, 1997.