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Analysis of AI-generated Waka Poems Borrowing Short Phrases from Human-Created Waka

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ABSTRACT

This paper employs a deep learning-based Waka generation model to computer-generate AI waka. From the perspective of AI waka borrowing human-created waka phrases, this paper compares and analyzes the quality of AI waka generated by the WakaVT model and two benchmark models. The analysis results indicate that, relative to the benchmark models, the latent variable sequence enhances the diversity of AI waka generated by the WakaVT model, effectively avoiding the issue of excessive borrowing of human-created Waka phrases in generated AI waka. The WakaVT model has successfully learned the vocabulary, grammar, and logical structure between sentences of human-created waka, enabling it to generate creative AI waka through novel word combinations and metaphorical techniques.

Keywords: *Waka, Poetry generation, Artificial intelligence(AI), Deep learning.*

1. INTRODUCTION

Waka is a traditional fixed-form poem expressed in classical Japanese, possessing high literary value in Japanese classical literature. Its development has been significantly influenced by Chinese classical culture, particularly Tang poetry [1]. In recent years, natural language processing tools driven by artificial intelligence (AI) technologies such as ChatGPT and DeepSeek have achieved remarkable results. These tools can learn human language to complete tasks such as writing emails, copywriting, translation, and academic papers, and engage in conversational interactions based on the context of the chat. However, the computer automatic generation method for poetry, especially classical poetry, is currently not yet perfected due to the difficulty of data modeling and the relative scarcity of waka data. Researchers have previously studied the generation method of Japanese haiku using recurrent neural network (RNN) and generative adversarial network (GAN) language models [2]. Compared to haiku generation, waka generation is more challenging because waka uses archaic Japanese vocabulary, which is more difficult to understand, compared to haiku that uses vocabulary close to modern Japanese. Haiku has only 17 syllables, while waka consists of an upper line with 17 syllables and a lower line with 14 syllables, which are closely related to each other [3]. The themes of waka include scenery and emotional life, etc. [4], which increases the difficulty of data modeling. The archaic Japanese voiced consonant syllables do not have voiced marks, making them difficult to identify in waka databases, thus making it challenging to construct a large-scale word segmentation dataset for machine learning. Masada et al. [5] proposed a method based on RNN-generated sequences for scoring waka automatic generation, but the waka generated by this model had many problems in terms of vocabulary collocation, word usage, sentence repetition, grammar, and coherence of waka content.

This paper employs the WakaVT computer-generated AI waka model, established by the author's team and based on the sequence-to-sequence Transformer [6], to generate AI waka. From the perspective of borrowing human-created waka phrases in AI waka, this paper compares and analyzes the quality of AI waka generated by the WakaVT model and two benchmark models. Three keywords, "あき" (autumn), "つき" (moon), and "こゑ" (sound), are selected and input into the three models to generate a total of 900 pieces of AI waka. By examining the borrowing of human-created waka phrases in the AI waka, a comparative

analysis is conducted on the quality of AI waka generated by the WakaVT model and the benchmark models.

2. WAKA GENERATION MODEL AND AI WAKA QUALITY EVALUATION METRICS

2.1 Waka Generation Model

A waka poem consists of 5 lines, containing 31 syllables in the pattern of 5/7/5/7/7. The first three short lines of a waka poem constitute the upper part, while the last two short lines constitute the lower part. There must be logic and connection between the upper and lower parts. To establish a waka generation model using deep learning methods, it is necessary to ensure the form, semantic quality, novelty, and diversity of the waka poems. In terms of form, AI-generated waka poems (AI waka) need to meet the syllable count requirements of 5/7/5/7/7, as well as the multi-layer structure of the upper and lower parts of a waka poem. Waka poems can be divided into four levels: phrase, 5/7 syllable short line, upper/lower part, and the entire waka poem. In terms of semantic quality, the waka poems generated by the model need to be grammatically correct in classical Japanese and semantically coherent. In terms of novelty, the model should generate waka poems with sufficient originality, avoiding excessive borrowing or simply piecing together fragments of human-created waka poems.

