



翻譯學院  
SCHOOL OF TRANSLATION  
香港恒生大學  
THE HANG SENG UNIVERSITY  
OF HONG KONG



深度學習研究與應用中心  
DEEP LEARNING RESEARCH & APPLICATION CENTRE  
香港恒生大學  
THE HANG SENG UNIVERSITY  
OF HONG KONG

# AI VS Human Translation: The Inevitable Replacement?

Dr Sai-cheong SIU

Director, Deep Learning Research and Application Centre

Associate Professor, School of Translation

The Hang Seng University of Hong Kong

# Artificial Intelligence

- New Translation Algorithms
- New Translation Applications

## AI and People

### Impact of AI on Translation and Communication

- What does translation technology mean for your business?
- What are the roles of AI and human translators in multilingual communication?



# Outline

- **Overview:** Translation Industry and Translation Technology
- **Types of Translation Technology:** Automatic Translation and More
- **AI for Translation:** Strengths, Weaknesses and the Way Forward



About Us

Private  
University

5 Schools  
(Business, Communication, Decision  
Sciences, Humanities and Social Science,  
and Translation)

The Hang Seng University of Hong Kong

Undergraduate and  
Postgraduate Programmes



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# School of Translation

1. Bachelor of Translation with Business
2. Master of Arts in Translation (Business and Legal)
3. Master of Arts in Translation (Computer-aided Translation)
4. Minor in European Studies



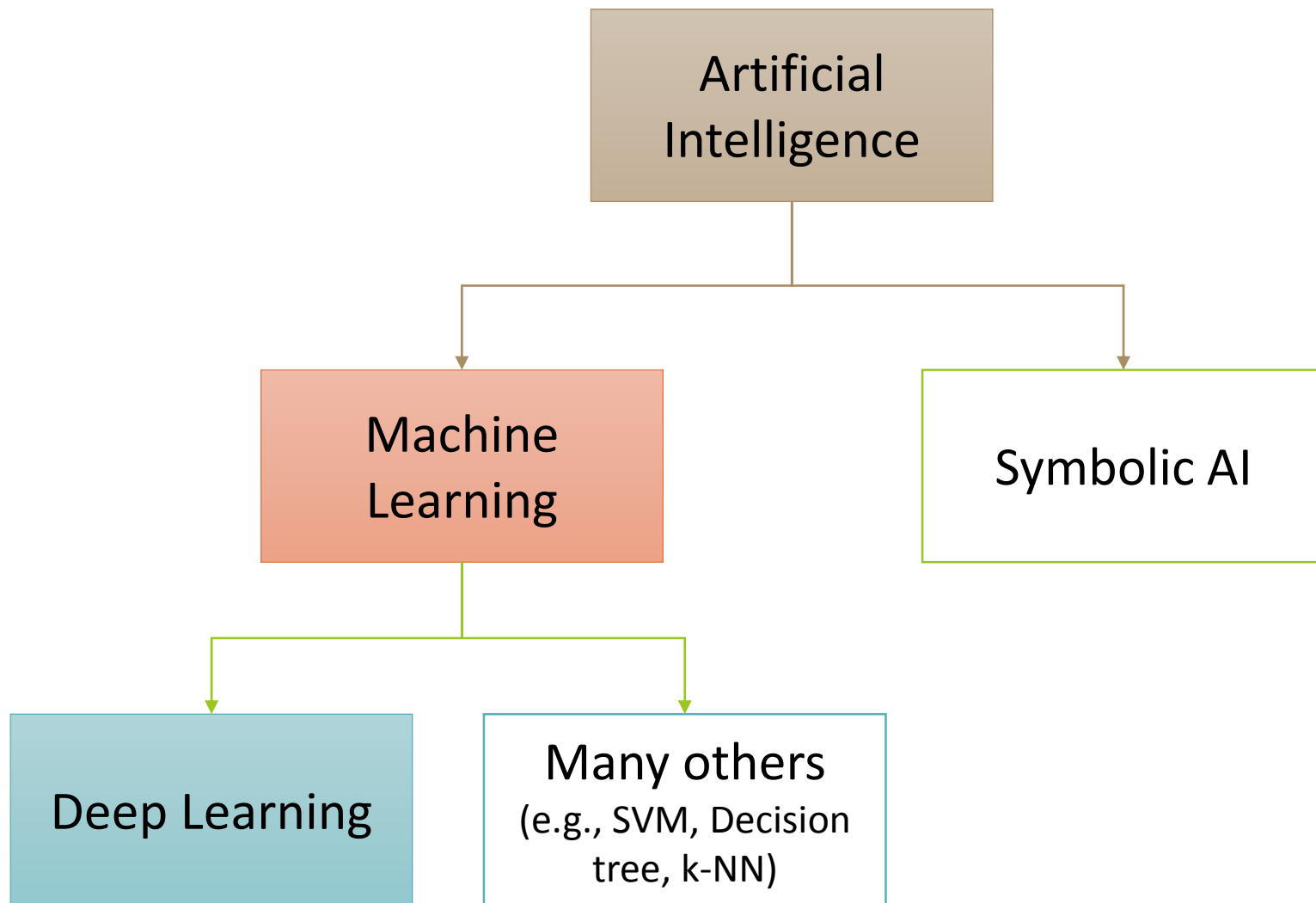
# Deep Learning Research and Application Centre



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# Deep Learning

- Deep Learning technology, which is based on neural networks and large training datasets, has shown great success in many applications.



# Deep Learning

AlphaGo

Speech  
recognition

Sentiment  
analysis

Summarization

Chatbot

Stock price  
prediction

Image  
classification

Object  
detection

Self-driving cars  
and many more



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# Deep Learning Research and Application Centre

- Funding of HK\$6.8 million
- Hardware: Graphics processing unit (GPU)-accelerated hardware for much faster training and decoding
- Software: PyTorch, Tensorflow, Keras, Transformer...
- Projects involving deep neural networks



# Projects (<https://dlc.hsu.edu.hk/>)

- Machine translation (e.g., automatic translation of listing documents; recent funding: HK\$1.4 million)
- Smart retail
- English proofreading
- Weather analysis, forecast and communication
- Detection of fake news
- Financial analysis



# Overview:

## Translation Industry and Translation Technology

# What do translators mean for your business? What does a translator do?

Translation

Interpreting

Localization

Bilingual  
Editing and  
Writing

Many more  
(e.g., transcription,  
certification, term  
management...)



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Translation  
Volume

Turnaround  
Time

Text types

Translation



Language  
Services

Linguistic  
and Cultural  
Issues

Technical  
Knowledge

Project  
Management



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It's more than  
Gxxxle Translate

# Translation Technology

Electronic tools  
for Translation



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# Types of Translation Technology

# Translation Technology

Electronic  
Dictionaries

Translation  
Memories

Terminology  
Databases

Automatic  
Translation



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# Electronic Dictionaries

General  
Dictionaries

Specialised  
Dictionaries



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# Example: HSUHK Business Translation Index



HSUHK Business Translation Index

[Home](#) [About Us](#) [Feedback](#) [Contact Us](#) [中文](#)

<http://www.hsuhkbt.com/>

Type and Search

economics


Go

Record 1: 經濟學


Multilingual Terms/Expressions

 (en)	Economics	 0  0
 (fr)	Sciences économiques	 0  0
 (jp)	経済学	 0  0
 (zh-cn)	经济学	 0  0
 (zh-hk)	經濟學	 0  0
 (zh-tw)	經濟學	 0  0


Additional Information (Powered by TranXLab and Wikipedia)

 (en) Economics (*/ˈiːkənəmiks, ɪˈkeɪ-/*) <sup>[1]</sup> <sup>[2]</sup> <sup>[3]</sup> is the social science that studies the production, distribution, and consumption of goods and services. <sup>[4]</sup>

Source: [Wikipedia](#) (under the [CC-BY-SA](#) License)

 (zh-hk) 經濟學是一門對產品和服務的生產、分配以及消費進行研究的社會科學。西方語言中的「經濟學」一詞源於古希臘的 οἰκονομία (英語: [oikonomia](#)) <sup>[1]</sup> <sup>[2]</sup>。

Source: [Wikipedia](#) (under the [CC-BY-SA](#) License)

 (fr) Les sciences économiques (ou la science économique ou encore l'économie) est une discipline des sciences humaines et sociales qui étudie de façon scientifique le fonctionnement de l'économie c'est-à-dire la description et l'analyse de la production, des échanges et de la consommation des biens et des services.

Source: [Wikipedia](#) (under the [CC-BY-SA](#) License)

この記事では経済学（けいぎがく、英: economics）について解説する。経済学の原語であるeconomicsという語彙は、新古典派経済学者 アルフレッド・マーシャルの名著『経済学原理』（英: *Principles of Economics*, 1890年）によって誕生。普及



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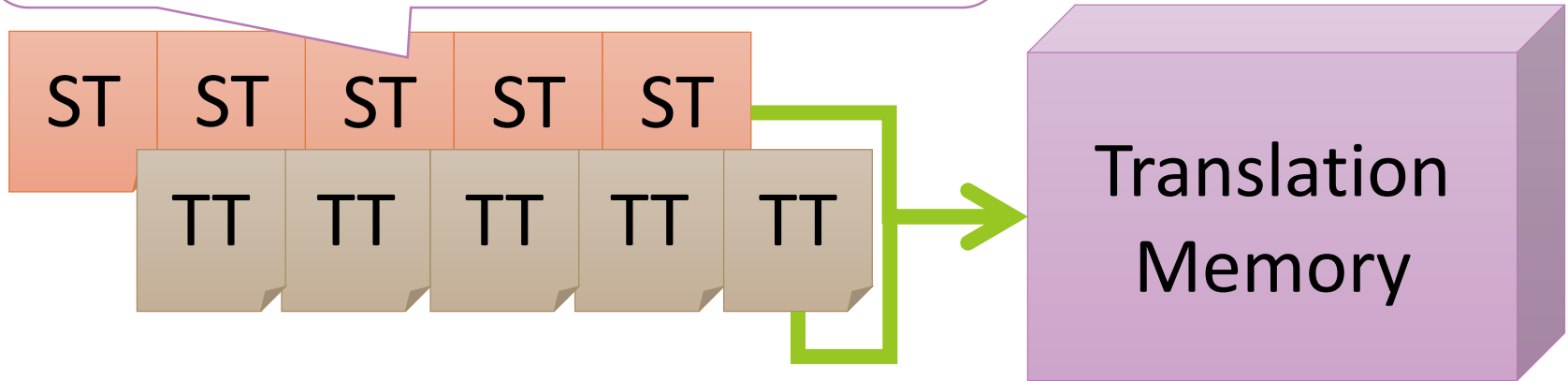


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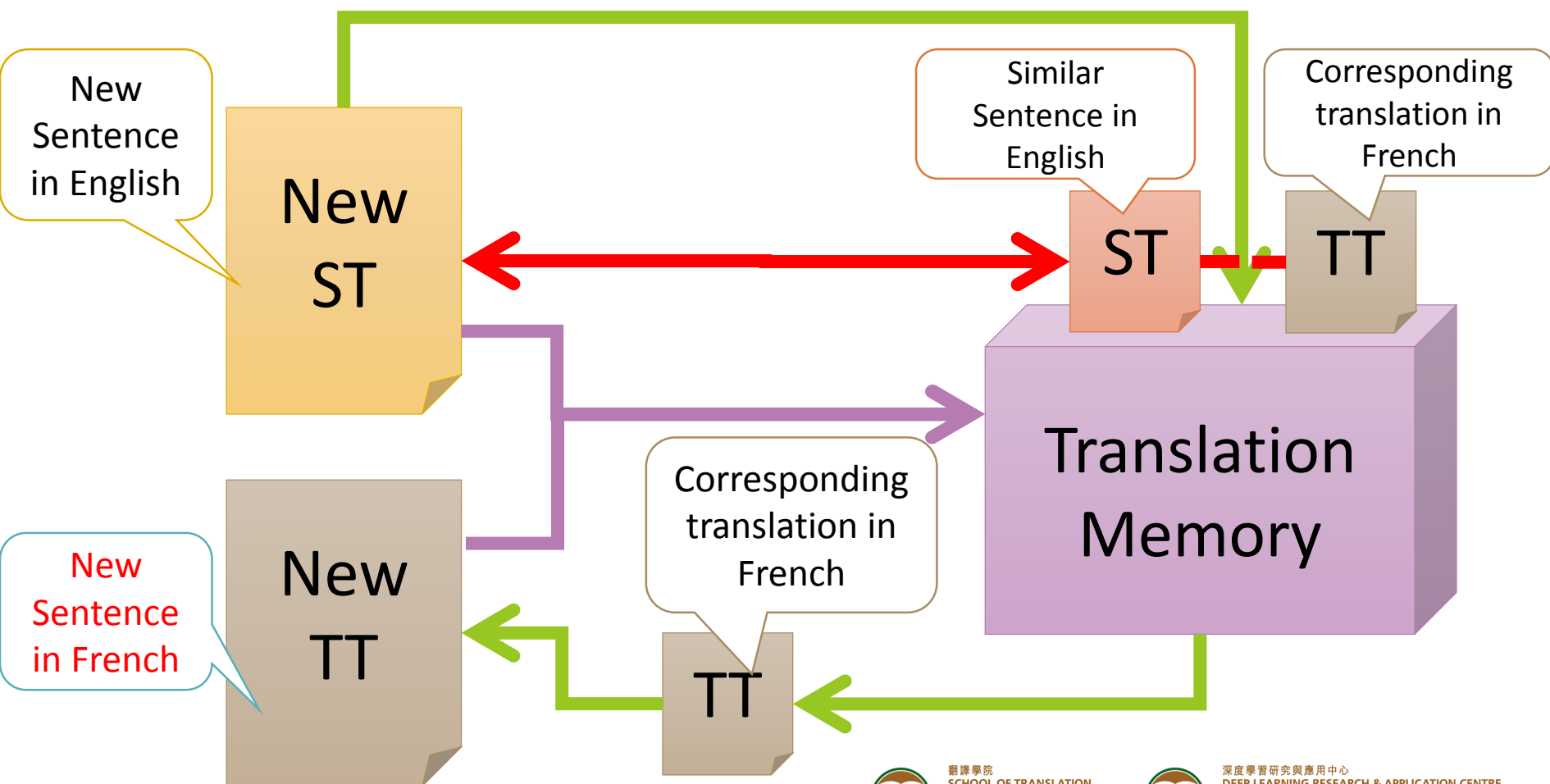
# Translation Memory (TM)

