



Unleashing the Potential of Artificial Intelligence in Translation: From General Applications to Purpose-built Innovations

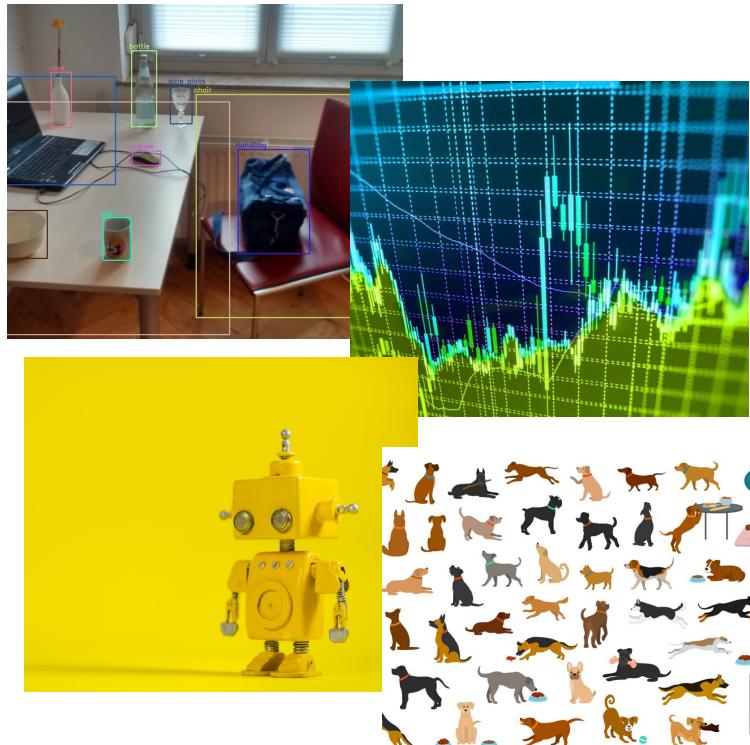
Sai-cheong SIU

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(Computer (-Aided) Translation)

The Hang Seng University of Hong Kong

AI is everywhere



Detection and recognition



Analysis and prediction



Robot control



Generation: Text, image and more

AI for Translation



AI-driven applications for
General Translation



AI-driven applications for
Specialized Translation

Outline

Part 1: An Overview of AI

Part 2: AI for General Translation

- Examples
- Strengths and Limitations
- Recommendations

Part 3: AI for Specialized Translation

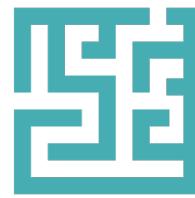
- Translation of Financial Documents
- Translation of Government Documents
- Translation of Buddhist Texts