The WakaVT model established by our author team is a waka generation model based on the sequence variational Transformer [6]. WakaVT utilizes a sequence of latent variables to model the word-level variability in waka data, ensuring the novelty and diversity of the generated results. Furthermore, based on the multi-level linguistic structural features between five short sentences and their context in waka, the researchers employ a multi-level fusion mechanism of self-attention (FMSA) to enhance the semantic quality of AI waka in terms of fluency, coherence, and meaning. To enable the model to fully learn the hierarchical structure of waka, the researchers propose the multi-level fusion mechanism of self-attention (FMSA), which focuses on the semantic relationships at different levels of waka through various multi-head attention sub-layers, and integrates information from each level before outputting.

To investigate the role of the latent variable sequence in the WakaVT model, the researchers conducted a comparative analysis of the AI and songs generated by two benchmark models: WakaVT-FMSA and TVAE+FMSA. The benchmark model WakaVT-FMSA is a baseline model derived from the WakaVT model by removing the FMSA component, meaning it excludes FMSA and solely incorporates the latent variable sequence and a general self-attention mechanism. The benchmark model TVAE+FMSA is a Transformer-based conditional variational autoencoder. Unlike WakaVT, TVAE models data using a unimodal distribution of a single latent variable, indicating that it includes both FMSA and a single latent variable.

2.2 Waka Data Preprocessing

When the AI-based waka generation model learns waka data using deep learning methods, the quantity of waka data directly affects the quality of the generated results. Typically, a large amount of waka data, exceeding 100,000 poems, is required. Therefore, the researchers constructed a large waka dataset containing 171,801 poems by preprocessing the waka data in the International Research Center for Japanese Culture's database through morae addition and word segmentation, enabling computers to recognize the vocabulary in waka collected from large waka databases such as the International Research Center for Japanese Culture's database [6]. They randomly selected 10,000 poems from the waka dataset as the validation set, 5,000 poems as the test set, and the remaining 156,801 poems as the training set.

2.3 AI Waka Generation Model and Quality Evaluation Metrics

2.3.1 AI Waka Generation

From the vocabulary used in the large Waka dataset the researchers established, three keywords with high usage frequency, namely "あき" (autumn), "つき" (moon), and "こえ" (sound), were randomly selected and input into the WakaVT model and two benchmark models, WakaVT-FMSA and TVAE+FMSA. Each keyword corresponds to a model that generates 100 Waka poems, resulting in a total of 900 AI waka poems.

2.3.2 Basic Evaluation Metrics for AI Waka Quality

The three basic indicators for evaluating AI waka quality include the content grammar,

coherence, and content. In terms of grammar, the main focus is on the number of syllables (57577) and word usage in the five sentences of the entire waka; in terms of coherence, the focus is on the correlation between the five short sentences of the entire waka, as well as the correlation between the upper and lower sentences of the waka; in terms of content, the focus is on the content and artistic conception surrounding the theme of the waka, as well as rhetorical techniques.

2.3.3 Evaluation of AI Waka Borrowing Human-created Waka Phrases

This paper sets the incorporation of two human-created waka phrases in an AI waka poem as the threshold, and considers the incorporation of three or more human-created waka phrases as excessive borrowing from human-created waka.

Here is an example to illustrate the use of AI waka quality assessment and the borrowing of human-created waka phrases.

AI waka (1): 夜を重ね 分け行くものは 涙川 思ふ心の 秋の夕暮(The night is late, and what partakes in it is the river of tears, in the heart's thoughts, in the autumn evening)

(WakaVT model)

This waka poem was generated by the WakaVT model using the input keyword "あき (autumn)" from the aforementioned 900 AI waka poems. Machine search results indicate that the third and fourth lines of this AI waka poem borrow from the following human-created Waka poem.

Waka (1): よしさらば 淵とも淀め 涙川 思ふ心の 底見えぬまで(Goodbye, farewell. Both the depths of the abyss and the tranquility of the lake, tears flow like a river, in the heart's thoughts, until the bottom of my heart is revealed.)

