心理與神經資訊學
(Psychoinformatics & Neuroinformatics)

課號：Psy5261　　教室： 博雅 101
識別碼：227U9340　　時間： 四 234


再三週學期就要結束囉
！

文字的表徵與類別損失函數
(Representations & Loss Function)

Localist vs. Distributed Reps.

不管是現實或模型可分為 localist 與 distributed

小美	1	0	0	0
小明	0	1	0	0
老張	0	0	1	0
老黃	0	0	0	1

小美	1	1	0	0
小明	0	1	1	0
老張	0	0	1	1
老黃	1	0	0	1

Localist coding 非常精確但不穩固

祖母神經元死了就無法辨認祖母了

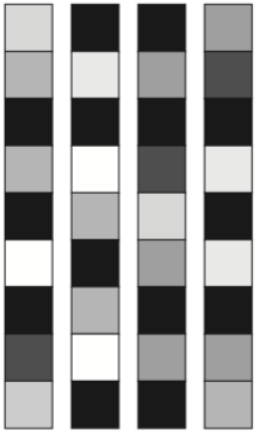
Distributed coding 較有效率但較不精確

可用 N 個神經元表徵 N 個以上的東西

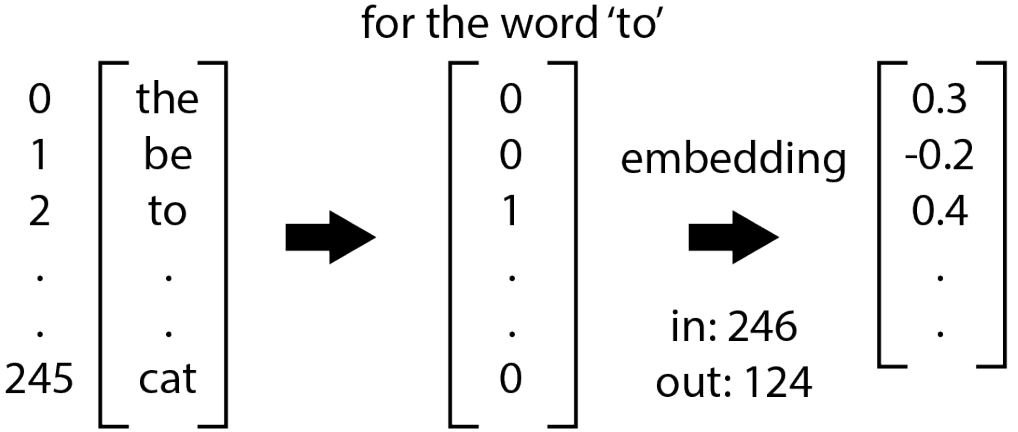
One-hot Encoding vs. Embedding

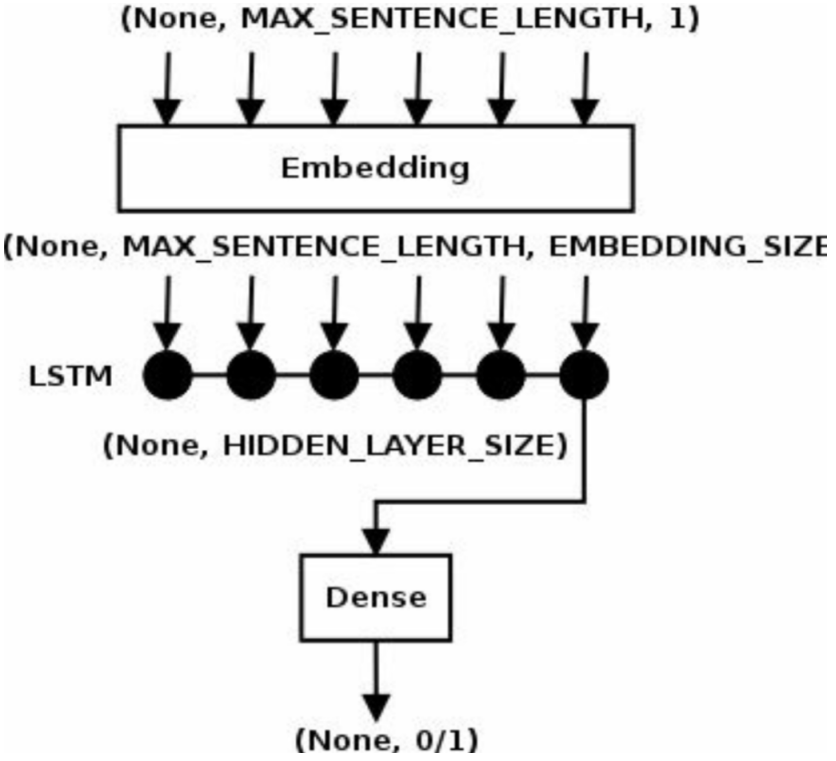
Embed. can be obtained from joint- or pre-training