ST = Sentence in English

TT = Sentence in French



# Translation Memory (TM)



# What does TM mean for your business?



Translation  
Speed



Translation  
Cost



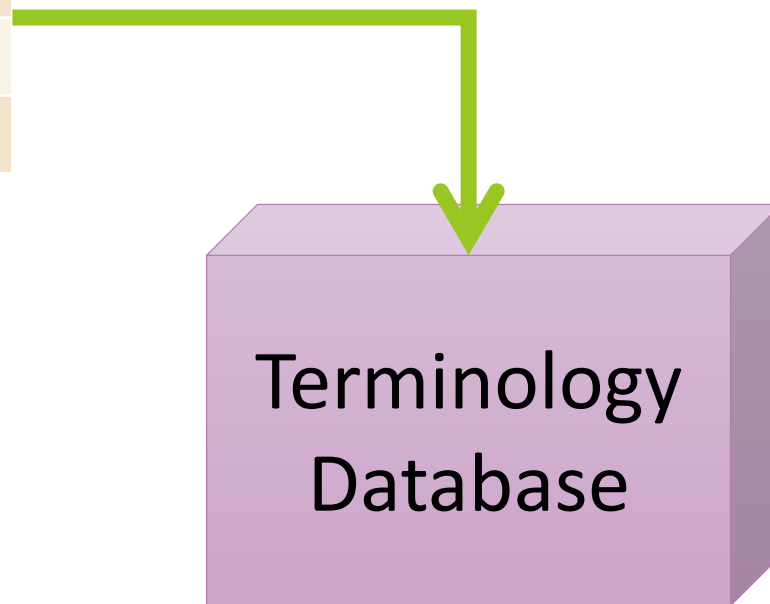
Translation  
Style



Translation  
Flexibility

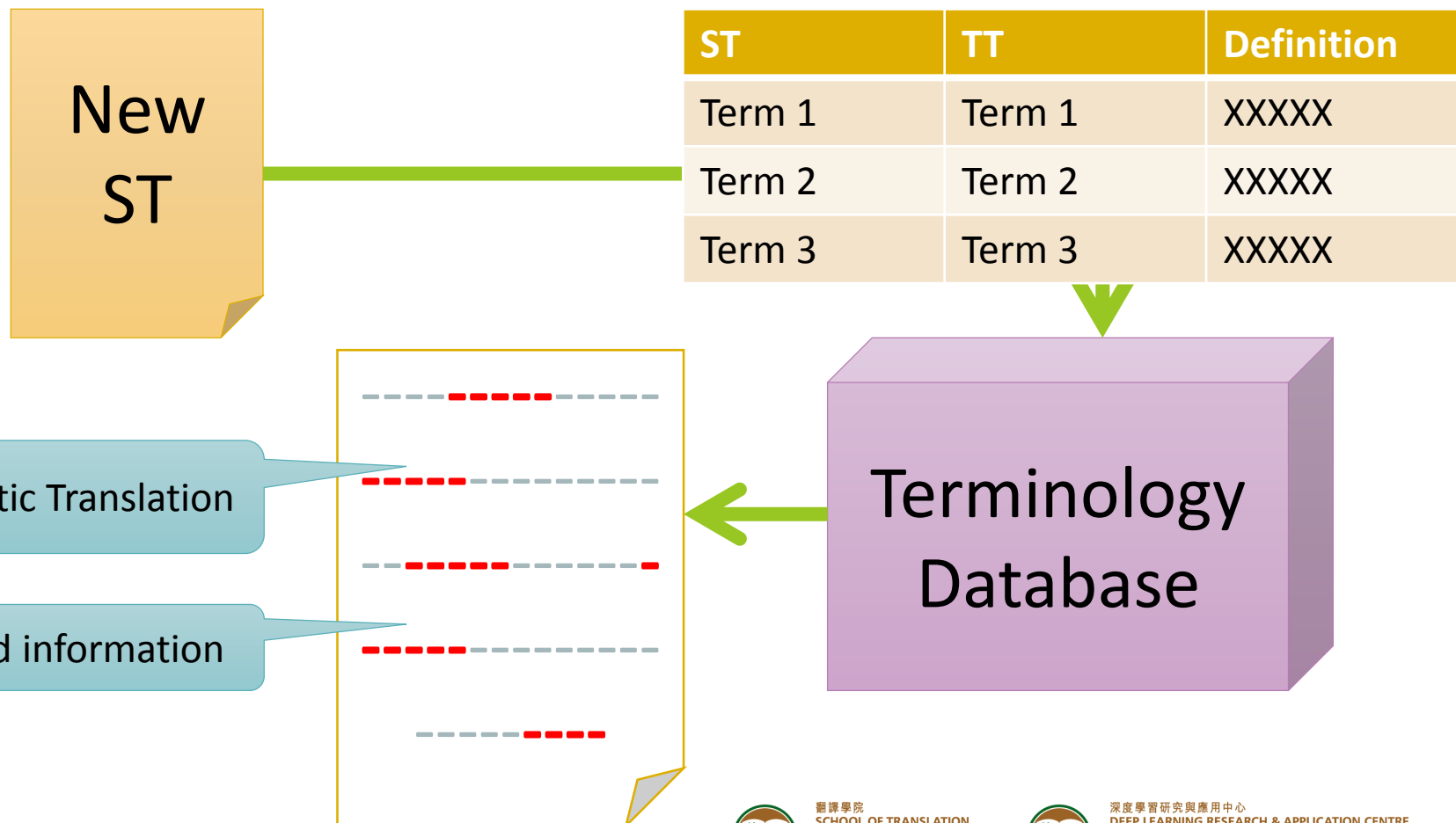
# Terminology Database (Termbase)