（草庵集・第七恋上・952・頓阿）(Cao An Collection, Seventh Love, 952, Don A)

Although AI waka (1) borrows two short sentences from human-created Waka (1), its content differs significantly from human-created Waka. This AI waka employs reasonable grammar, with close connections between the five short sentences, smooth content, clear themes, and conforms to the artistic conception of Waka. In terms of grammar, coherence, and content, it can be rated a full 5 points. It is evident that the WakaVT model has accurately learned the vocabulary and grammar of human-created Waka, as well as the logical structure between sentences, and is capable of generating creative AI waka through novel word combinations and metaphorical techniques.

3. STATISTICAL AND COMPARATIVE ANALYSIS OF AI WAKA BORROWING SHORT PHRASES FROM HUMAN-CREATED WAKA IN VARIES MODELS

“Table 1” itemizes the statistical results of three waka generation models, WakaVT, WakaVT-FMSA, and TVAE+FMSA, generated by inputting three keywords: "あき" (autumn), "つき" (moon), and "こゑ" (sound). Each keyword corresponds to 100 AI waka generated by each model. The data includes the quality scores of AI waka in terms of "grammar", "coherence", "content", and "average of the three"; "proportion of using more than two sentences", which refers to the proportion of AI waka that borrow two or more short sentences from human-created waka; and "proportion of excessive borrowing", which refers to the proportion of AI waka that borrow three or more short sentences from human-created waka.

Table 1. Data statistics of 900 AI waka poems generated by three models: WakaVT, WakaVT-FMSA, and TVAE+FMSA, utilizing human-created waka phrases

Model	Keywords	Grammar	Consistency	Content	Average	Proportion of borrowing more than 2 sentences accounts	Over-borrowing ratio
WakaVT	あき (Autumn)	[4.90.]	[4.31.]	[3.66.]	[4.29.]	7.00%	1.00%
	つき (Moon)	[4.91.]	[4.33.]	[3.84.]	[4.36.]	17.00%	2.00%
	こゑ (Sound)	[4.83.]	[4.26.]	[3.81.]	[4.30.]	32.00%	10.00%
	Total	[4.88.]	[4.30.]	[3.77.]	[4.32.]	19.66%	4.33%
WakaVT-FMSA	あき (Autumn)	[4.75.]	[3.60.]	[3.07.]	[3.81.]	23.00%	1.00%

Model	Keywords	Grammar	Consistency	Content	Average	Proportion of borrowing more than 2 sentences accounts	Over-borrowing ratio
WakaVT-FMSA	つき (Moon)	[4.73.]	[3.35.]	[3.02.]	[3.70.]	25.00%	3.00%
	こゑ (Sound)	[4.58.]	[3.27.]	[2.91.]	[3.59.]	40.00%	14.00%
	Total	[4.69.]	[3.41.]	[3.00.]	[3.70.]	29.33%	6.00%
TVAE+FMSA	あき (Autumn)	[4.94.]	[3.79.]	[3.41.]	[4.05.]	34.00%	10.00%
	つき (Moon)	[4.90.]	[3.66.]	[3.44.]	[4.00.]	57.00%	19.00%
	こゑ (Sound)	[4.81.]	[3.27.]	[3.08.]	[3.72.]	60.00%	22.00%
	Total	[4.88.]	[3.57.]	[3.31.]	[3.92.]	50.33%	17.00%