One-hot word vectors:
- Sparse
- High-dimensional
- Hardcoded



Word embeddings:
- Dense
- Lower-dimensional
- Learned from data





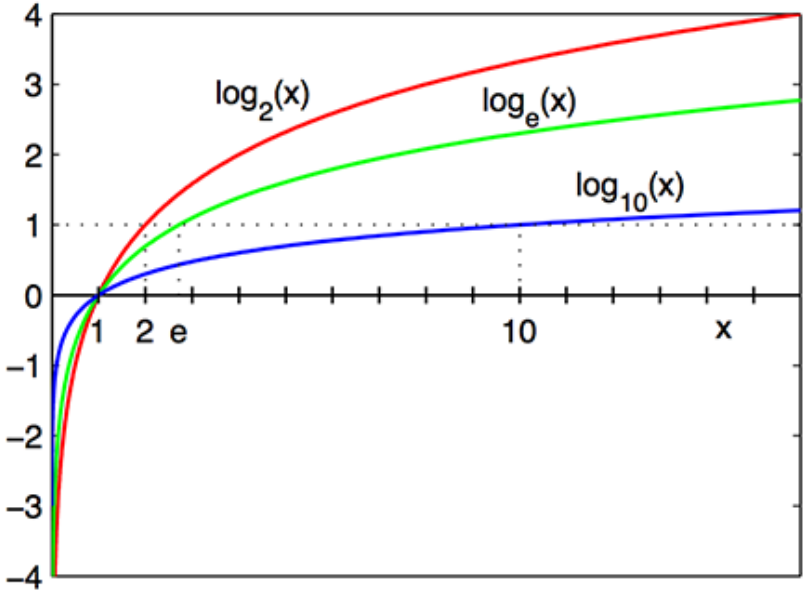
Loss Functions

迴歸問題用 mean squared error (MSE)

分類問題用 cross-entropy

$\hat{\mathbf{y}}$ $\qquad$ $\mathbf{y}$

$$\begin{bmatrix} 0.1 \\ 0.5 \\ 0.4 \end{bmatrix} \qquad D(\hat{\mathbf{y}}, \mathbf{y}) = -\sum_j y_j \ln \hat{y}_j \qquad \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$$



循環神經網路
(Recurrent Neural Networks)

從知覺到動作

相同 / 類似的知覺不一定產生一樣的動作

紅	黑	綠	藍
黃	橙	黑	棕
紫	黃	藍	黃
綠	棕	紅	紫

數學上無解：

x= 紅 → y= 紅 (叫意)

x= 紅 → y= 綠 (叫色)