ST	TT	Definition
Term 1	Term 1	XXXXXX
Term 2	Term 2	XXXXXX
Term 3	Term 3	XXXXXX





# Terminology Database (Termbase)



# What do Termbases mean for your business?

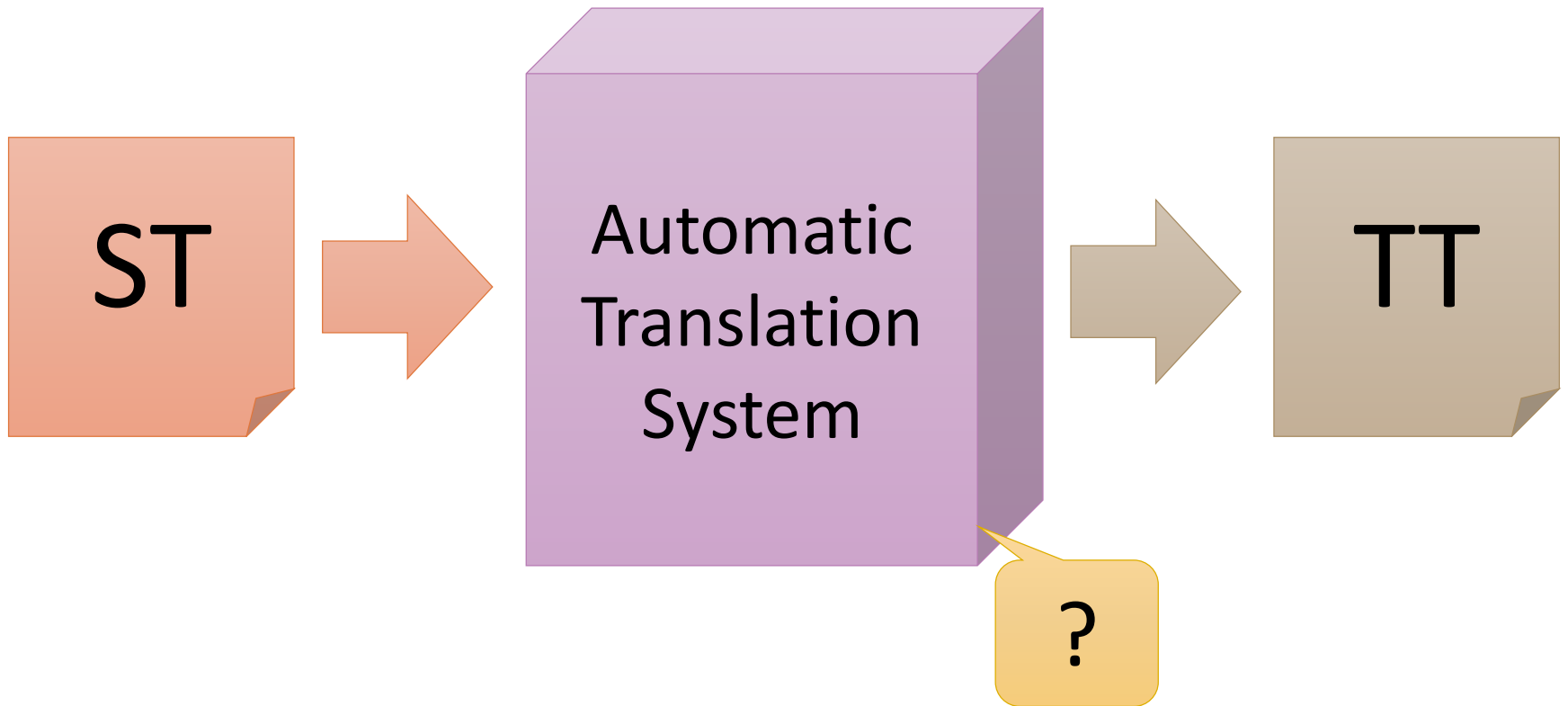


Accuracy



Consistency

# Machine Translation (MT)



# Methods

Rule-based Approach

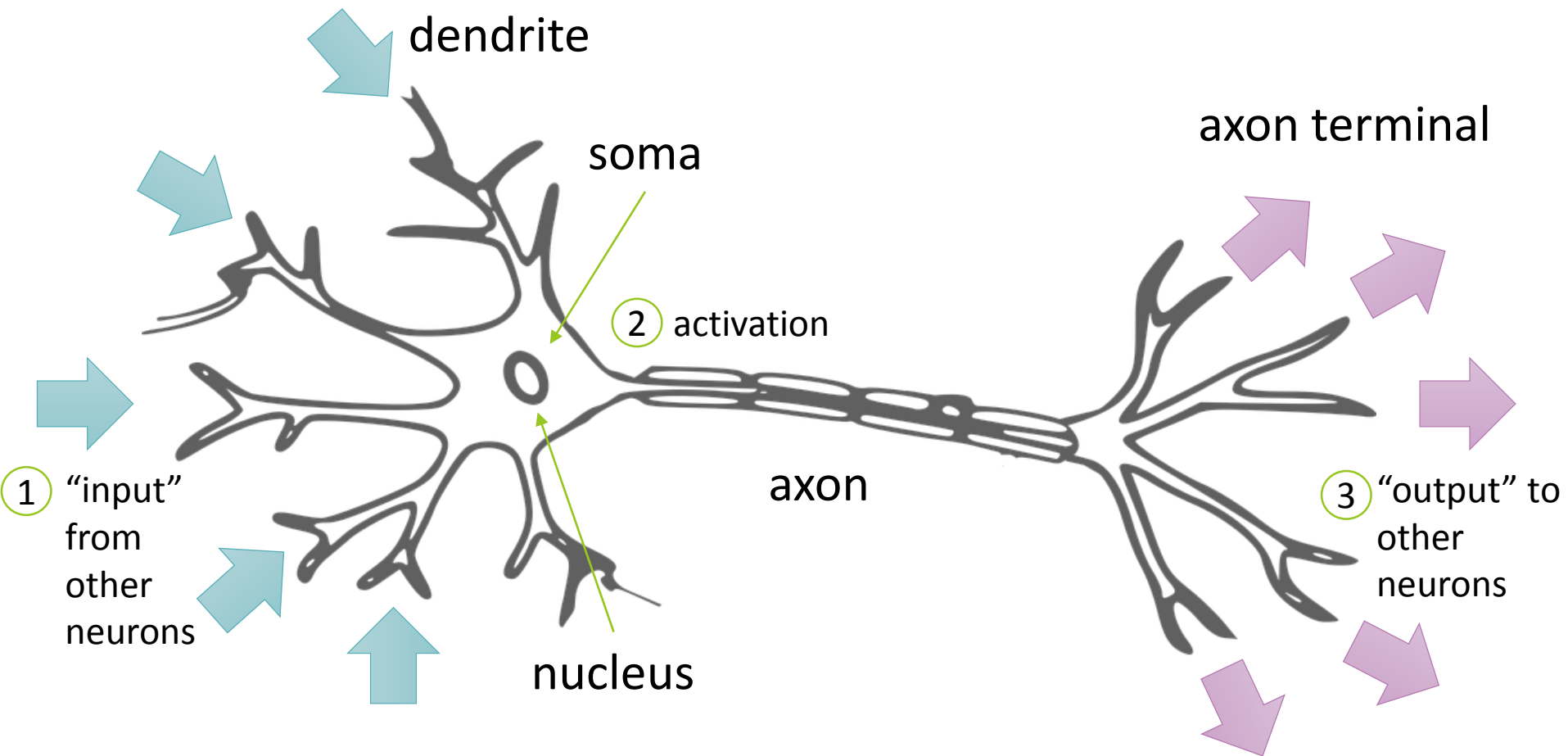
Example-based Approach

Statistical Approach

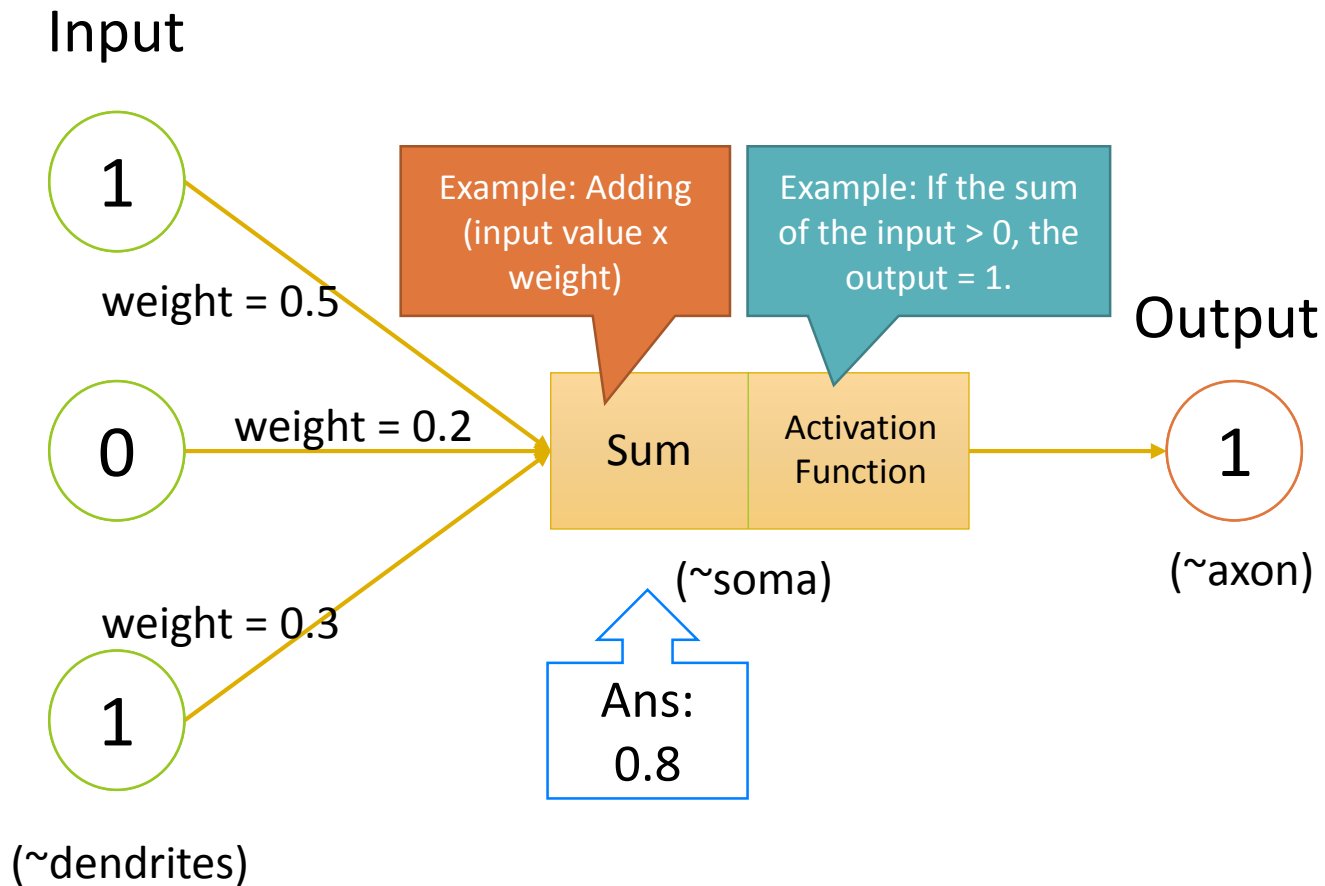
Deep Learning Approach



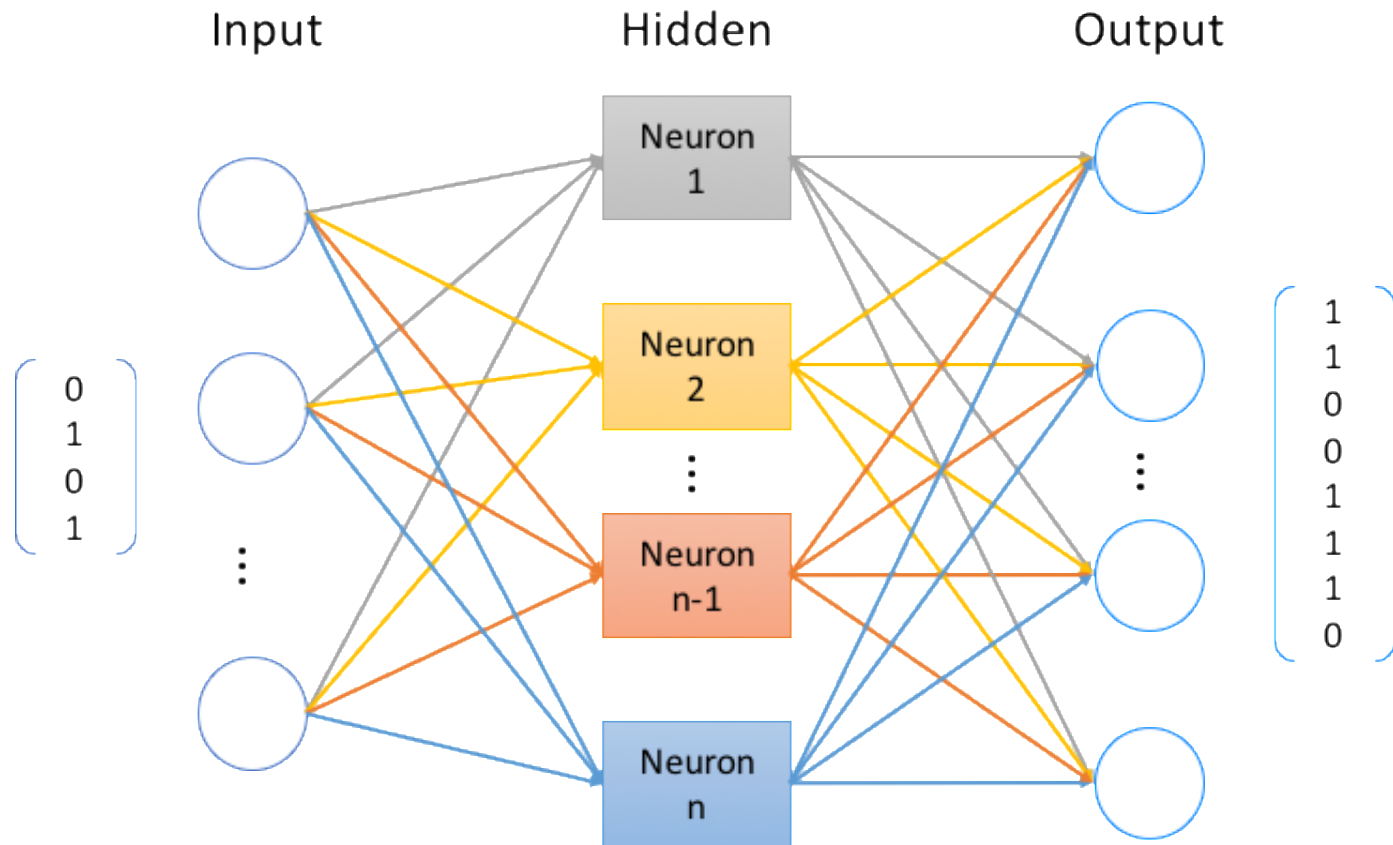
# Biological Neuron



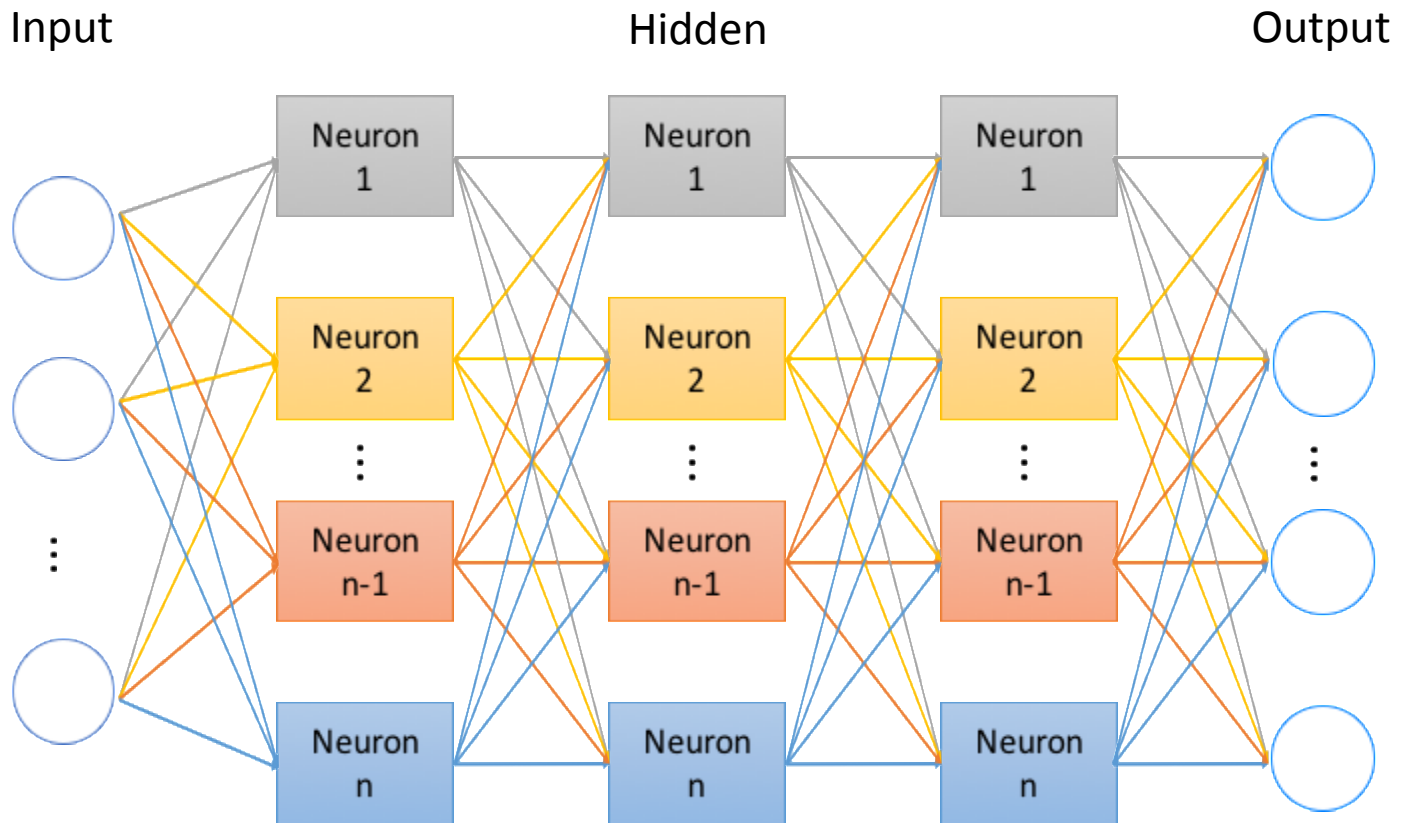
# Artificial Neuron



# Artificial Neural Network: Many Neurons



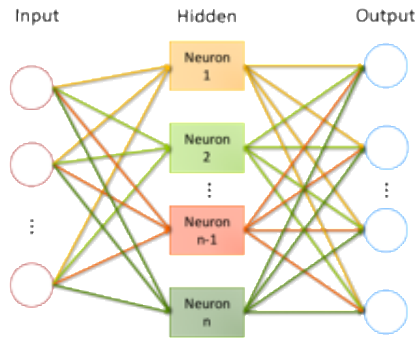
# Deep Learning: Multiple Hidden Layers



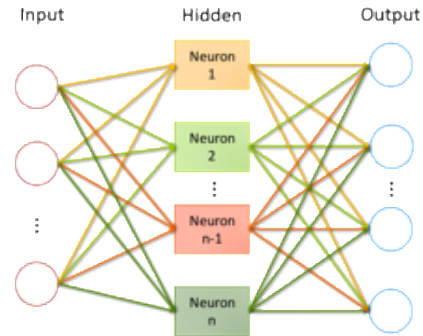


# Neural Machine Translation (NMT)

ST



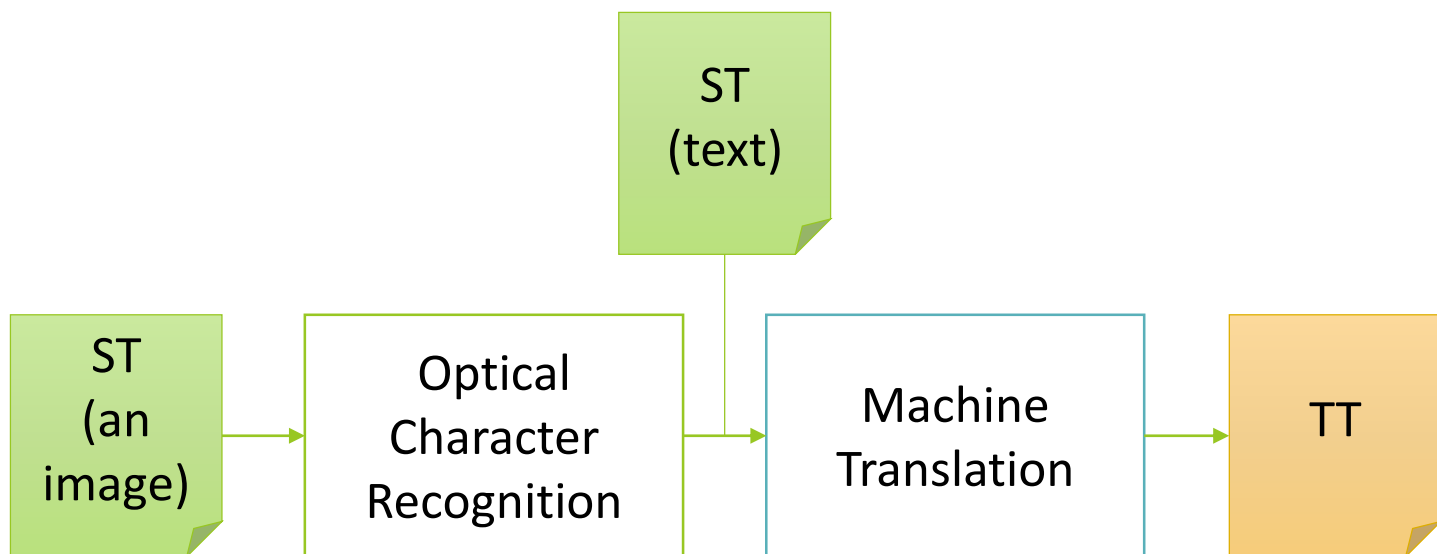
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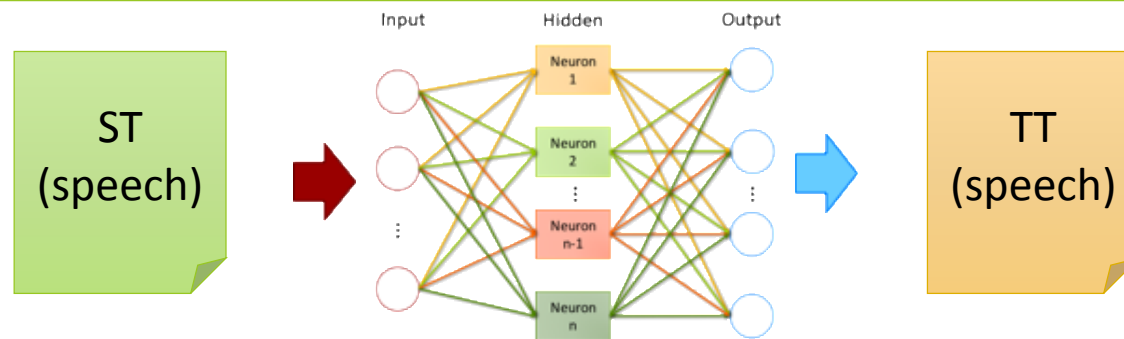
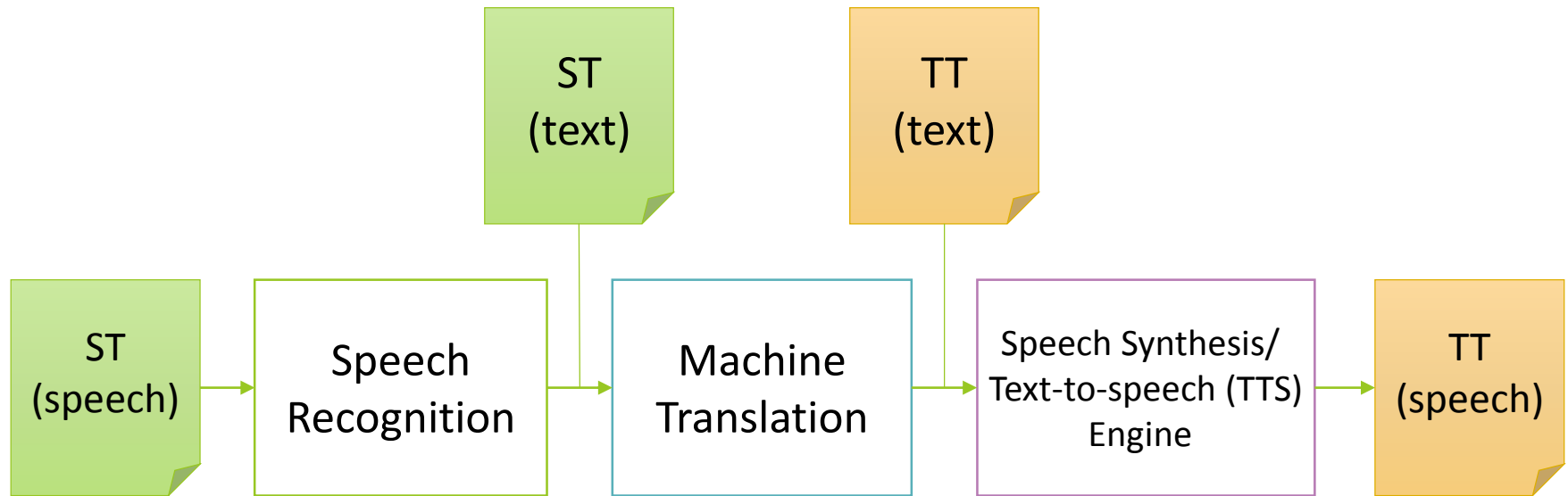
TT