1. An Overview of AI

Features



Uses deep neural networks extensively



Reduces need for hand-crafted rules and feature engineering



Requires big data, powerful hardware, advanced algorithms

2. AI for General Translation

Conventional approaches



Rule-based Machine Translation



Example-based Machine Translation



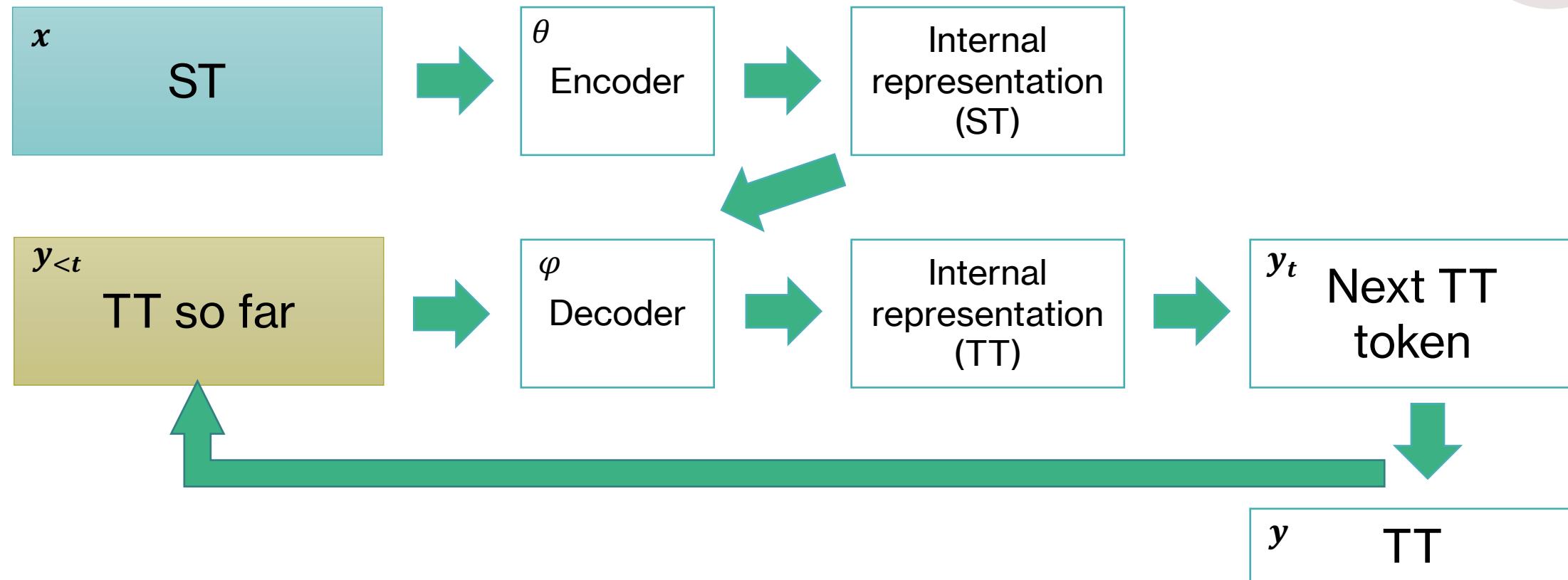
Statistical Machine Translation

AI-driven tools applicable to translation: Examples

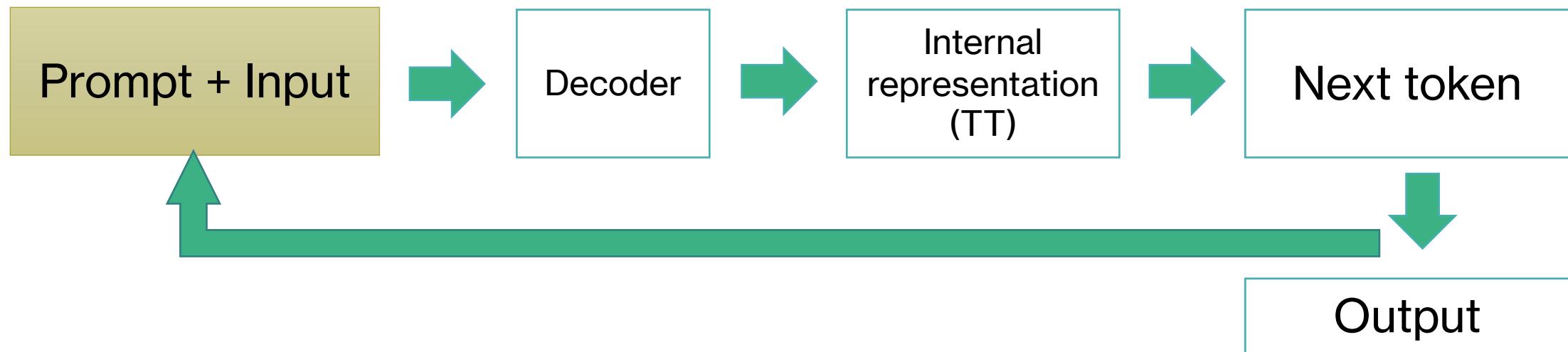
Neural machine
translation

Large language
models (e.g.,
ChatGPT)