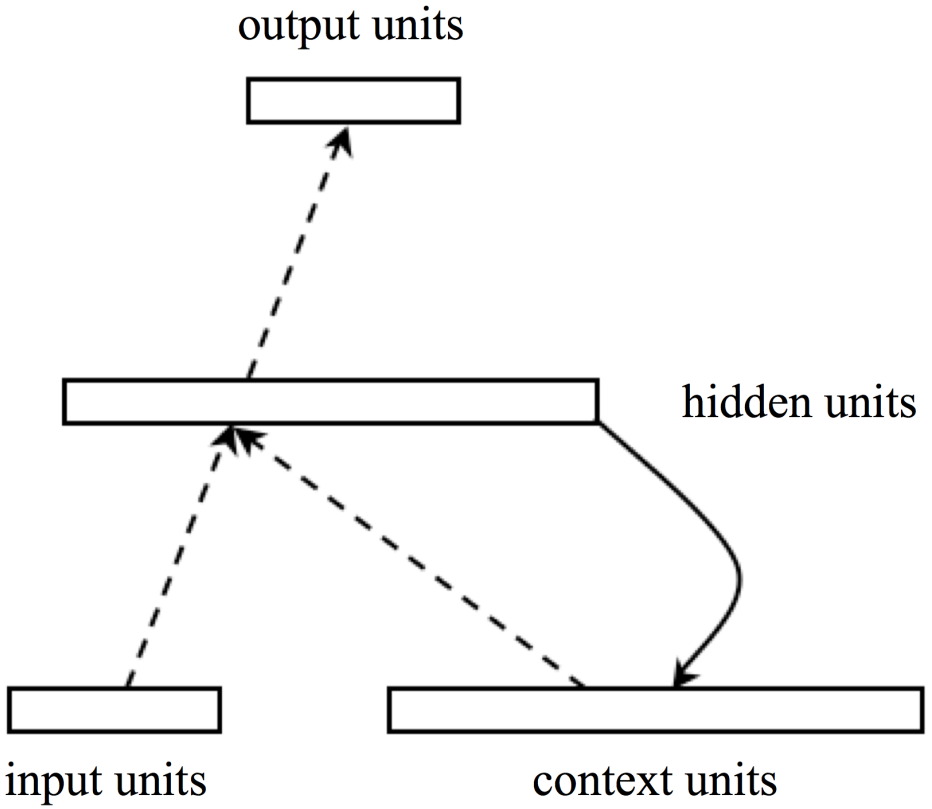
數學上有解：

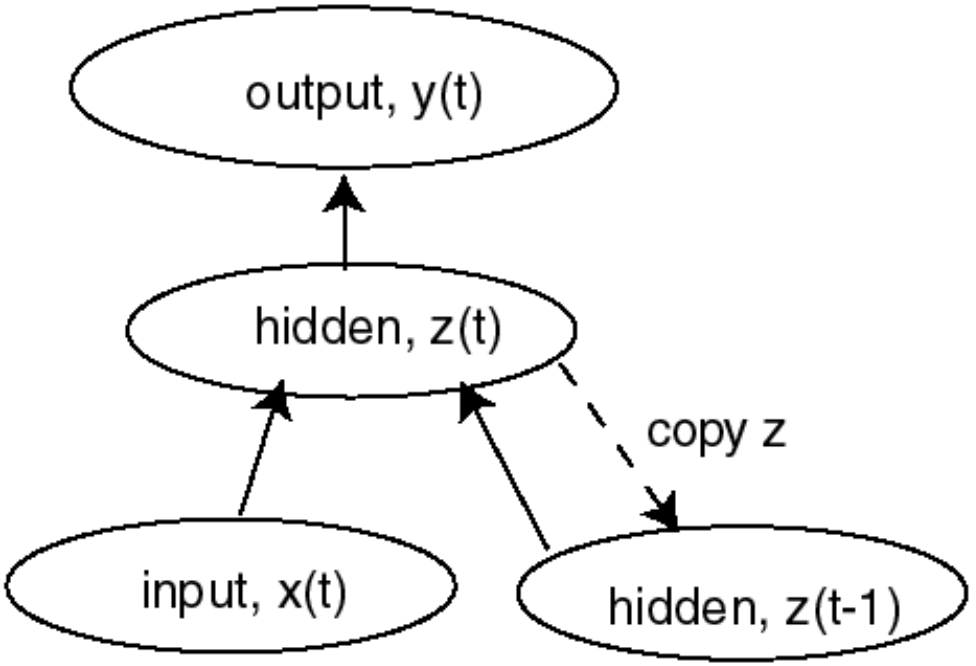
x=(紅 , 叫意) → y= 紅

x=(紅 , 叫色) → y= 綠

Simple RNN (1/2)

by Elman (1990)