# Image Translation



# Speech Translation



# Other Tools

Corpora and  
Concordancers

Localization  
Tools

Translation  
Servers

Checkers

Tool for  
summarization

Computer-  
aided Editing  
Tools



# AI for Translation: Strengths, Weaknesses and the Way Forward

# Strengths

Speed

Gist  
Translation

Translation  
Draft

Translation of  
Repetitive  
Elements

Term  
Consistency

Language  
Learning



# Weaknesses

Accuracy

Ambiguity

Limited  
Context

Cultural  
Issues

Limited Text  
Types

Lack of  
Reasoning



# The Way Forward

## Collaboration

Modes

Tools

Skills

Identifying ways of collaboration  
for different translation activities



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# Levels of User-Computer Interaction



Human  
Translation



Machine-  
aided/assisted  
Human  
Translation (MAHT)



Human-  
aided/assisted  
Machine  
Translation (HAMT)



Machine  
Translation (MT)



# The Way Forward

## Collaboration

Modes

Tools

Skills

Designing tools for different types of translation:  
Facilitating human-human interaction and human-  
computer interaction



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Tools

Language  
Professionals

Translation  
Researchers

General Public

General  
Translation

Domain-  
specific  
Translation

Other  
Language  
Services



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# Integrated Tools for Translation of Financial Documents

## Significance of financial translation: IPO documents as an example

Largest IPO Centre:  
US\$36.5 billion in  
2018

Integral Part of  
Initial Public  
Offerings

Bilingual  
Prospectuses

IPO documents are usually prepared by lawyers and accountants in English and need to be translated to Chinese as required by HKEX. The translation task, usually handled by printing companies, is costly and labor-intensive.

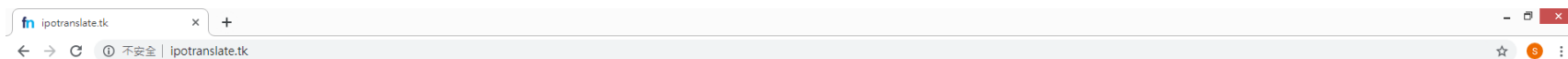


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# Tool 1: IPO Translate



## 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.

Load Sample

Translate

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.

#### 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 2

本招股章程副本連同本招股章程「附錄五—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。

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#### Translation 2

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# Tool 2: FinTranX

## Feature 1

Deep Learning  
Technology

## Feature 2

Domain-specific  
Machine  
Translation

## Feature 3

Tool Integration  
for Interaction

1. Automatic Translation: Generation of translation draft
2. Translation Memory: Reuse of previous translations
3. Terminology Databases: Translation of terms
4. External Databases: Online research

# The Way Forward

## Collaboration

Modes

Tools

Skills

Developing skills for better  
collaboration in the era of AI-  
aided Translation



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## Language Skills

Reading, Writing,  
Listening and  
Speaking



## Translation Skills

Translation Methods  
and Translation  
Theories



Evaluation

Editing

Project  
Management

Tool Operation  
and  
Customization

Database  
Management

AI and  
Machine  
Learning



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# AI VS Human Translation: Inevitable Collaboration

Language professionals familiar with AI  
Language professionals **NOT** familiar with AI

# Thank you very much!

- Email: [scsiu@hsu.edu.hk](mailto:scsiu@hsu.edu.hk)



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# Additional Information

# Research on Financial Translation



**2014:** Hang Seng Management College Business Translation Index

**2015:** “Automated Pre-editing and post-editing: A Hybrid Approach to the Computerized Translation of IPO Prospectuses”, Journal of Translation Technology 1(1)

**2016:** Neural Machine Translation

**2017:** Establishment of Deep Learning Centre

**2018:** Project Supported by the Innovation and Technology Fund

**2019:** Development of an Integrated Platform for Translation of IPO Documents



# Example: HSUHK Business Translation Index



HSUHK Business Translation Index

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Type and Search

economics

Go


<http://www.hsuhkbt.com/SearchBTI?search=technical+analysis>

Record 1: 經濟學


## Multilingual Terms/Expressions

 (en)	Economics	 0  0
 (fr)	Sciences économiques	 0  0
 (jp)	経済学	 0  0
 (zh-cn)	经济	 0  0
 (zh-hk)	經濟學	 0  0
 (zh-tw)	經濟學	 0  0


## Additional Information (Powered by TranXLab and Wikipedia)

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Source: [Wikipedia](#) (under the [CC-BY-SA](#) License)

 (fr) Les sciences économiques (ou la science économique ou encore l'économie) est une discipline des sciences humaines et sociales qui étudie de façon scientifique le fonctionnement de l'économie c'est-à-dire la description et l'analyse de la production, des échanges et de la consommation des biens et des services.

Source: [Wikipedia](#) (under the [CC-BY-SA](#) License)

この記事では経済学（けいぎがく、英: economics）について解説する。経済学の原語であるeconomicsという語彙は、新古典派経済学者 アルフレッド・マーシャルの名著『経済学原理』（英: *Principles of Economics*, 1890年）によって誕生。普及



深度學習研究與應用中心  
DEEP LEARNING RESEARCH & APPLICATION CENTRE  
香港恒生大學  
THE HANG SENG UNIVERSITY  
OF HONG KONG

# MT Methods





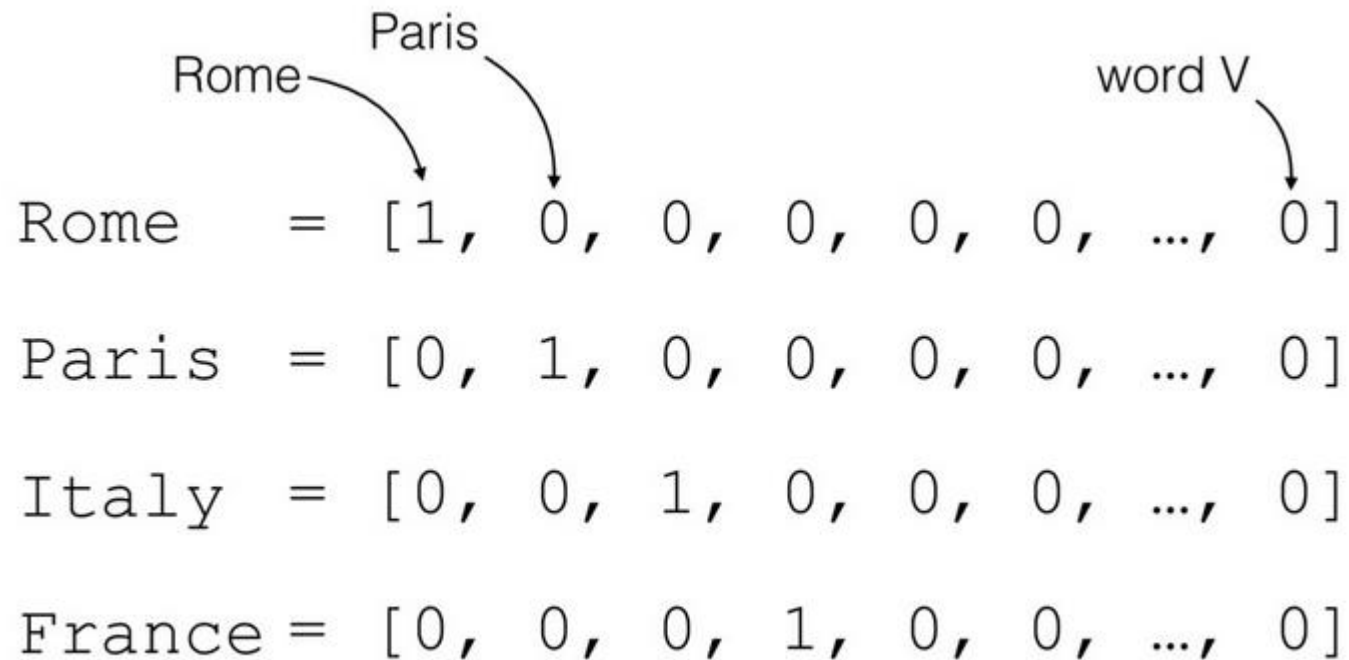
# Traditional Approaches to Machine Translation

01	Rule-based Machine Translation	<ul style="list-style-type: none"><li>● I go to school by train.</li><li>● 我／去／學校／乘／火車／。</li><li>● 我乘火車去學校。</li></ul>
02	Example-based Machine Translation	<ul style="list-style-type: none"><li>● I go to school by train.</li><li>● I go to school by <u>taxi</u>. 我乘<u>計程車</u>去學校。</li><li>● 我乘火車去學校。</li></ul>
03	Statistical Machine Translation	<ul style="list-style-type: none"><li>● Translation Model <math>P("I"   "我") \times P("go"   "去") \times \dots</math></li><li>● Language Model: <math>P("我乘火車去學校")</math></li></ul>

# Word Embedding



# Word Embedding (1): One-hot Vector

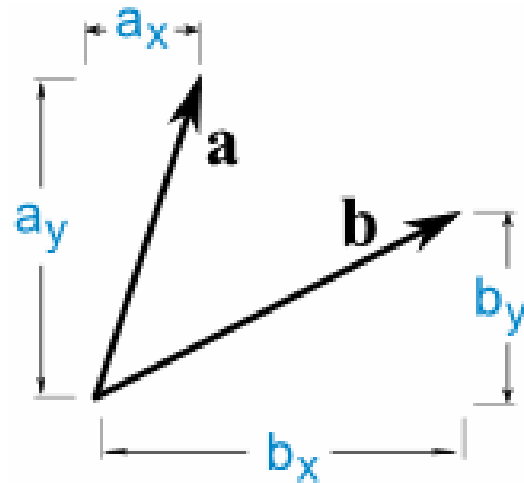
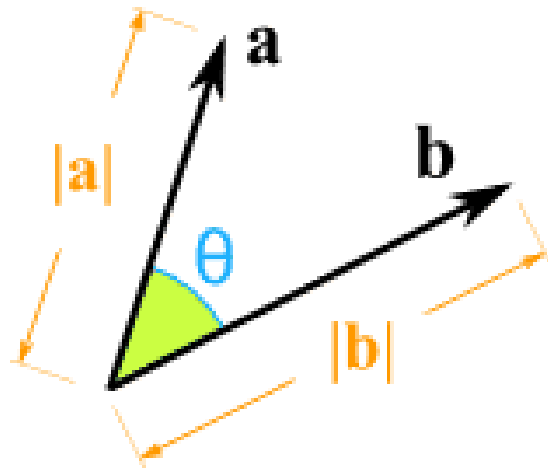