- Comparison among models: As shown in “Table 1”, the proportions of the 300 AI waka generated by the three models, WakaVT, WakaVT-FMSA, and TVAE+FMSA, respectively borrowing more than two waka lines from human-created waka are 19.66%, 29.33%, and 50.33%, respectively. The proportions of borrowing more than three waka lines are 4.33%, 6.00%, and 17.00%, respectively. Compared to the WakaVT model and WakaVT-FMSA model using a sequence of hidden variables, the TVAE+FMSA model using a single hidden variable significantly increases the borrowing of short waka lines from human-created waka in the generated AI waka. This indicates that the sequence of hidden variables enhances the diversity of AI waka generated by the WakaVT model and effectively avoids the issue of excessive borrowing of short waka lines from human-created waka in the generated AI waka. Furthermore, compared to the WakaVT-FMSA model, the WakaVT model with FMSA slightly improves the borrowing of short waka lines from human-created waka in the generated AI waka, suggesting that the multi-level fusion self-attention mechanism also plays a role in enhancing the diversity of AI waka generated by the model and mitigating the issue of excessive borrowing of short waka lines from human-created waka in the generated AI waka.
- "Over-borrowing" from human creations and song lyrics: As can be seen from “Table 1”, the proportion of borrowing in WakaVT, WakaVT-FMSA, and TVAE+FMSA has decreased to 4.33%, 6.00%, and 17.00%, respectively. It is evident that the hidden variable sequence enables the model to better avoid the issue of "over-borrowing" from human creations and song lyrics in generating AI lyrics.

4. EXAMPLE ANALYSIS OF AI WAKA GENERATED BY VARIOUS MODELS, BORROWING HUMAN-CREATED WAKA PHRASES

Next, the researchers select 300 waka poems generated by three models with the input keyword "あき (autumn)" as examples, and compare and analyze the borrowing of human-created waka phrases by AI waka poems from each model.

4.1 WakaVT model

Through computer retrieval, among the 100 AI waka generated by the WakaVT model using "あき (autumn)" as the keyword, 7 AI waka borrowed more than 2 phrases from human-created waka. Among them, 6 borrowed 2 phrases from human-created waka, and 1 borrowed 4 phrases from human-created waka. The AI waka that borrowed 4 phrases from human-created waka is as follows:

AI waka (2): 紅葉ばは 時雨に出でで なりにけり 篠田の森の 秋の夕露 (Red leaves fall, drizzle falls, they become accustomed to the autumn dew in Shinoda's forest)

(WakaVT model)

The first and third sentences, as well as the fourth and fifth sentences, of this AI waka poem borrow from the following two human-created waka poems.

Waka (2): 紅葉ばは 道もなきまで なりにけり 時雨の後の 庭の秋風 (Red leaves, swaying in the wind,

without a path to follow, as autumn winds sweep through the courtyard after the rain)

(内裏百番歌合・145・詠み人知らず) (Inside, a hundred songs merge together, 145, the unknown singer)

Waka (3): とにかくに しげき思ひの 類かな 篠田の森の 秋の夕露 (In the autumn dew of Shinoda's forest, thoughts of nobility and elegance are all that remain)

(続後拾遺集・巻十二恋二・775・詠み人知らず)

(Continued from "Shikigami no Kanae - Volume 12: Rin II - 775 - The Unknown Singer")

The fifth sentence of AI waka (2) is insufficiently related to the first four sentences, and the third and fifth sentences are insufficiently related to the other three sentences.

4.2 TVAE+FMSA Model

Among the 100 AI waka poems generated by the TVAE+FMSA model using the keyword "あき (autumn)", 34 poems borrowed more than two short sentences from human-created waka poems. Specifically, 4 AI waka poems borrowed 3 sentences, and 6 borrowed 4 sentences, indicating that a total of 10 AI waka poems exhibit "over-borrowing" issues.

- Borrowing examples from human creations and songs, the author will provide three short sentences.

AI waka (3): 高砂の 尾の上の鹿の 声立てて 松に知られぬ 秋の夜の月 (The sound of deer on the top of the high sandy ridge, rising up to the moon on an autumn night unknown to the pine)

(TVAE+FMSA)

The first, second, and third lines of this AI waka poem borrow from the following human-created waka poem.