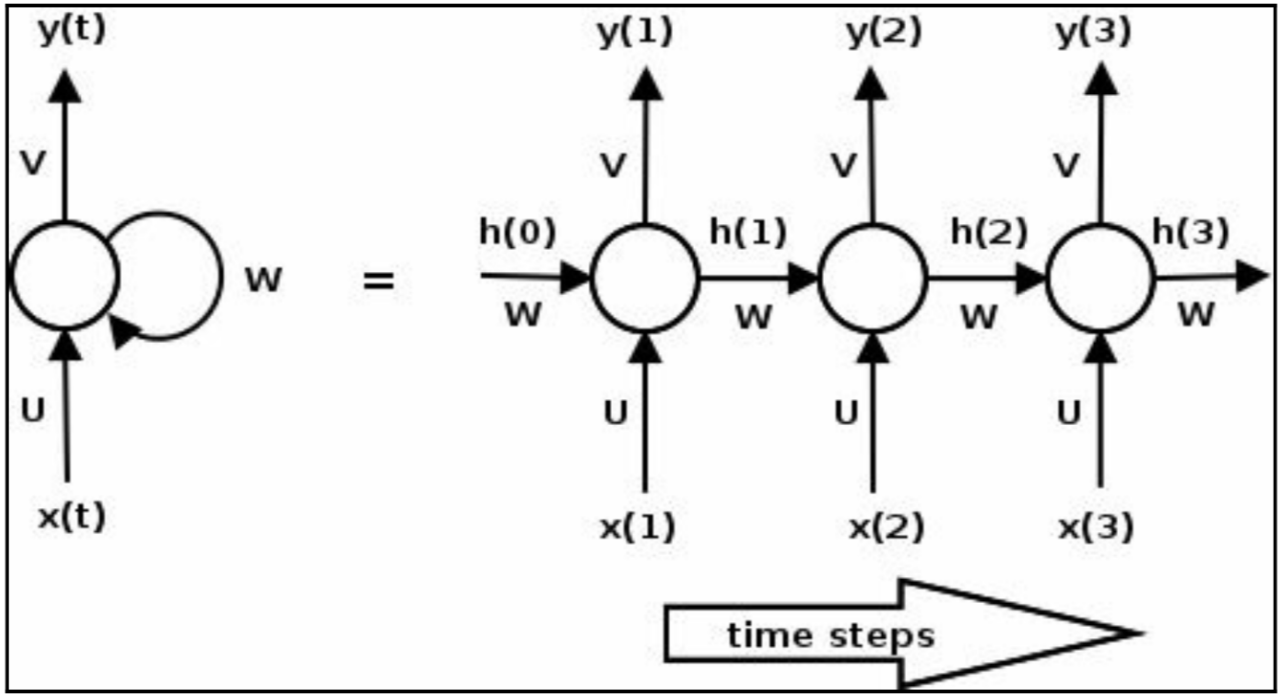




to process sequential information

Simple RNN (2/2)