For more information, visit

<https://medium.com/@athif.shaffy/one-hot-encoding-of-text-b69124bef0a7>

# Problem

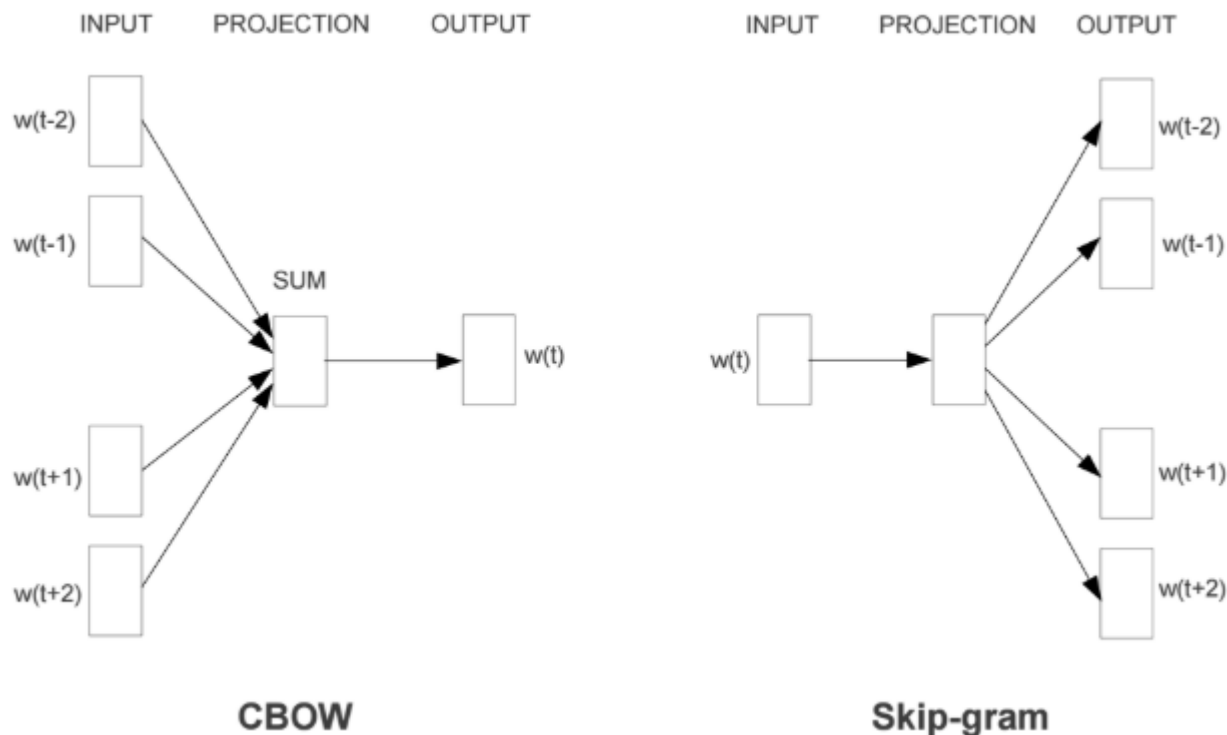
$$\mathbf{a} \cdot \mathbf{b} = a_x \times b_x + a_y \times b_y = |\mathbf{a}| |\mathbf{b}| \cos(\theta)$$