Waka (4): 高砂の 尾の上の鹿の 声立てて 風より変はる 月の影かな (Is it the sound of a deer standing on the end of a high sandbar, or the changing shadows of the moon like the wind)

(拾遺愚草・巻上千五百番歌合百首・1046・藤原定家)

(Shi Yi Yu Cao · Juan Qian Wu Bai Fan Ge He Bai Shou · 1046 · Teng Yuan Dìng Jia)

Upon comparison, it becomes evident that the content of AI waka (3) bears excessive similarity to the borrowed human-created waka (4). Such excessive borrowing should be avoided in AI waka.

4.3 WakaVT - FMSA Model

Among the 100 AI waka poems generated by the WakaVT-FMSA model using the keyword "あき (autumn)", 23 poems borrowed more than two short sentences from human-created waka, of which 22 borrowed two short sentences and one borrowed three short sentences. AI waka poems that borrowed three short sentences from human-created waka are as follows: The AI waka that borrowed 3 phrases from human-created waka is as follows:

AI waka (4): 女郎花 人の心は 知らねども 色に慣れたる 秋の叢雨 (Lady flower, people's hearts, though unaware, get used to colors, autumn rain)

(WakaVT-FMSA)

The first and third lines, as well as the second and third lines, of this AI waka poem borrow from the following two human-created waka poems respectively.

Waka (5): 女郎花 花の心は 知らねども 名を菊にこそ 折らまほしけれ (Lady's flower, though you know not its name, yet you know it well by its petals folded like a chrysanthemum)

(太皇太后宮亮平経盛朝臣家歌合・12・詠み人知らず)

(Empress Dowager's Palace, Liangpingjing, Shengchao, Courtier's Song Collection, Volume 12, Unknown Singer)

Waka (6): 住み慣るる 人の心は 知らねども やがて寂しき 山の影かな (The heart of one who has grown accustomed to living alone, though unaware, soon becomes lonely, like the shadow of a mountain)

(新続古今集・巻十八雑中・1813・詠み人知らず)

(Shintoki-Kodansha, Volume 18, Miscellaneous, 1813, "Omi no Hitomi no Zora")

The first and fifth lines of "AI waka (4)" depict the scenery of autumn, while the second and third lines describe flowers that are unaware of human emotions. There is a certain correlation between these four lines, but the fourth line has a weaker connection with the other lines.

5. COMPARISON OF AI WAKA GENERATED BY WAKAVT AND TVAE+FMSA MODELS

Next, the author selected two models with good quality in AI and song generation, WakaVT and TVAE+FMSA, and generated 200 AI and songs by inputting the keyword "つき (Moon)" as an example. The author counted the 36 AI waka with high scores in the basic evaluation items of grammar, coherence, and content generated by these two

models, and provided their borrowing situation from human-created waka.

From “Table 2”, it can be seen that among the 100 AI waka songs generated by the WakaVT model using the keyword "month", a total of 23 AI waka scored full marks in terms of grammar, coherence, and content. Among them, 18 AI waka (5) to (22) did not have the problem of borrowing short phrases created by humans. AI waka (23) to (26) are AI and Song with 2 borrowed sentences. On the basis of accurate grammar, close relationship between sentences, and rich content of waka imagery, these AI wakas have good originality and diversity. AI waka (27) borrowed three short sentences created by humans, which is an excessive borrowing situation.

Table 2. 23 examples of AI waka generated by the WakaVT model with the input keyword "つき (Moon)"