effectively has VERY deep layers

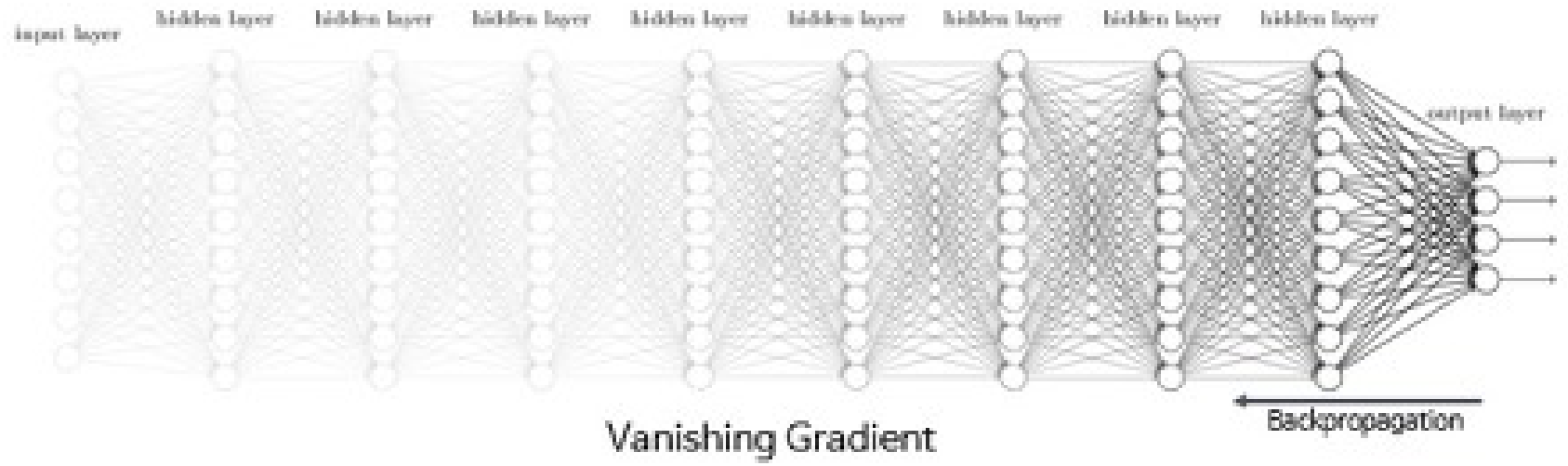


$$h_t = \tanh(Wh_{t-1} + UX_t)$$

$$y_t = \text{softmax}(Vh_t)$$

Temporal Backpropagation

also suffers from vanishing gradient problem



$$\frac{\partial \xi}{\partial U} = \sum_{t=0}^{n} \frac{\partial \xi}{\partial S_t} x_t$$

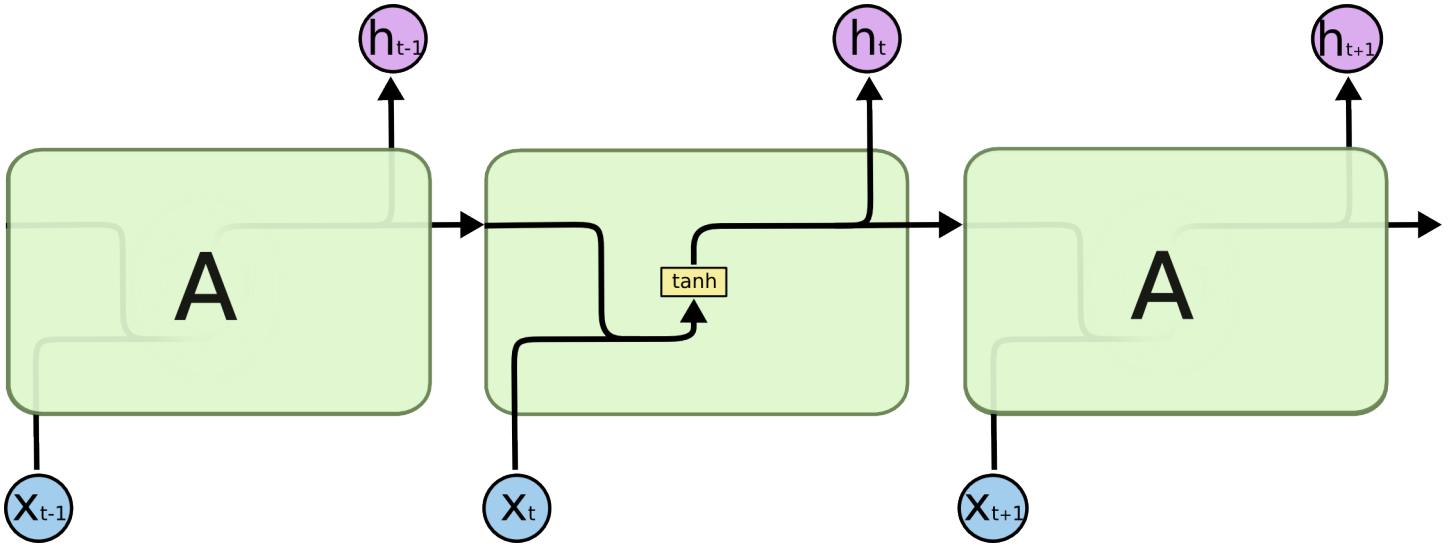
$$\frac{\partial \xi}{\partial S_{t-1}} = \frac{\partial \xi}{\partial S_t} \frac{\partial S_t}{\partial S_{t-1}}$$