For more information, visit

<https://www.mathsisfun.com/algebra/vectors-dot-product.html>

# Word Embedding (2): Continuous Bag of Words and Skip-gram



For more information, visit

<https://mubaris.com/2017/12/14/word2vec/>

NMT

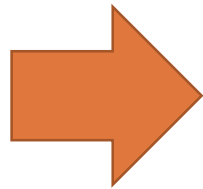


# Methods

Rule-based Approach

Example-based Approach

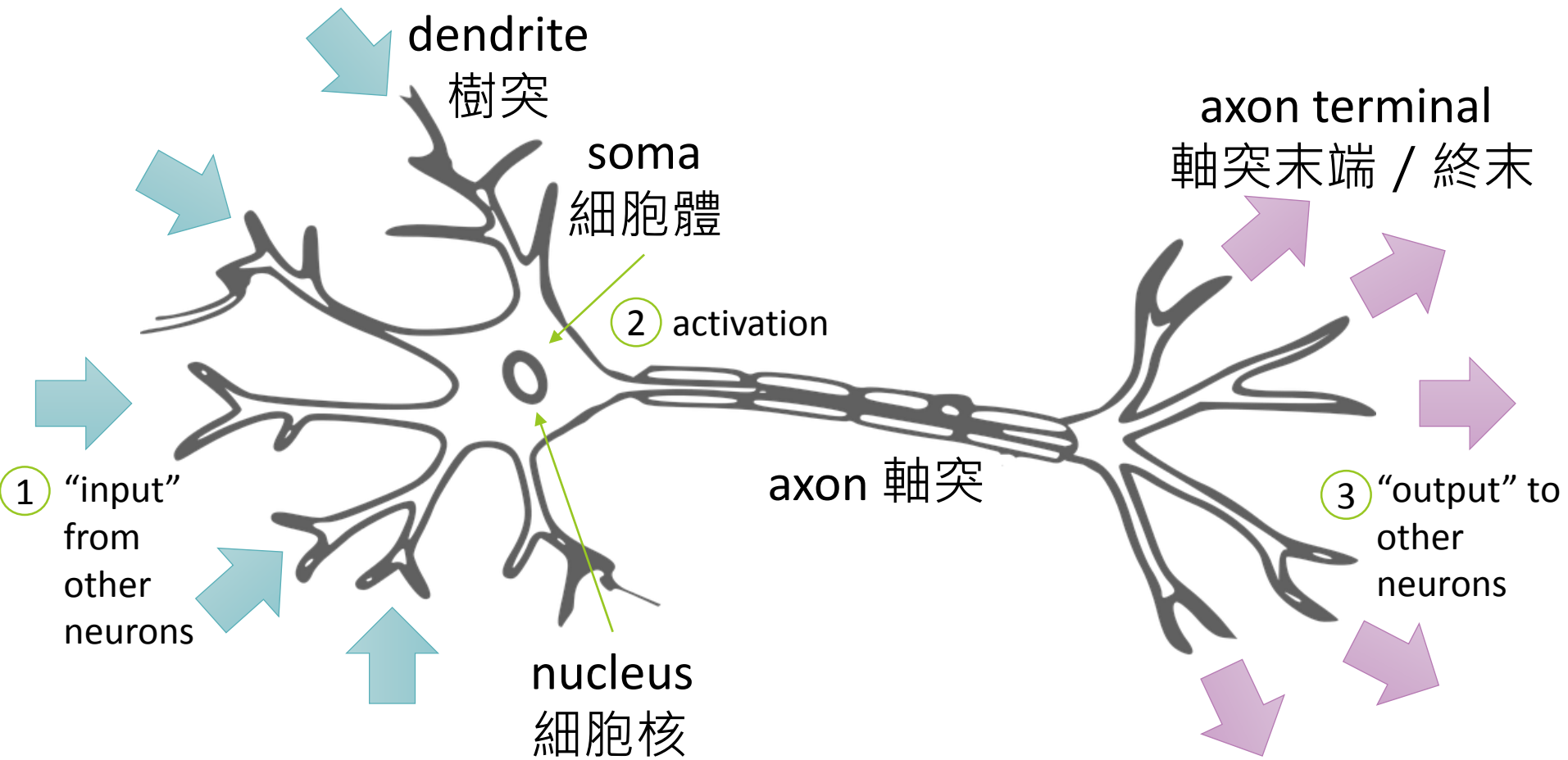
Statistical Approach



Deep Learning Approach

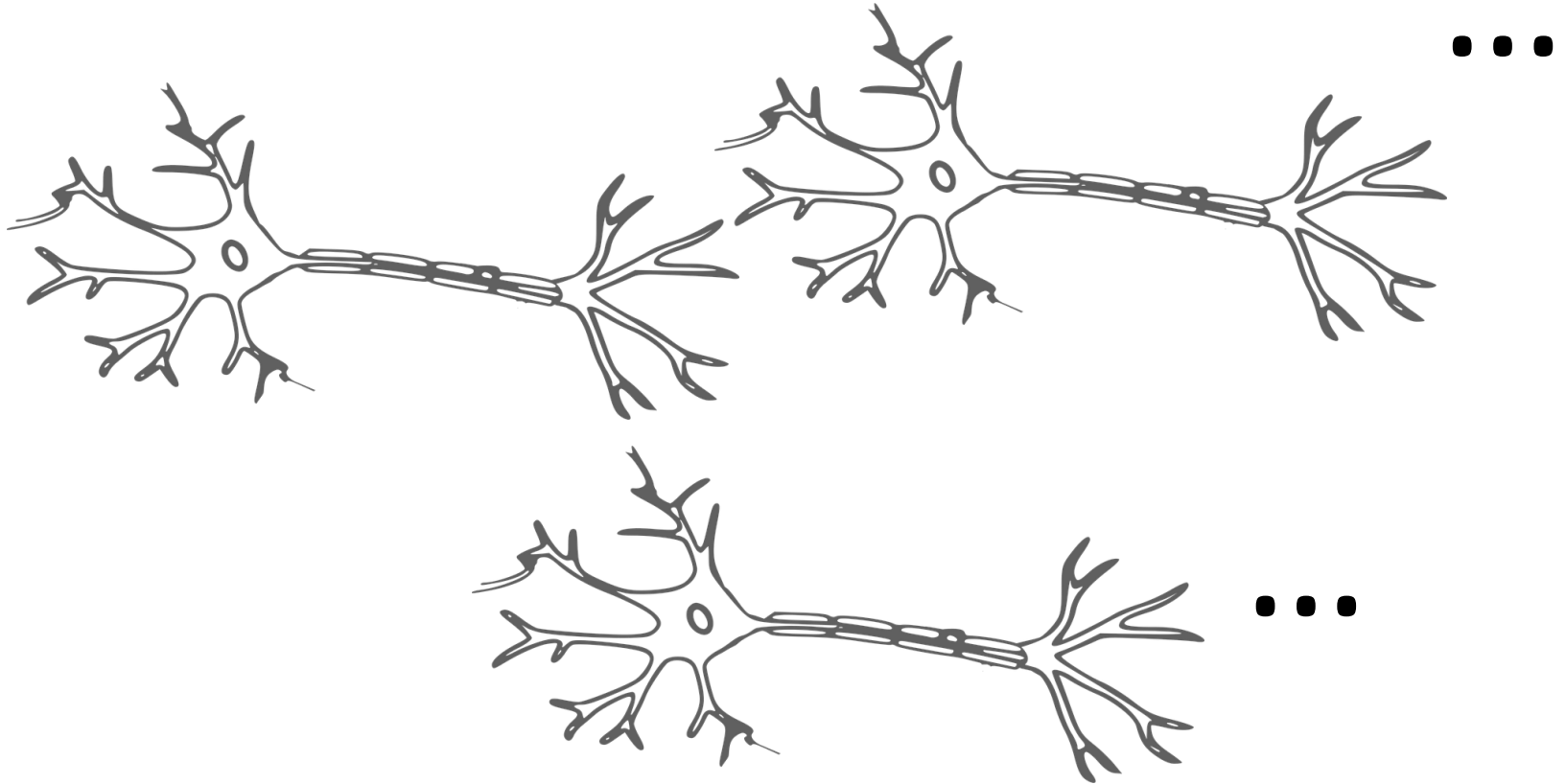


# Biological Neuron

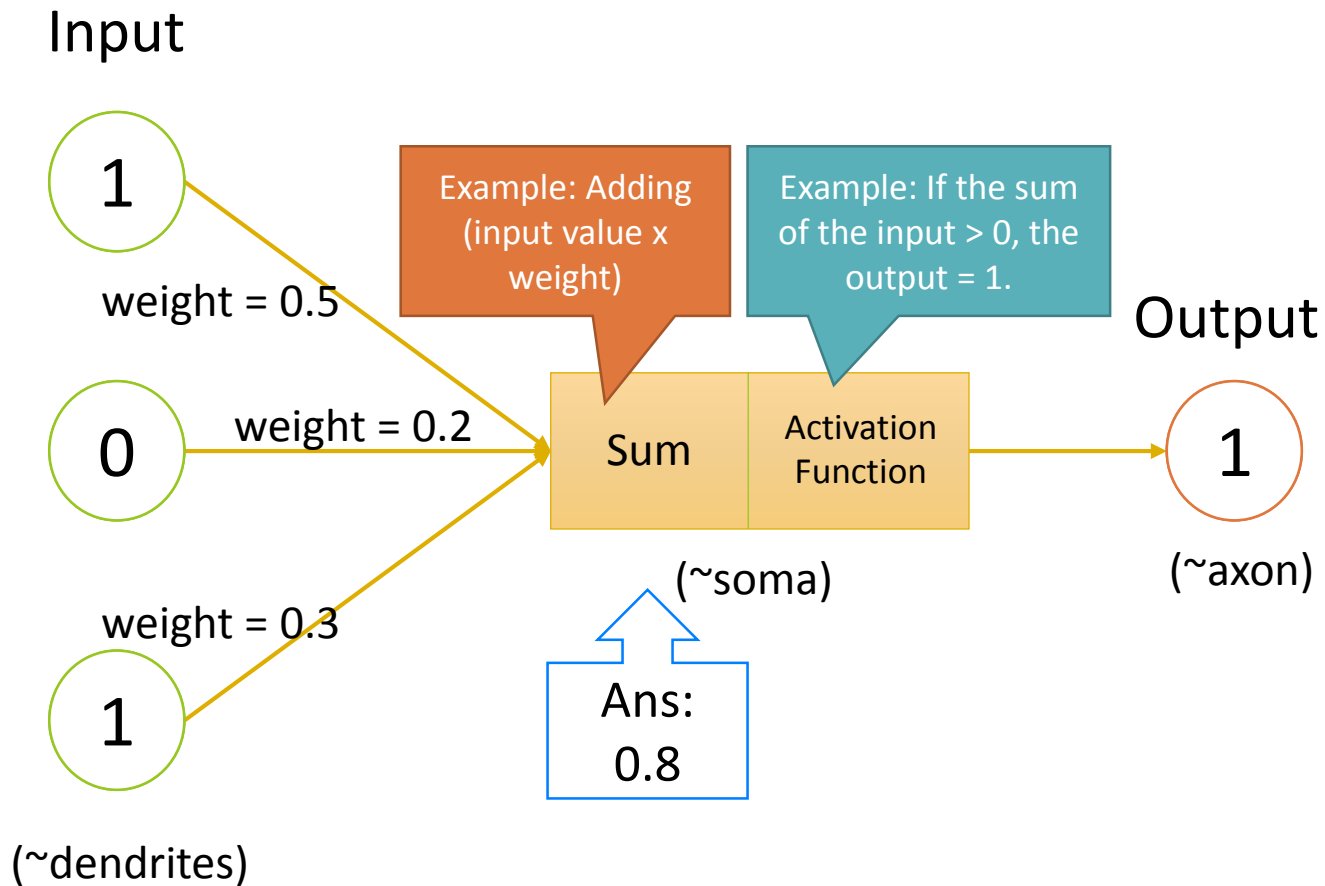




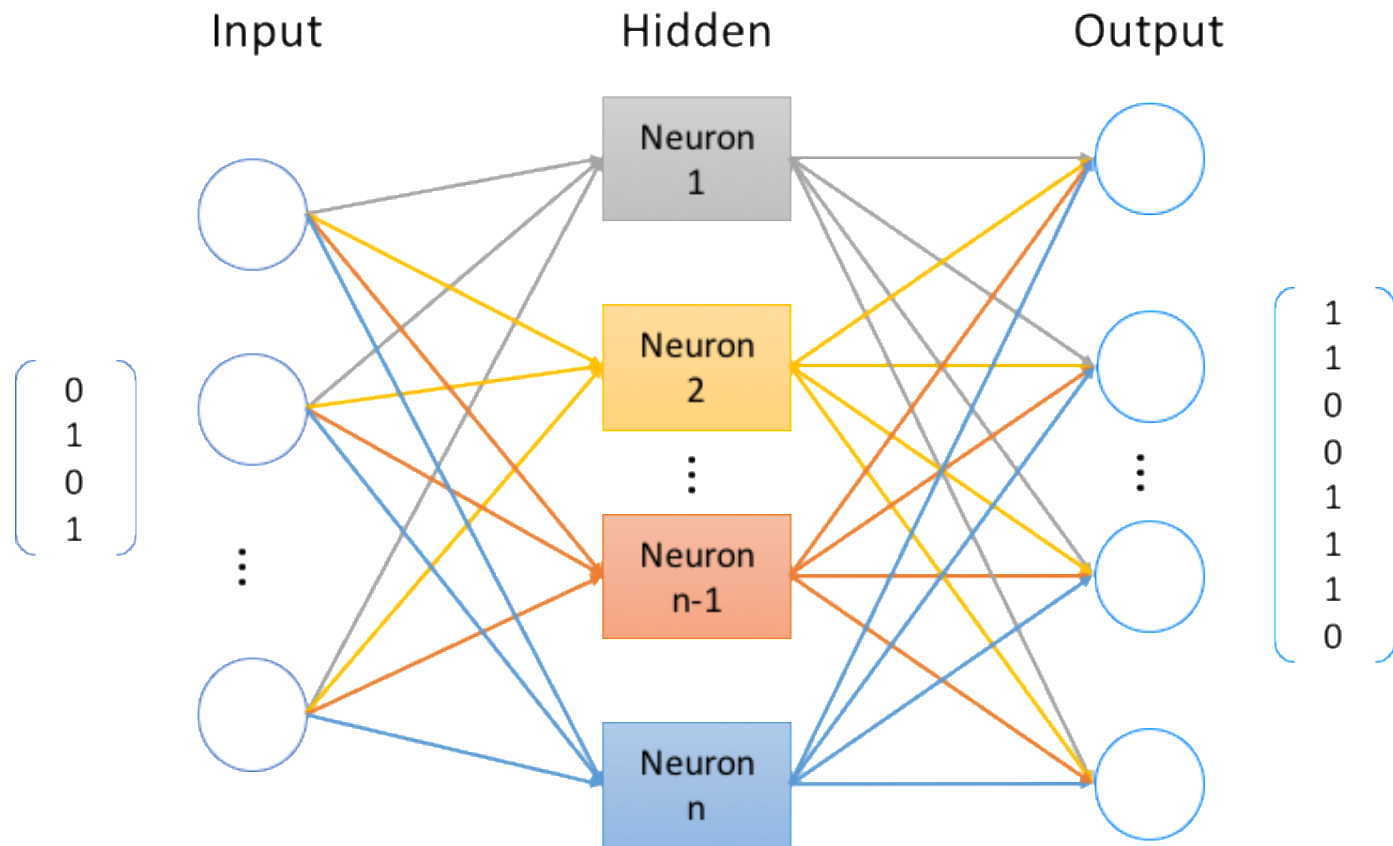
# Biological Neural Network



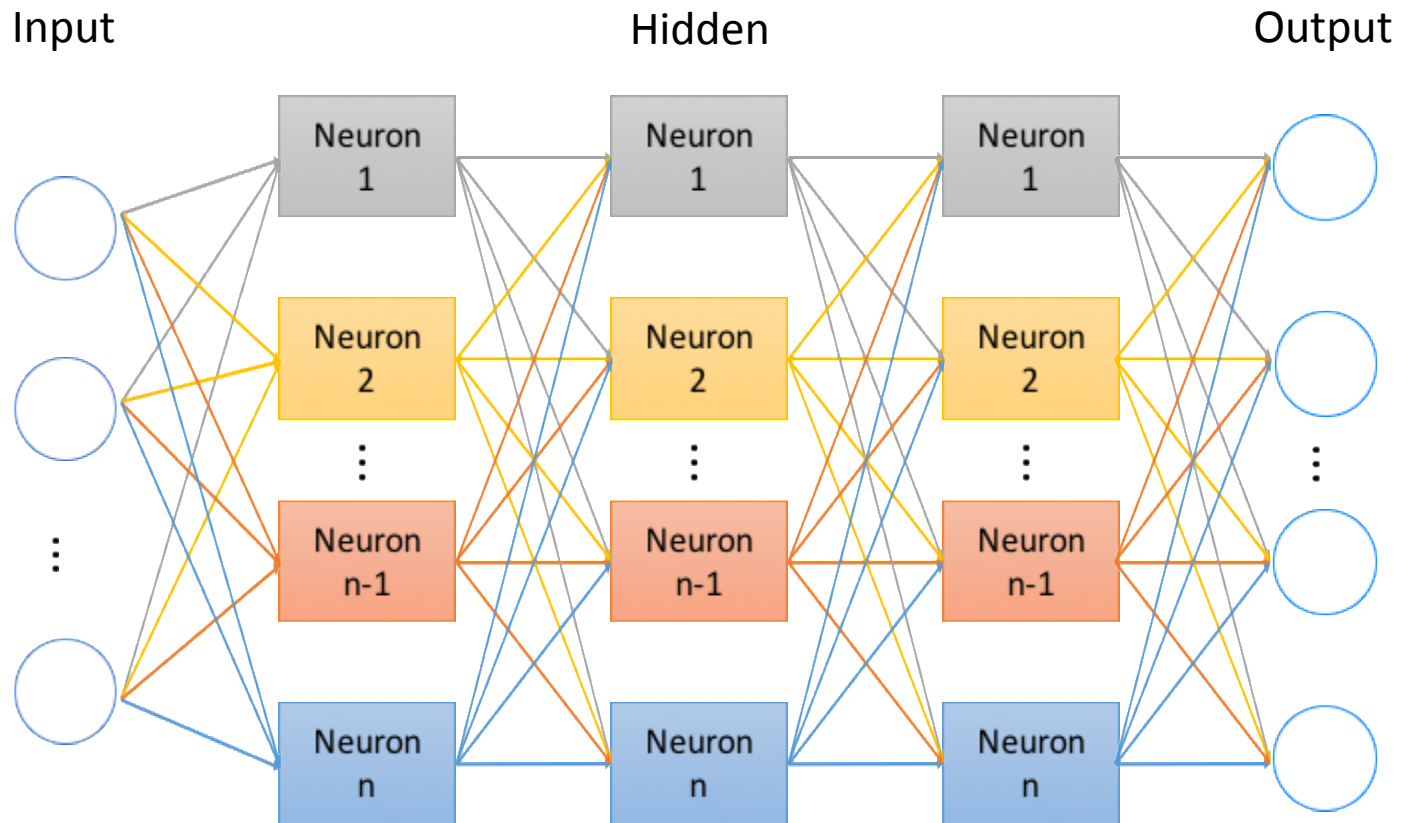
# Artificial Neuron



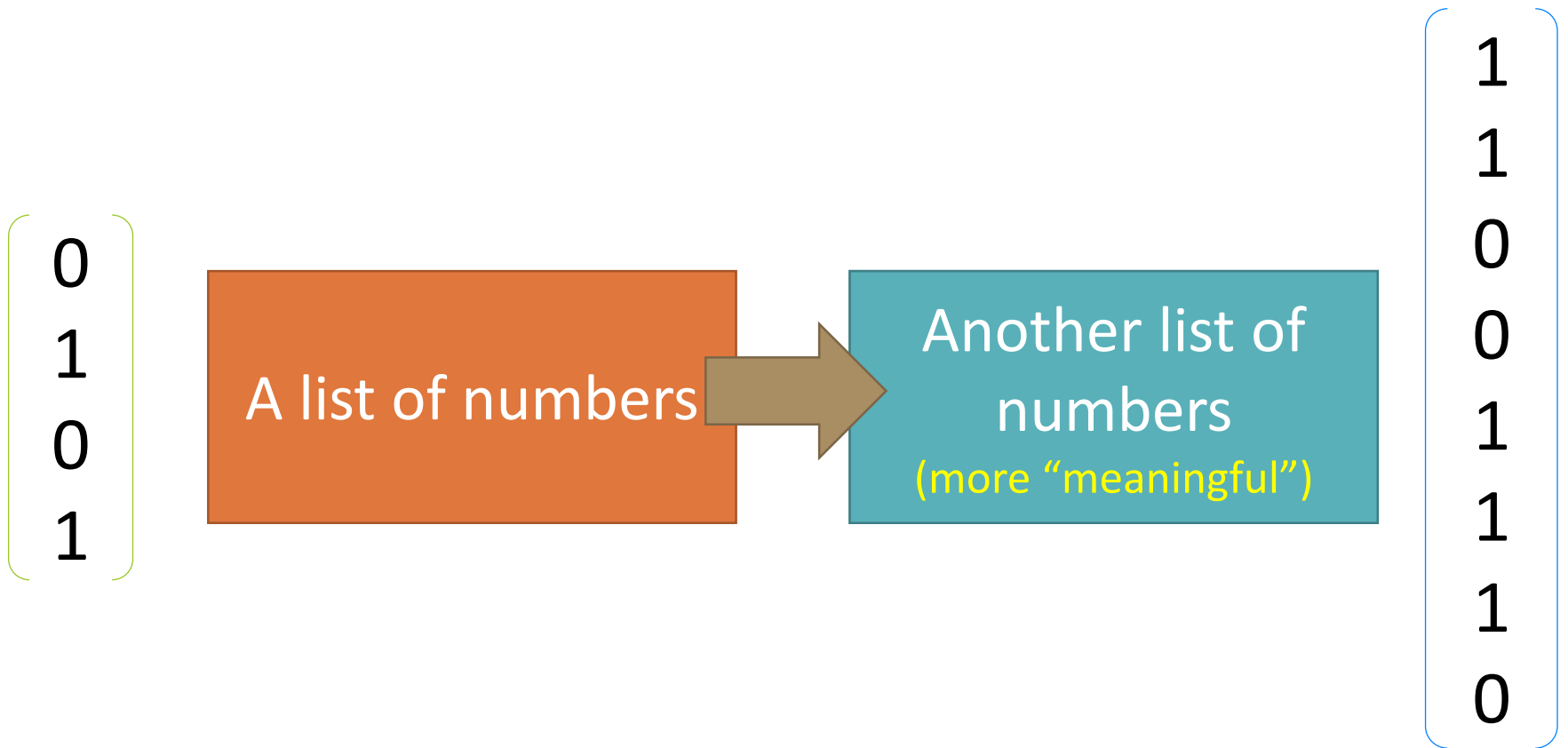
# Artificial Neural Network: Many Neurons



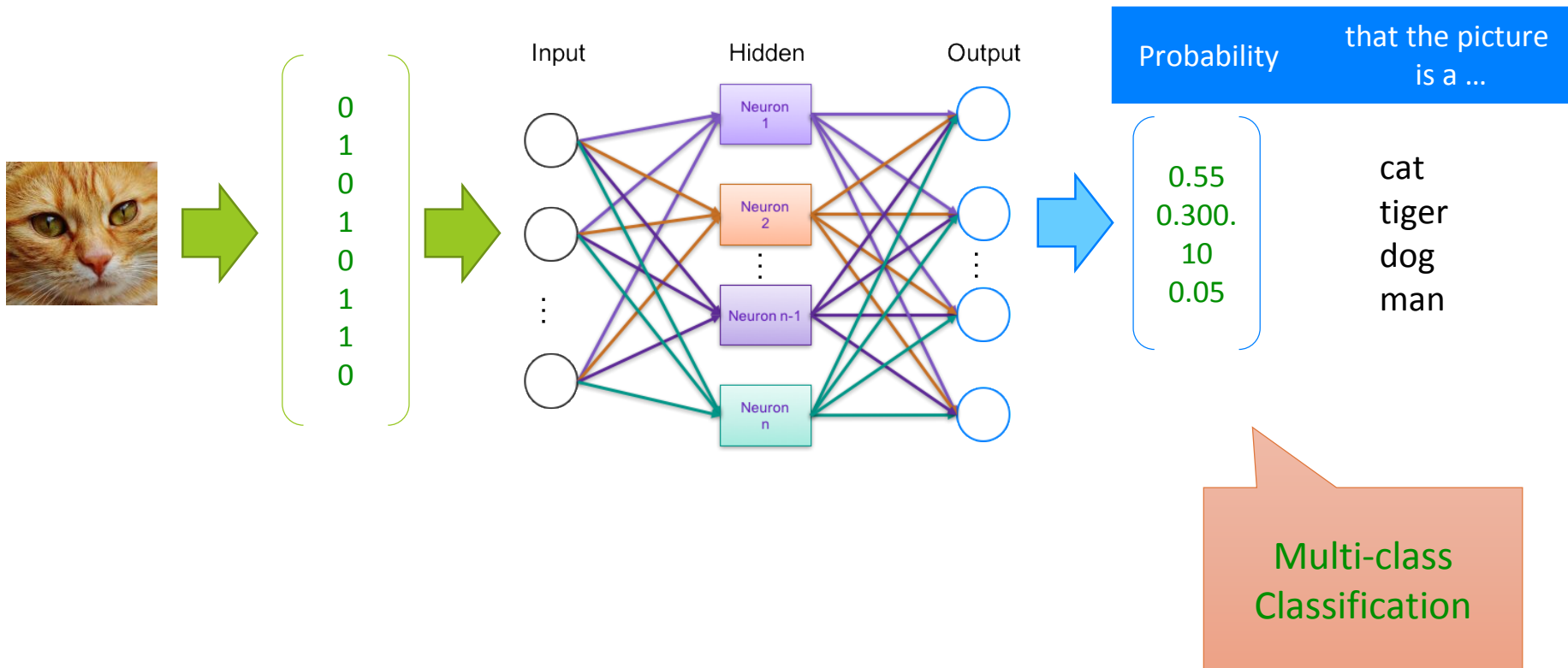
# Deep Learning: Multiple Hidden Layers



# Artificial Neural Network



# Artificial Neural Network and Image Processing



# Automatic Translation as a Prediction Problem: Given X, what is the next word?

Given the following:

ST: I / go / to / school / by / bus / . /

TT: 我 / 乘

Which of the following is most likely to be the next word?

公車

火車

學校

咖啡

電腦

翻譯



# Deep Learning and Automatic Translation

Given [I] / [go] / [to] / [school] / [by] / [train] / [.] , what is the next word?