Neural Machine Translation



Decoder-based Large Language Models like ChatGPT



Formally, we have

Neural Machine Translation

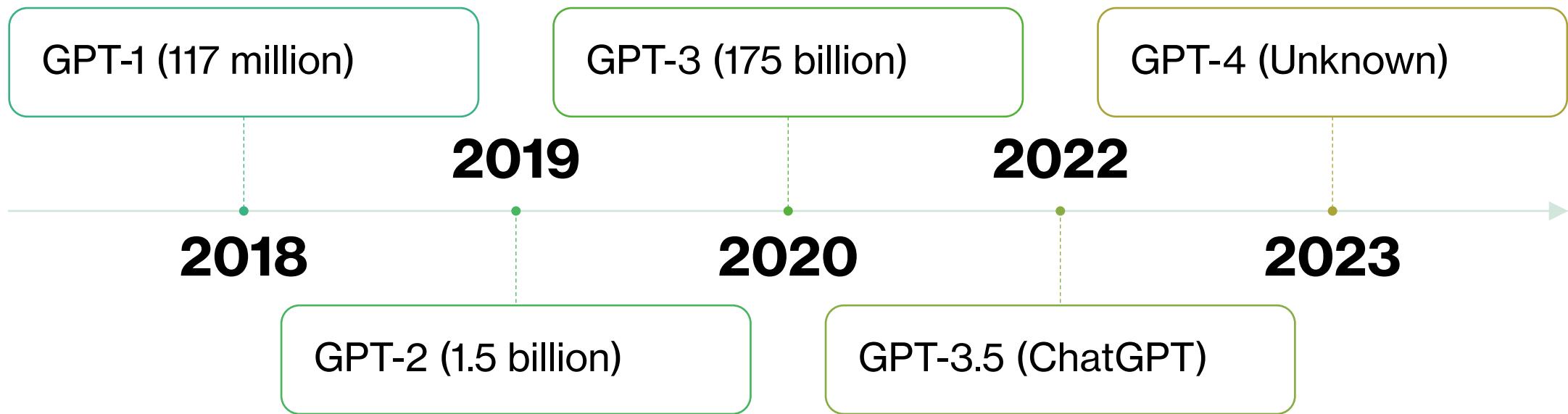
$$p(\mathbf{y}|\mathbf{x}) = \prod_{t=1}^n p_{\theta,\varphi}(y_t|\mathbf{x}, \mathbf{y}_{<t})$$

Decoder-based Large Language Models

$$p(\mathbf{y}|\mathbf{m}, \mathbf{x}) = \prod_{t=1}^n p_{\varphi}(y_t|\mathbf{m}, \mathbf{x}, \mathbf{y}_{<t})$$

ChatGPT: An Example

$$p(y|\mathbf{m}, \mathbf{x}) = \prod_{t=1}^n p_{\varphi}(y_t|\mathbf{m}, \mathbf{x}, \mathbf{y}_{<t})$$



Common architectures

- Read more: Siu (2023b)

1. Recurrent
Neural Networks
(RNN)

Bidirectional RNN with
Attention

Example:

$$\begin{aligned}\vec{h}_t &= \vec{f}(x_i, \vec{h}_{t-1}) & \vec{h}_t &= \vec{f}(x_i, \vec{h}_{t+1}) \\ h_t &= [\vec{h}_t^\top; \vec{h}_t^\top]^\top \\ a(s_{t-1}, h_m) &= \frac{\exp(score(s_{t-1}, h_m))}{\sum_{k=1}^i \exp(score(s_{t-1}, h_k))} \\ z &= q(\{h_1, \dots, h_i\}) = \sum_{m=1}^i a(s_{t-1}, h_m) h_m \\ p(y_t | y_{<t}, z) &= g(s_{t-1}, y_{t-1}, z)\end{aligned}$$