AI waka sequence number	AI waka and borrowed human-created waka	Borrowing status
(5)	名に高き 御室の山の 桜花 今宵の月の 限りなければ (If not within the bounds of the moon tonight, in the cherry blossoms of the lofty Miya-no-yama)	No
(6)	眺むれば ありあけの月 なほ冴えて 光も澄める 天の橋立 (If you look up, you'll see the moon shining brightly, illuminating the sky like a bridge in the sky)	No
(7)	冬の夜半 心づくしの 名残まで 月を見るべき ありあけの空 (In the middle of a winter night, with a heart full of thoughts, one should gaze upon the moon until the end of its name, in the vast, open sky)	No
(8)	知らざりし ありあけの月 光にも 心を添へて 見る夜なりけり (In the night, where the moon, unknown and full, casts its light, my heart is filled with warmth)	No
(9)	春霞 かすめる空に 見し月の 曇りなき夜の 契りなりけり (Spring clouds, drifting in the sky, witnessing the moon's fleeting presence, a promise made in the night)	No
(10)	軒近き 我が真木の葉に 見えつるも いくありあけの 月の影かな (Close to the window, I see the moon's shadow on the leaves of the real tree, which seems to be an intruder)	No
(11)	明かし方 天の川瀬に あととめて 宿れる月の 明け方の空 (The illuminated path, the river of the sky, the night's end, the sky at dawn where the moon rests)	No
(12)	聞く人も 同じ心に 出づるかな ありあけの月 隈なかるらむ (Those who listen also emerge with the same heart, the moon that never sets, wandering aimlessly)	No
(13)	山里は 問ふ人あれや ほととぎす しばし時雨の 月に鳴くらむ (In the mountains, there are those who inquire, who are somewhat hesitant, who sing in the moon of intermittent rain)	No
(14)	あしひきの 山の端分けて 出づるより ありあけの月 明け方の空 (Rather than emerging from the mountainside where the sky meets the earth, the moon rises above the clear sky)	No
(15)	澄む月を 山ほととぎす 深山より いる方遠く 鳴き渡るかな (The moon, shining clear, seems to light up the mountain, and from deep within the mountains, a distant cry echoes)	No
(16)	朝日射す 峰の木の葉は 晴れやらで 猶予ふ月の 澄み渡るかな (The sun shines on the leaves of the mountain trees, as if they are greeting the clear and serene moonlight)	No
(17)	朝夕に 見れども飽かぬ 山里は 月の光を 任せてぞ見る (Even though I see it day and night, I am never tired of gazing at the moonlight in the mountains)	No
(18)	まきもくの 峰の高嶺の 明け方に 雲居の花に 月ぞさやけき (To the moonlit flowers of the cloud-covered peak, on the side of the mountain where the sun rises)	No
(19)	さ牡鹿の 声も寂しき 真木の戸に 晴れゆく月の 影を待つかな (Shall we await the silhouette of the moon shining through the door of the lonely, real wood, as the deer's cry echoes)	No
(20)	いづくにか 心をとめて 天の川 清き河原に 出づる月かな (Is it the moon that emerges from the clear riverbed, calming the heart as it flows along the heavenly river) (This waka is the same as the AI waka (2) in the second part of the paper)	No
(21)	隈もなく 今宵の月の 浮雲に なほ行く末を 思ひこそやれ (Without hesitation, I ponder the fate of the moon's floating clouds tonight)	No
(22)	ありあけの 山のあなたの 浮雲に わが澄む月の 影ぞ残れる (In the shadow of the moon, your floating clouds in the mountains, where I can see your face, remain)	No
(23)	もの思ふ 月の桂の いづくにて 山ほととぎす 空に鳴くなり (Thoughts of things, like the moon's laurel wreath, gently swaying in the mountain breeze, resonate in the sky) (borrowed from human-created waka poem: 千載集 118 (Senzai Collection 118))	2 lines