我

[I] / [go] / [to] / [school] / [**by**] / [train] / [.] / [我]  $\Rightarrow$  ?

乘

[I] / [go] / [to] / [school] / [by] / [**train**] / [.] / [我] / [乘]  $\Rightarrow$  ?

火車

[I] / [**go**] / [**to**] / [school] / [by] / [train] / [.] / [我] / [乘] / [火車]  $\Rightarrow$  ?

去

[I] / [go] / [to] / [**school**] / [by] / [train] / [.] / [我] / [乘] / [火車] / [去]  $\Rightarrow$  ?

學校

[I] / [go] / [to] / [school] / [by] / [train] / [.] / [我] / [乘] / [火車] / [去] / [學校]  $\Rightarrow$  ?

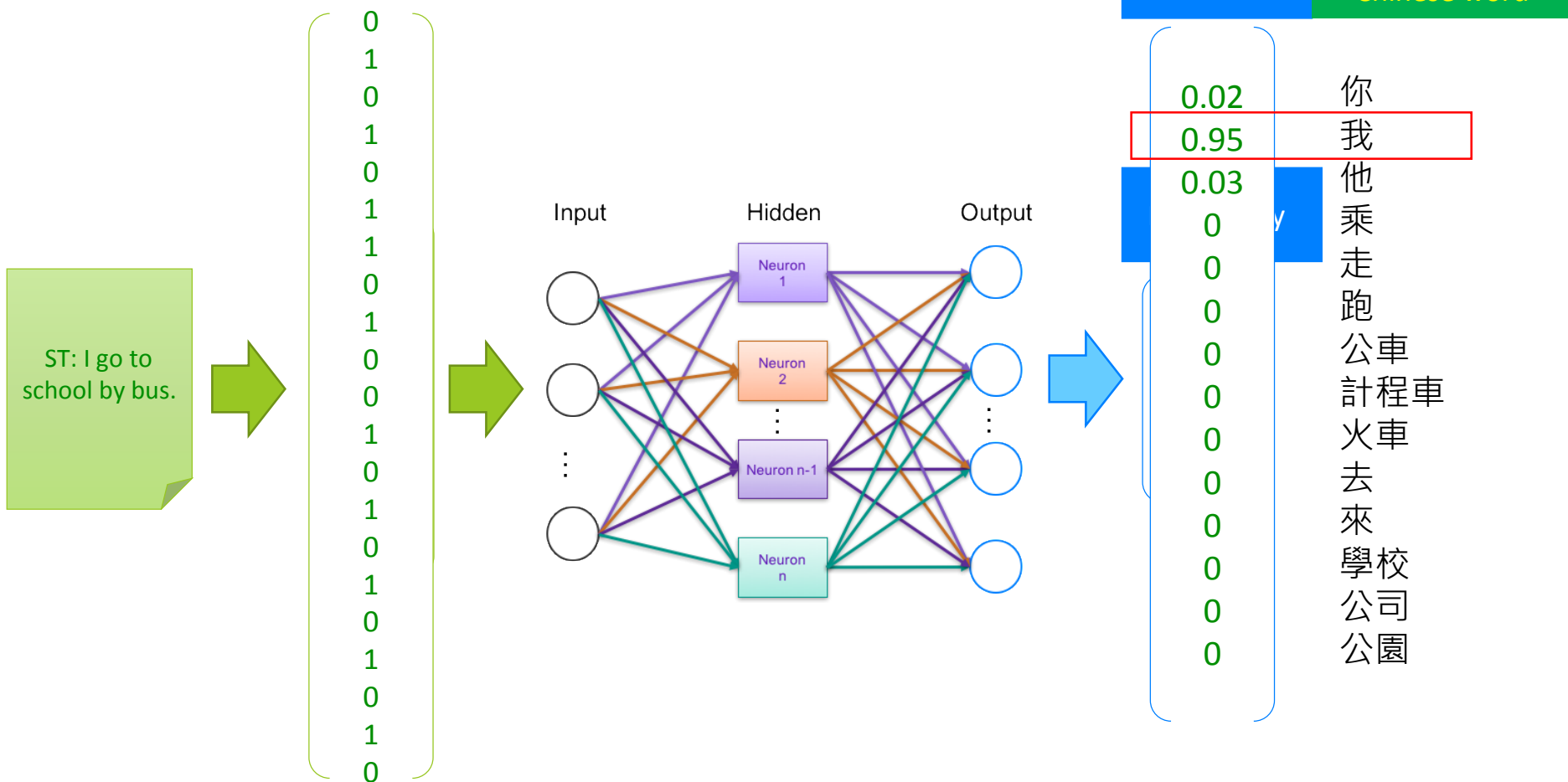
。

Translation: 我乘火車去學校。

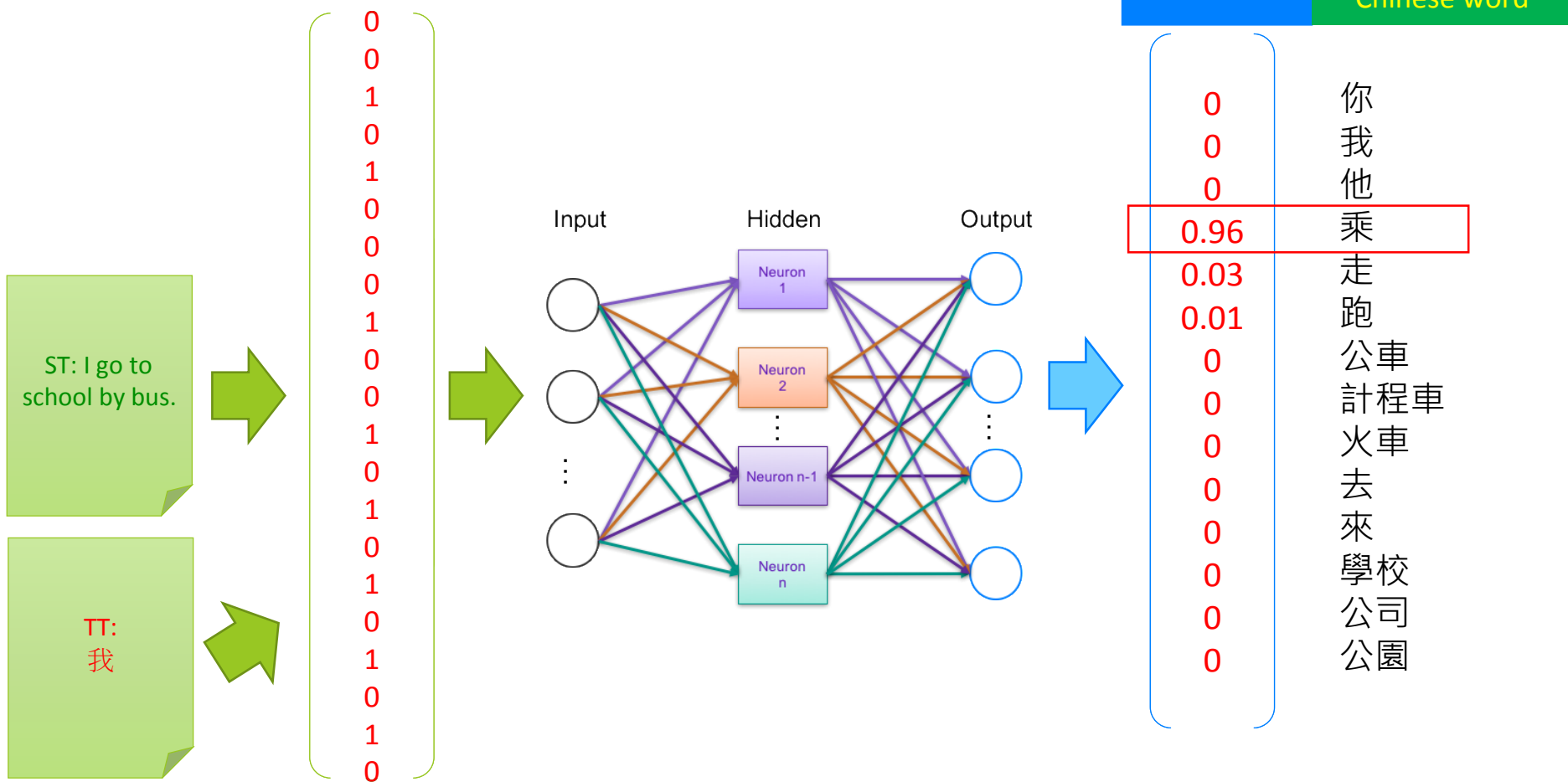




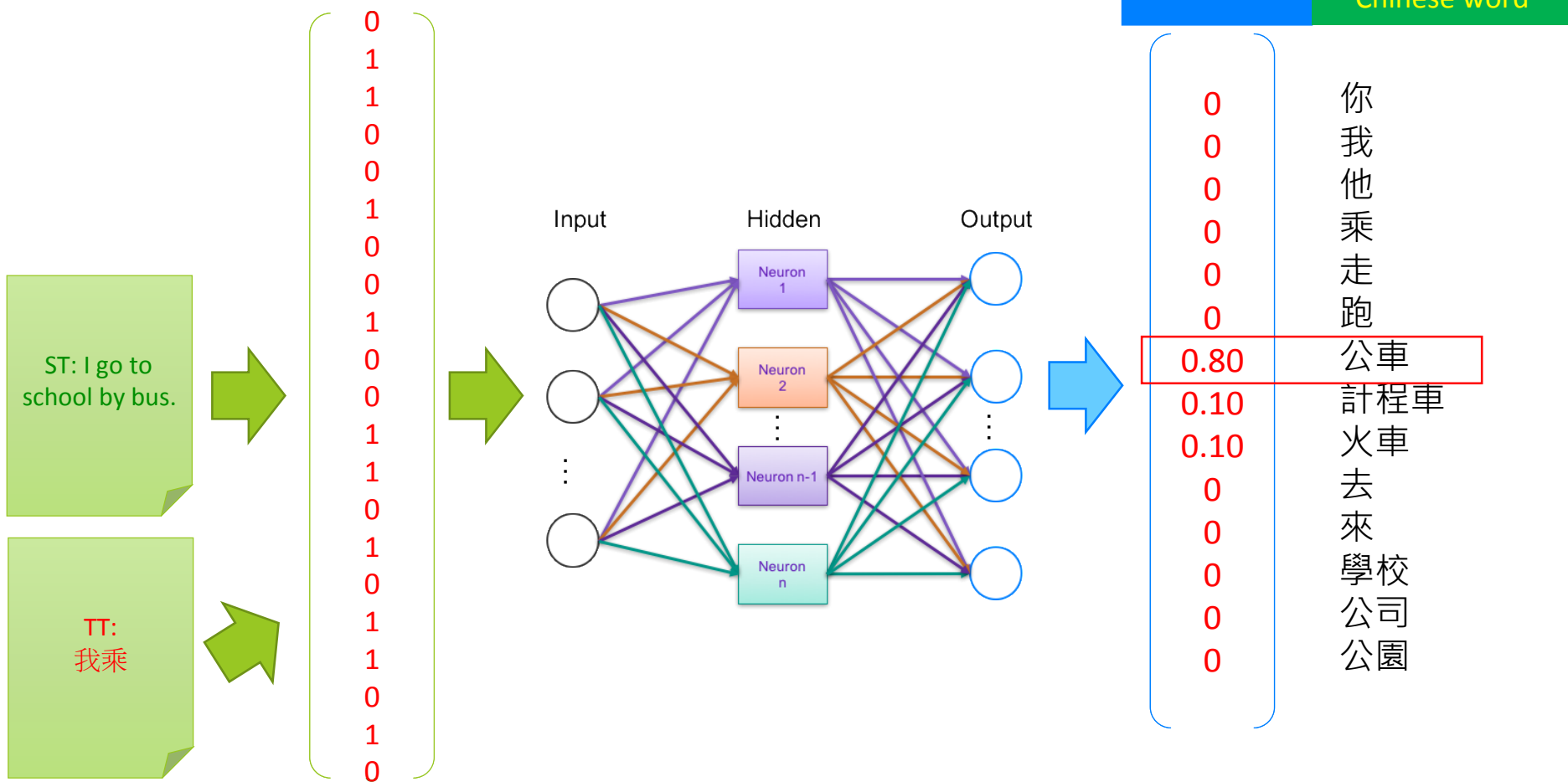
# Neural Machine Translation as Multi-class Classification