2. Convolutional
Neural Networks
(CNN)

One-dimensional
convolutional layer

Example:

$$y_{d,n} = \sum_{m=1}^M \sum_{k=0}^{K-1} w_{kM+m,n} x_{d+k,m}$$

3. Self-attention
Neural Networks
(e.g.,
Transformer)

Multi-head Attention with
Queries, Keys and Values

Example:

$$\begin{aligned}scoremat(Q, K) &= softmax(QK^\top \cdot scale) \\ attention(Q, K, V) &= (scoremat(Q, K))V \\ head_h &= attention(W_Q Q, W_K K, W_V V) = attention(Q_h, K_h, V_h) \\ multihead(Q, K, V) &= W_{multihead}[head_1; head_2; \dots; head_H]\end{aligned}$$

Strengths



Higher **BLEU** scores



Enhanced contextual awareness:
dynamic word representations



Integrated support: ST explanation, TT suggestions, quality assessment, and interactive editing (see Siu 2023a)

Limitations

- Difficulty with long sentences
- Limited effectiveness in specialized domains
- Inadequate support for non-English languages
- Insufficient background knowledge and in-depth contextual analysis
- Potential for errors such as hallucination and outdated information.

ChatGPT: Limited knowledge after 2021

Who's the Chief executive of HKSAR government?

The Chief Executive of the [Hong Kong Special Administrative Region](#) (HKSAR) government as of my knowledge cutoff of September 2021 is Carrie Lam Cheng Yuet-ngor. However, please note that my training data only goes up until that point, so there may have been a change in leadership since then.

Hallucination: An Interesting Example

- See Siu (2023a)
- Translate the following into English: 行政長官李家超今日（三月十五日）繼續在北京的訪問行程。他先後拜訪國家科學技術部、文化和旅遊部、海關總署和商務部，與各部門領導就共同關注的事宜交換意見。文化體育及旅遊局局長楊潤雄、政制及內地事務局局長曾國衛、保安局局長鄧炳強、商務及經濟發展局局長丘應樺、醫務衛生局局長盧寵茂教授和創新科技及工業局局長孫東教授亦有出席相關會面。

ChatGPT's translation

- On March 15th, the Chief Executive, Mr. Carrie Lam, continued her visit to Beijing. She visited the Ministry of Science and Technology, the Ministry of Culture and Tourism, the General Administration of Customs, and the Ministry of Commerce, and exchanged views with leaders of these departments on matters of common concern. The Director of the Tourism Bureau, Mr. Yang Runxiong, the Director of the Constitutional and Mainland Affairs Bureau, Mr. Patrick Nip, the Director of the Security Bureau, Mr. John Lee Ka-chiu, the Director of the Commerce and Economic Development Bureau, Mr. Edward Yau Tang-wah, the Director of Health, Professor Sophia Chan Siu-chee, and the Director of the Innovation and Technology Bureau, Professor Alfred Sit Wing-hang, also attended the relevant meetings.

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3. AI for Specialized Translation

Development of AI-driven applications for specialized translation

- Platform 1: IPOTranslate
- Platform 2: GovPR Translation
- Platform 3: DharmaBridge

Platform 1: IPOTranslate

- An online platform for computer (-aided) translation of prospectuses for Initial Public Offerings (IPOs) from English into Chinese

The work was supported by a grant from the Innovation and Technology Commission (Project No. ITF/238/17).

IPOTranslate

Technology for Translation of IPO Prospectuses

What's IPOTranslate?

IPOTranslate is a web-based platform for computer (-aided) translation of prospectuses for Initial Public Offerings (IPOs) from English into Chinese. The system is the product of a machine translation project supported by the Innovation Technology Fund (Project title: Machine Translation of IPO Documents (ITF/238/17)), which was completed in May 2019 and aimed to explore the possibilities of supporting the translation of IPO documents by applying deep learning technology.

IPO Translate (English-Chinese Translation)

Source Text

Hong Kong Exchanges and Clearing Limited. The Stock Exchange of Hong Kong Limited and Hong Kong Securities Clearing Company Limited take no responsibility for the contents of this Prospectus, make no representation as to its accuracy or completeness, and expressly disclaim any liability whatsoever for any loss howsoever arising from or in reliance upon the whole or any part of the contents of this Prospectus.