AI waka sequence number	AI waka and borrowed human-created waka	Borrowing status
(24)	宵の間に 出でやらぬ月 長き夜の 姨捨山の 峰の秋風 (During the night, the moon that never sets, the long autumn wind on the peak of Mount Ise) (Borrowed from the human-created waka poem: 続千載集 459；壬二集 1717(Continuing for a Thousand Years" (Set 459); "Renji 1717"))	2 lines
(25)	あしひきの 山のあなたや こと問はむ 姨捨山の 月を見てまし ("Ashikino Yamano anata wa koto omu wa tsukuyama no tsukue o mi mashite mashi") (Borrowed from human-created waka: 続後拾遺集 222（The Later Collection of Miscellaneous Poems, Vol. 222))	2 lines
(26)	ほととぎす 今は都の 山の端の 紅葉は同じ 月を見るかな (Hoto tosu, now in the city of Kyoto, at the edge of the mountain, are the autumn leaves gazing at the same moon, perhaps?)(Borrowed from human-created waka poem: 風雅集 333；後鳥羽院御集 1536 (Fuga Shū" 333; "Gōdaigakuin Goshū" 1536))	2 lines
(27)	ほととぎす 姨捨山の ありあけの 月の桂に 音をや鳴くらむ (The sound of music resonates in the moon's laurel, the only one in the Yosetsu Mountain) (borrowed from human-created waka: 伊勢集 404；仙洞影供歌合 13；千五百番歌合 713；仙洞影供歌合 19；仙洞影供歌合 4；洞院摂政家百首 396；内裏百番歌合 66 (Ise Collection 404; Sendō Yōgū-kagami 13; Senkōban-kagami 713; Sendō Yōgū-kagami 19; Sendō Yōgū-kagami 4; Tōin Shūjōka 396; Uchiri Hyōban-kagami 66))	(More than 3 lines)

"Table 3" presents the basic evaluation metric scores generated by the TVAE+FMSA model for the 13 AI waka that achieved full scores. Among these 13 AI wakas, only four, namely AI waka (28) to AI waka (31), did not borrow any human-created song phrases. However, five AI waka borrowed two human-created song phrases, and four AI waka borrowed three or more human-created waka phrases. For example, the first four sentences of AI waka (39) borrowed human-created waka phrases; the first and second sentences, the second and third sentences, and the first and third sentences of AI waka (40) borrowed three different human-created song phrases, respectively. This result indicates that AI waka generated by the TVAE+FMSA model lacking a hidden variable sequence are prone to this intricate and excessive borrowing of human-created waka phrases.

Table 3. 13 examples of AI waka generated by the TVAE+FMSA model with the input keyword "つき (Moon)"

AI waka sequence number	Waka	Borrowing status
(28)	夏の夜の 月の光を 見渡せば 天の川瀬に 千鳥鳴くなり (When gazing at the moonlight of a summer night, one can hear the chirping of countless birds in the sky)	No
(29)	梅が香を 身に染むものと 眺むれば 月の桂の 色を見るかな (When one gazes at what plum blossoms have stained on their body, they might see the color of the moon's laurel)	No
(30)	移りゆく 月の桂の 花の色 風に任せて 問ふ人もなし (As I journey, I leave the color of the moon's laurel flowers to the wind, without asking anyone)	No
(31)	夜をさむみ 明石の浦に 澄む月の とも千鳥鳴く 声ぞ聞こゆる (As the night falls, the moonlight clears the Akashi Peninsula, and the sound of thousands of birds singing can be heard)	No
(32)	小夜更けて 傾く月の 影も無し 山のあなたの さ牡鹿の声 (As the night deepens, the moon's silhouette fades away, leaving behind only the voice of the mountain's red deer)(Borrowed from a human-written song: 延文百首 1262 (Yanwen Baishou 1262))	2 lines
(33)	ひさかたの 月の桂の 花の色 君が千歳の 初めなるらむ (The color of the flowers on the moon's laurel, you are the beginning of a thousand years, my dear) (borrowed from human-created waka: 18 poems including 新勅撰集 483 (New Edict Compilation 483))	2 lines
(34)	木の葉散る 嵐の音も なかりけり 月の都の ありあけの空 (Leaves of wood fall, the sound of the wind is not heard, the sky of the moon's capital is clear) (Borrowed from human-created waka poem: 正治初度百首 1247 (Zoshizaki Hundred Verses 1247))	2 lines
(35)	あしひきの 山のあなたの 月を見て わが恋ひ渡る ほととぎすかな (As I gaze upon the moon over the mountain, my love seems to be crossing over, as if it's about to bloom) (Borrowed from the human-created waka poem: 洞院摂政家百首 1705 (Dongyuan Shouzouji Baishou 1705)；壬二集 1738 (Niji 2 Collection 1738))	2 lines
(36)	わが宿の 草葉の露も あるものを 心も知らぬ 月の影かな (Is the dew on the grass leaves in my inn also something unknown to the heart, like the shadow of the moon?) (Borrowed from the human-created waka poem: 草庵集 362 (Cao'an Collection 362))	2 lines