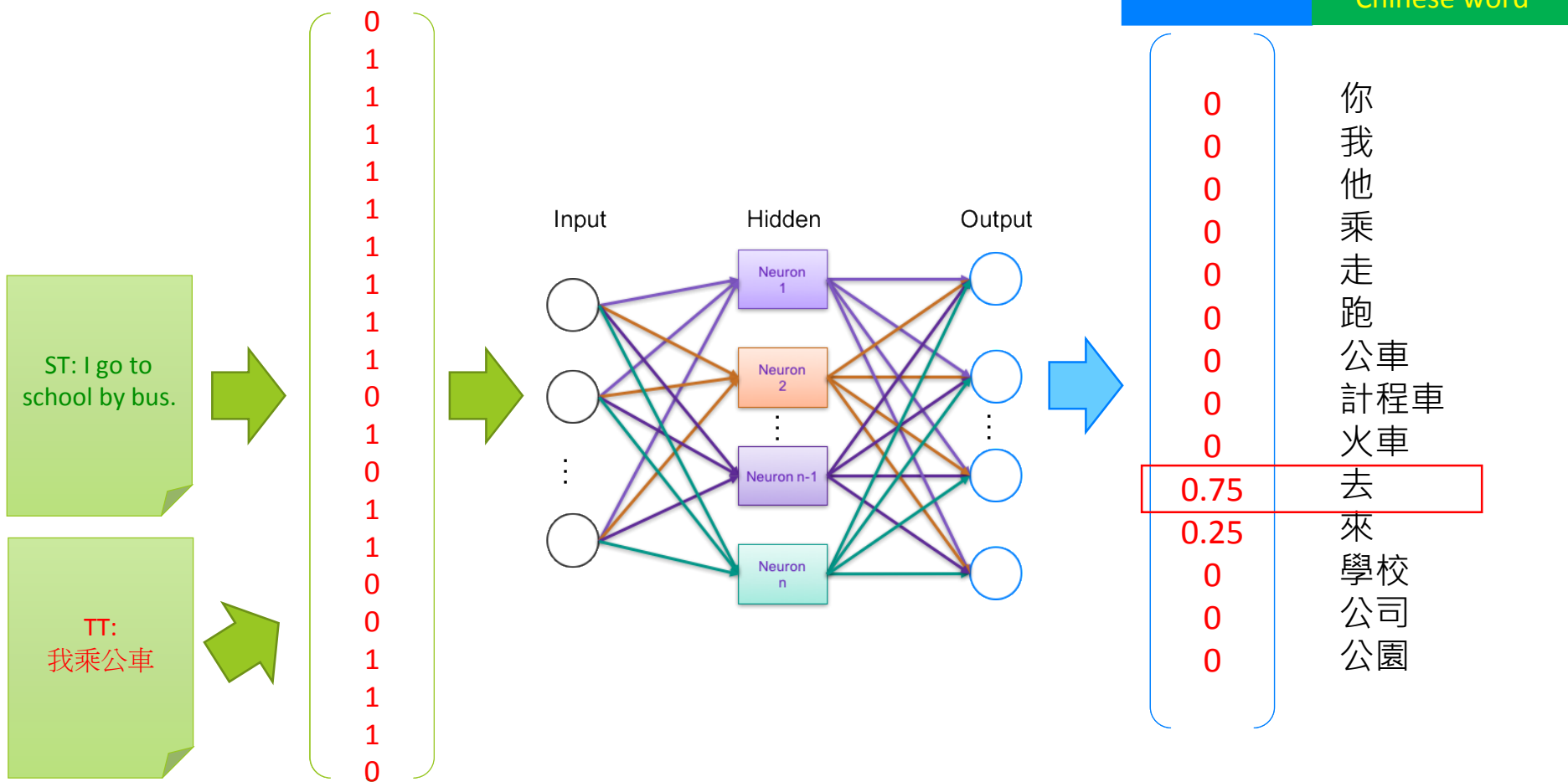
# Neural Machine Translation



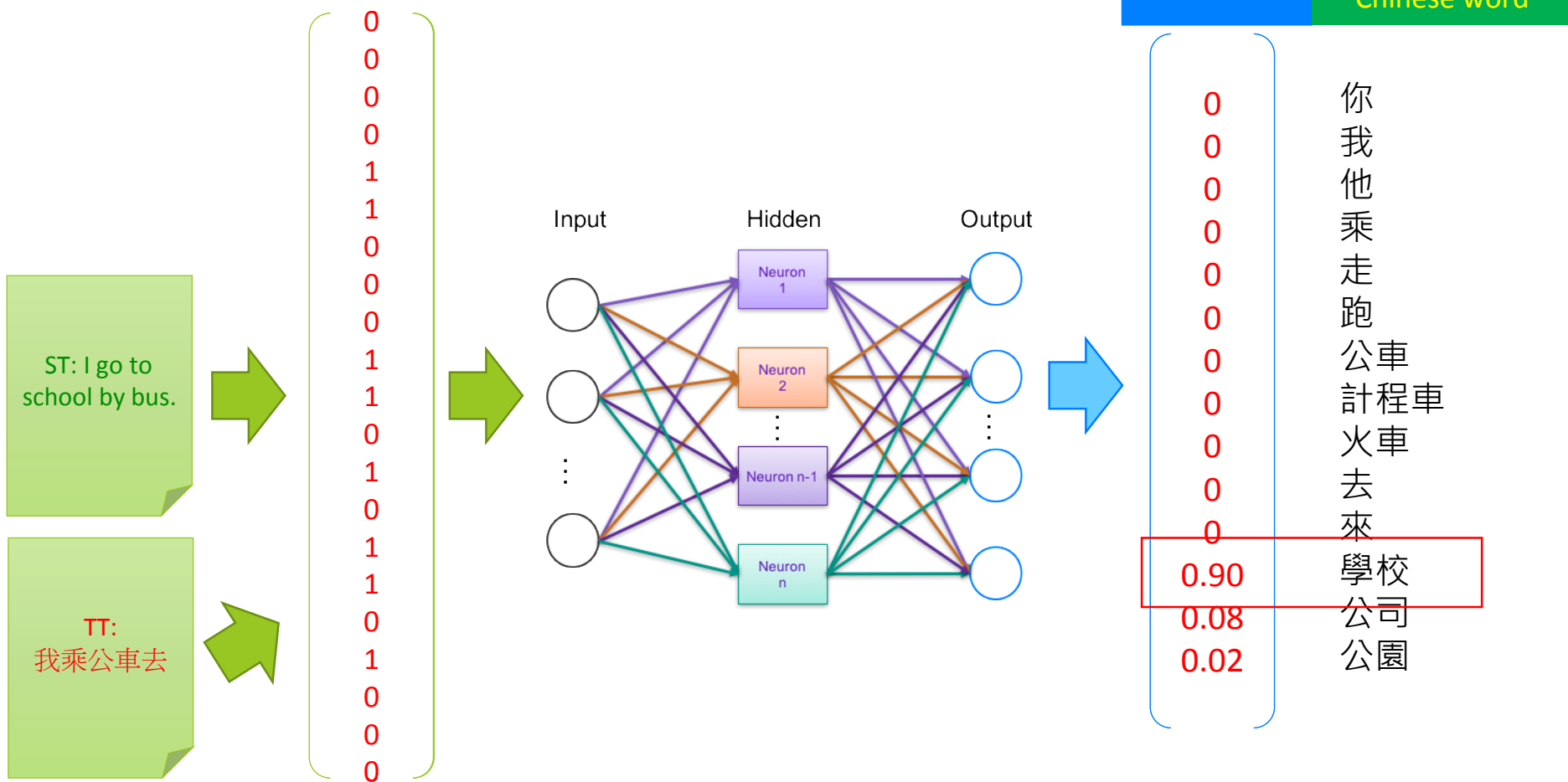
# Neural Machine Translation



# Neural Machine Translation



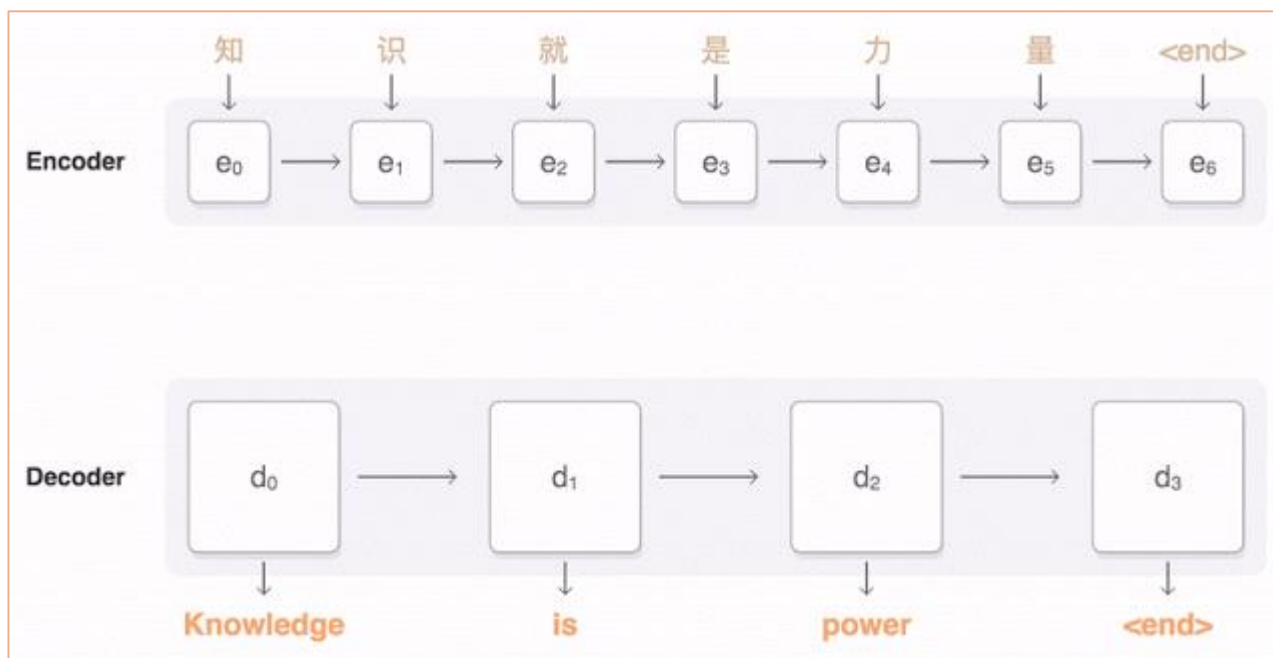
# Neural Machine Translation



# Bidirectional LSTM



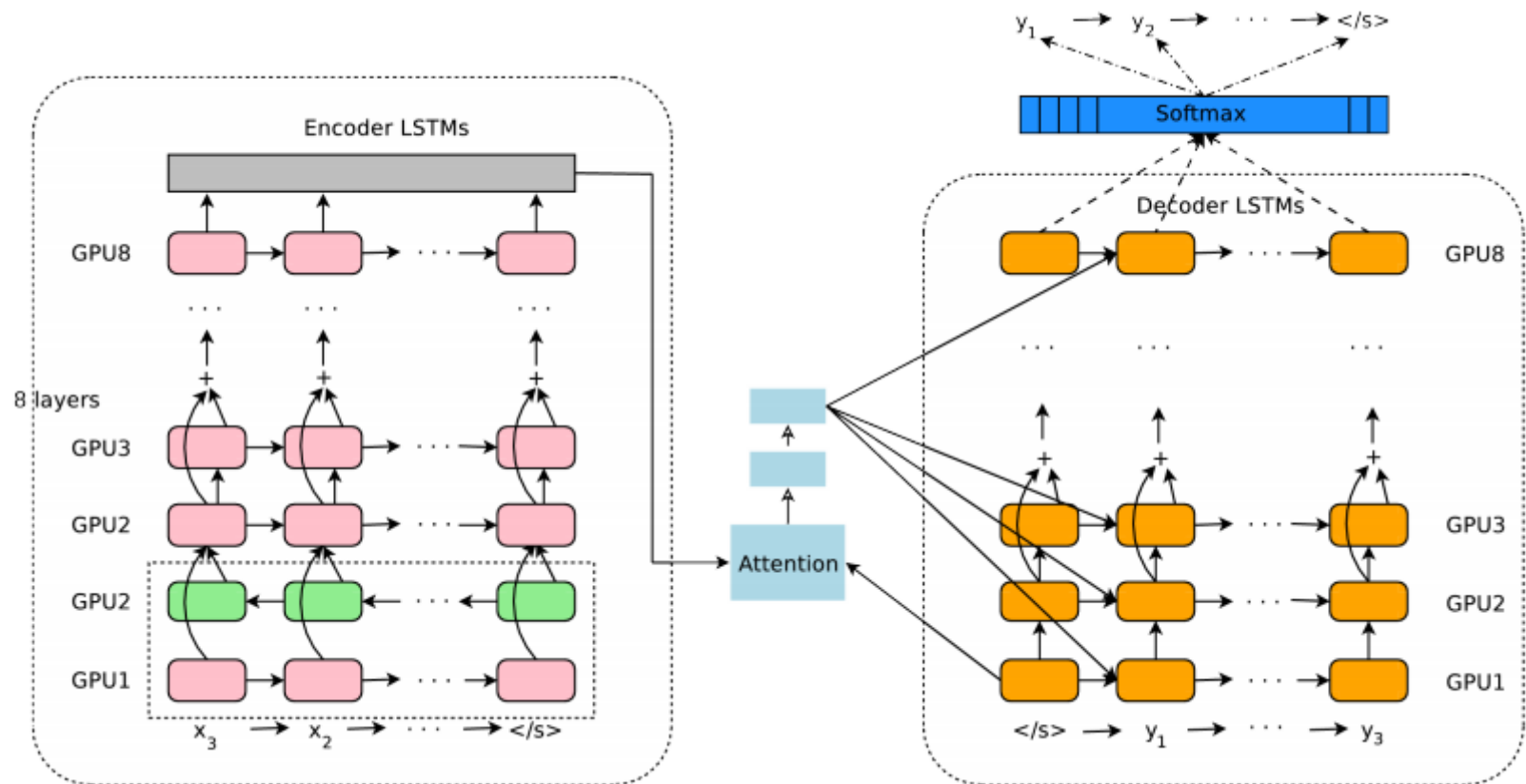
# RNN Encoder-decoder with Attention



For more information, visit

<https://ai.googleblog.com/2016/09/a-neural-network-for-machine.html>

# RNN Encoder-decoder with Attention



For more information, visit

<https://arxiv.org/pdf/1609.08144.pdf>



# Self-attentional Transformer



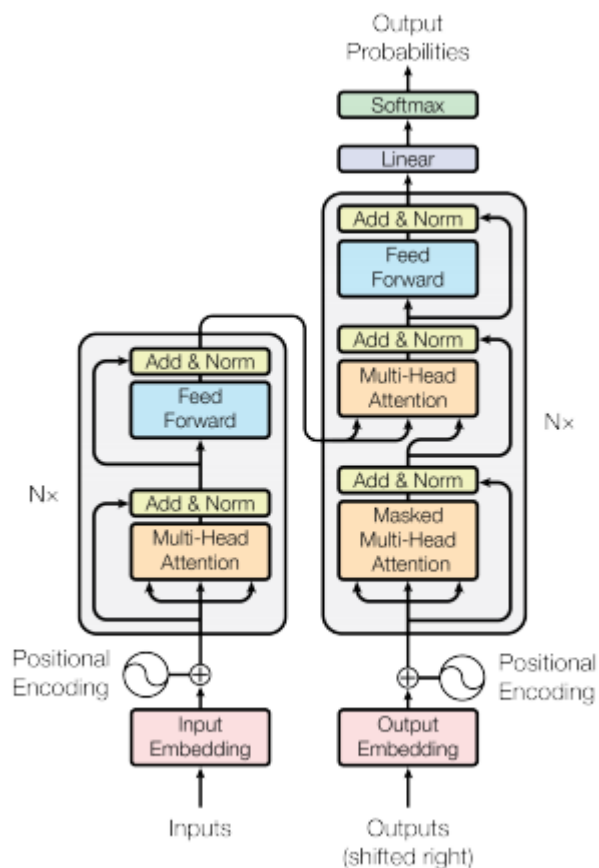
# Self-attentional Transformer



For more information, visit

<https://ai.googleblog.com/2017/08/transformer-novel-neural-network.html>

# Self-attentional Transformer



For more information, visit

<https://arxiv.org/pdf/1706.03762.pdf>

# Evaluation



# Automatic Evaluation

The use of Bilingual Evaluation Understudy (BLEU) metric (Papineni, Roukos, Ward, & Zhu, 2002), a measure of n-gram precision with a value between 0 and 1, comparing a machine translation output with a reference:

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