A copy of this Prospectus, having attached thereto the documents specified in 'Appendix V — Documents Delivered to the Registrar of Companies and Available for Inspection' to this Prospectus, has been registered by the Registrar of Companies in Hong Kong as required by section 342C of the Companies (Winding Up and Miscellaneous Provisions) Ordinance (Chapter 32 of the Laws of Hong Kong). The Securities and Futures Commission and the Registrar of Companies in Hong Kong take no responsibility for the contents of this Prospectus or any other document referred to above.

Unleashing the Potential of Artificial Intelligence in Translation (Sai-cheong Siu June 2023)

[Load Sample](#) [Translate](#)

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IPO Prospectuses in Hong Kong

- IPO prospectus is a comprehensive document that outlines the details of a company's financial health, operations, and plans.
- In Hong Kong, IPO prospectus must be available in both English and Chinese to cater to the diverse investor base and comply with regulatory requirements.
- This has led to high demand for professional translation services to ensure accurate and timely translations.

Features of the platform

- **Feature 1:** Specialized NMT models trained on financial documents
- **Feature 2:** Two models with distinct architectures for generation of two results

1. Recurrent
Neural Networks
(RNN)

Bidirectional RNN with
Attention

2. Self-attention
Neural Networks
(e.g.,
Transformer)

Multi-head Attention with
Queries, Keys and Values

IPO Translate (English-Chinese Translation)

Source Text

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Load Sample

Translate

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Translation 1

香港交易及結算有限公司、香港聯合交易所有限公司及香港證券結算有限公司就本招股章程的內容概不承擔任何責任，概不就其準確性或完整性表示任何聲明，並明確概不就本招股章程所載的全部或任何部分產生的任何虧損而產生的任何損失承擔責任。

Translation 2

香港交易及結算所有限公司、香港聯合交易所有限公司及香港中央結算有限公司對本招股章程的內容概不負責，對其準確性或完整性概不發表任何聲明，並明確表示概不就因本招股章程全部或任何部分內容而產生或因依賴該等內容而產生的任何損失承擔任何責任。

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Translation 1

本招股章程的副本連同本招股章程「附錄五一送呈公司註冊處處長及備查文件」所載文件所附的文件，已根據公司（清盤及雜項條文）條例第342C條（香港法例第32章）的規定於香港公司登記。

Translation 2

本招股章程副本連同本招股章程「附錄五一送呈公司註冊處處長及備查文件」所述文件，已根據公司（清盤及雜項條文）條例（香港法例第32章）第342C條的規定由香港公司註冊處處長登記。

The Securities and Futures Commission and the Registrar of Companies in Hong Kong take no responsibility for the contents of this Prospectus or any other document referred to above.

Translation 1

證券及期貨事務監察委員會及香港公司註冊處處長概不就本招股章程或上文所述任何其他文件的內容負責。

Translation 2

證券及期貨事務監察委員會及香港公司註冊處處長對本招股章程或上述任何其他文件的內容概不負責。

Example

- Source Text : You should rely only on the information contained in this prospectus to make your investment decision.
- Reference Translation : 閣下應僅依賴本招股章程所載資料作出投資決定。
- General MT : 您應僅依賴本招股說明書中包含的信息來做出您的投資決定。
- Our Model: 閣下應僅依賴本招股章程所載資料作出投資決定。

Experiment: results

	Google	IPOTranslate Model 1	IPOTranslate Model 2
BLEU Score	36.89	44.48	53.73

$$BLEU = 100 \cdot \min(1, e^{1-\frac{r}{c}}) \cdot \exp\left(\sum_{n=1}^N w_n \log p_n\right)$$

Platform 2: GovPR Translation

- An AI-driven platform for the translation of government press releases

The work was supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (Project No. UGC/FDS14/H16/18).