AI waka sequence number	Waka	Borrowing status
(37)	高砂の 尾の上の桜 咲きにけり 雲居遥かに 月を見るらむ (Cherry blossoms bloom atop the sand dunes, as clouds drift far away, gazing at the moon) (Borrowed from the human-created waka poem: 後拾遺集 120 (Houshikigumi 120))	(More than 3 lines)
(38)	春霞 たなびく雲の 絶え間より 心の内に 月を見るかな ("Spring Cloud, as if suspended between the clouds, one might gaze upon the moon within the heart") (Borrowed from a human-composed waka poem: 夫木抄 1469 (Fukiwa Choshi 1469)；新古今集 413 (Shin Kojinshū 413)；内大臣家後度歌合 9 (Uchi-daimitsu-ya Goto-gokai 9)；千五百番歌合 458 (Sen-go-ban-gokai 458))	(More than 3 lines)
(39)	秋萩の 花咲きにけり ひさかたの 月の桂の 影や見ゆらむ (The flowers bloom in the autumn, and the shadows of the moon's branches are seen and admired) (Borrowed from human-created waka: 18 poems including 古今集 128 (Kojinshū 128))	(More than 3 lines)
(40)	高円の 尾の上の桜 咲きにけり 今宵の月の 影や見ゆらむ (The cherry blossoms on the high hilltop bloom, illuminated by the moon's shadow tonight) (Borrowed from human-created waka: 民部卿家歌合 18 (Minbu Kyokai Goka 18)；千載集 391（Tsukuyoshi Goshinshū 391))	(More than 3 lines)

6. CONCLUSION

This article examines 900 AI waka poems generated by the WakaVT model and two benchmark models, WakaVT-FMSA and TVAE+FMSA, and conducts a comparative analysis of the borrowing of human-created waka short sentences in the AI waka poems generated by each model. The analysis results show that, compared to the benchmark models, the latent variable sequence improves the diversity of AI waka poems generated by the WakaVT model, effectively avoiding the issue of AI waka poems borrowing human-created waka short sentences. The multi-level fusion self-attention mechanism also plays a certain auxiliary role in this regard. The WakaVT model accurately learns the word choice, grammar, and logical structure between sentences of human-created waka, and is able to generate creative AI waka poems through novel metaphorical techniques, providing inspiration for human waka creation.

REFERENCES

[1] Liu Xiaojun, An Example of Classical Japanese Waka Poetry Drawing Inspiration from Bai Juyi's Poetry [J]. Journal of Japanese Language Study and Research, 2003(03): 52-56.

[2] Wu, X., Klyen, M., Ito,K. & Z. Chen. Haiku generation using deep neural networks[A]. In M. Yamamoto(ed.). Annual Conference of the Language Processing Society [C]. Kyoto: Language Processing Society, 2017: 1133-1136.

[3] Zhao Qing, On Synesthesia in Waka Poetry - Centered on "Plum Fragrance" [J]. Journal of Japanese Language Study and Research, 2009, 94(03): 94-99.

[4] Huang Yiding, The Origin and Evolution of Chinese-style Imagery in Waka Poetry: Focusing on the Imagery of "Chrysanthemum" [J]. Journal of Japanese Language Study and Research, 2016(01): 101-110.

[5] Masada, T. & A. Takasu. LDA-based scoring of sequences generated by RNN for automatic Tanka composition[A]. In Y. Shi(ed.). International Conference on Computational Science[C]. Wuxi: Springer International Publishing, 2018: 395-402.

[6] Takeishi, Y., Niu, M., Jin, Z., Yang, Q. Waka VT: A sequential variational transformer model for Waka generation[J]. Neural Processing Letters, 2022(2): 731-750.