Our systems



This bilingual database (English/Chinese) is designed to enhance the quality of "GovPR Translation", an automatic translation engine for the rendition of HKSAR government press releases. The database is like a translation memory (TM). Different from conventional TMs for translators, however, it features not only sentences but also smaller units such as phrases and words extracted from the government press releases from 2016 to 2018 (DATA.GOV.HK).

The present work is also useful for [translators and language professionals](#) who would like to find bilingual sentences containing a specific expression. For example, if you are not sure how to translate the term "Chief Executive" or "把握機遇", just type your expression in the text box below, and the bilingual examples provided may be useful.

Type your expression here (English or Chinese):

[useful-resources](#)



GovPR Translation is an automatic translation engine for the rendition of HKSAR government press releases. It features (1) the development of neural translation networks trained on general documents, partially in-domain documents (government documents), and in-domain documents (press releases between 2016 and 2018) and (2) the use of a translation memory prior to automatic translation to facilitate the processing of expressions with existing translations.

The present work is also useful for [translators and language professionals](#) as it provides useful translation drafts that take into consideration of the writing style of government press releases and common expressions, and this may help reduce post-editing efforts and thus enhance the speed and quality of translation.

The demo provided here is Version 0.2 released in 2021 with support for English-Traditional Chinese translation. As we use a computer without a GPU, it may take longer time to translate your text. Please be patient.

Type your English text here:

This platform is designed for the translation of government press releases.

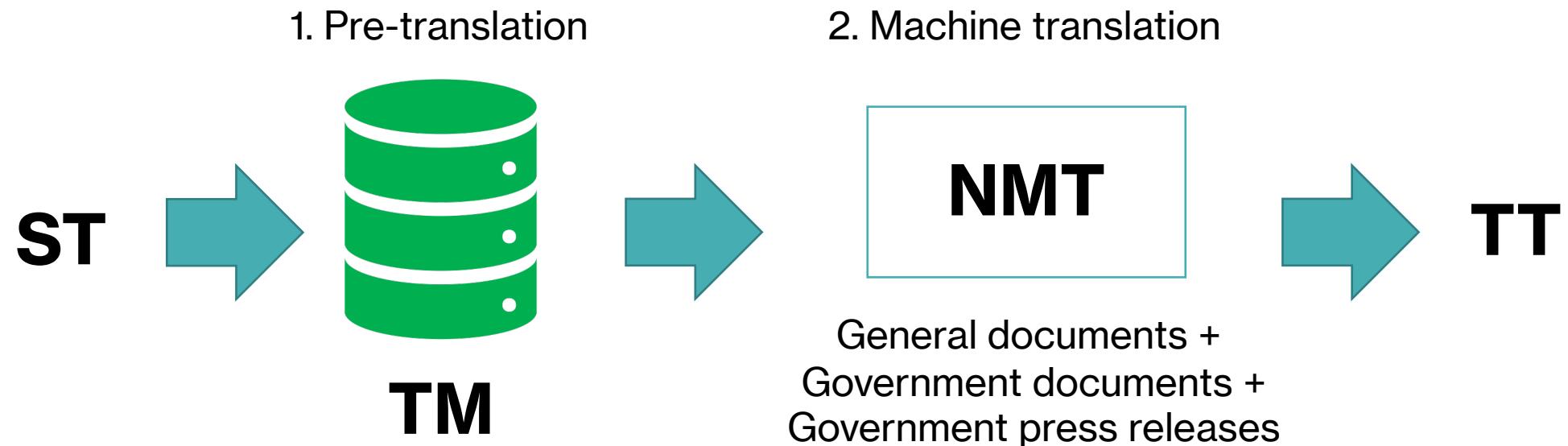
Hong Kong Government Press Releases

- An important communication channel between the government and the public
- Information provided by different bureaus and departments
- Example:
<https://www.info.gov.hk/gia/general/today.htm>
- Three versions: English, Traditional Chinese, and Simplified Chinese

Features of our approach

- **Feature 1:** Development of NMT models trained on specialized data
- **Feature 2:** Integration of Translation Memory (TM) and NMT

Two key stages



Example (Siu 2022)

- Source Text: The Leisure and Cultural Services Department (LCSD) will implement special opening hours at its performance venues and URBTIX outlets during the Lunar New Year holidays, an LCSD spokesman announced today (January 21). Details are as follows:
- Official Reference Translation: 康樂及文化事務署（康文署）發言人今日（一月二十一日）宣布，農曆新年期間轄下各表演場地及城市售票網售票處的開放時間如下：
- Output 1 (NMT): 康文署發言人今日(一月二十一日)宣布,康樂及文化事務署(康文署)將於農曆新年假期舉行特別開放時間及城市售票網,詳情如下:
- Output 2 (GovPR Translation): 康文署發言人今日(一月二十一日)宣布,在農曆新年假期期間,其表演場地及城市售票網售票處會實施特別開放時間,詳情如下:

Experiment: results

	BLEU score of model without pre-translation	BLEU score of model with pre-translation	BLEU difference after pre- translation
Google	23.73	35.51	+11.78
Our Work	38.75	44.71	+5.96

$$BLEU = 100 \cdot \min(1, e^{1-\frac{r}{c}}) \cdot \exp\left(\sum_{n=1}^N w_n \log p_n\right)$$

Platform 3: DharmaBridge

- An AI-powered platform for translating modern Buddhist writings from Chinese into English

The work is part of an on-going project supported by a grant from the Research Matching Grant Scheme.

Buddhist Text Translation

When discussing Buddhist text translation, we often focus on translating ancient sutras into modern languages. Examples:

- Sanskrit
- Pali
- Classical Chinese
- Tibetan

Buddhist Translation in the Digital Age

We focus on modern Buddhist writings.

- Explaining Buddhist teachings using modern language
- Providing modern examples that illustrate how Buddhist principles can be practically applied in daily life

Features

- **Feature 1:** Enhanced support for Buddhist expressions g
- **Feature 2:** Incorporation of user translation data u
- **Feature 3:** Multiple translation drafts

$$p(y|\mathbf{m}, \mathbf{x}, g, u) = \prod_{t=1}^n p_\delta(y_t|\mathbf{m}, \mathbf{x}, g, u, y_{<t})$$

$$w_t = \arg \max_{w_t \in V_T} p_\delta(y_t|\mathbf{m}, \mathbf{x}, g, u, y_{<t}) \rightarrow w_t \sim \frac{e^{\frac{p_\delta(y_{t_i}|\mathbf{m}, \mathbf{x}, g, u, y_{<t})}{\tau}}}{\sum_{y_{t_j} \in V_T} e^{\frac{p_\delta(y_{t_j}|\mathbf{m}, \mathbf{x}, g, u, y_{<t})}{\tau}}}$$

4. More Information

Read More

“ChatGPT and GPT-4 for Professional Translators: Exploring the Potential of Large Language Models in Translation” (Siu 2023a) [\[Link\]](#)

- An Overview of ChatGPT and its Predecessors
- ChatGPT as a Tool for Translators: Exploring Use Cases
- Strengths and Limitations of ChatGPT in the Context of Translation
- Impacts of ChatGPT on Translators and Language Professionals
- The Future of ChatGPT as a Translation Tool



Read More

“Deep Learning and Translation Technology” - see Chapter 47, *Routledge Encyclopedia of Translation Technology* (2nd Edition) (Siu 2023b)

- An Introduction to Deep Learning
- Main Tasks of Deep Learning
- An Overview of Neural Machine Translation
- Recurrent Neural Networks for Translation
- Convolutional Neural Networks for Translation
- Self-attention Neural Networks for Translation
- Deep Learning for Other Translation-related Applications
- Other Noteworthy Trends



Read More

“Where Neural Machine Translation and Translation Memories Meet: Domain Adaptation for the Translation of the HKSAR Government Press Releases” – International Journal of Techno-humanities 1(1): 45-66 (Siu 2022)

Thank you!