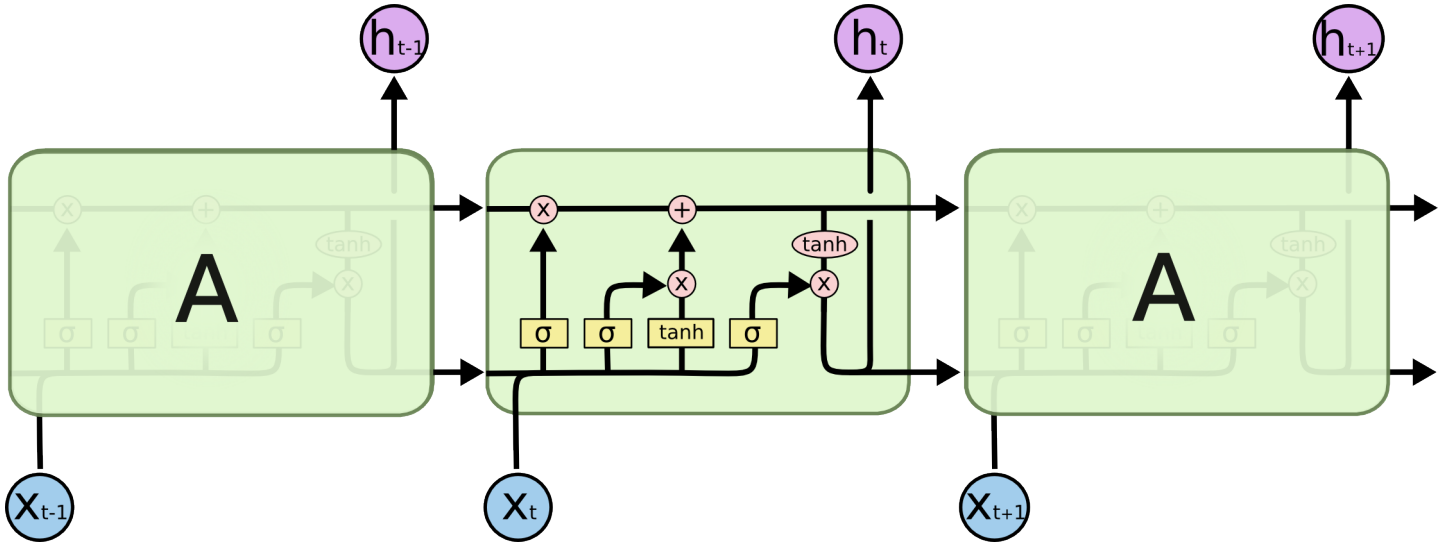
$$\frac{\partial \xi}{\partial W} = \sum_{t=1}^{n} \frac{\partial \xi}{\partial S_t} S_{t-1}$$

$$\frac{\partial S_t}{\partial S_{t-m}} = \frac{\frac{\partial S_t}{\partial S_{t-1}} * \cdots * \partial S_{t-m+1}}{\partial S_{t-m}}$$

Long Short-term Memory (1/2)

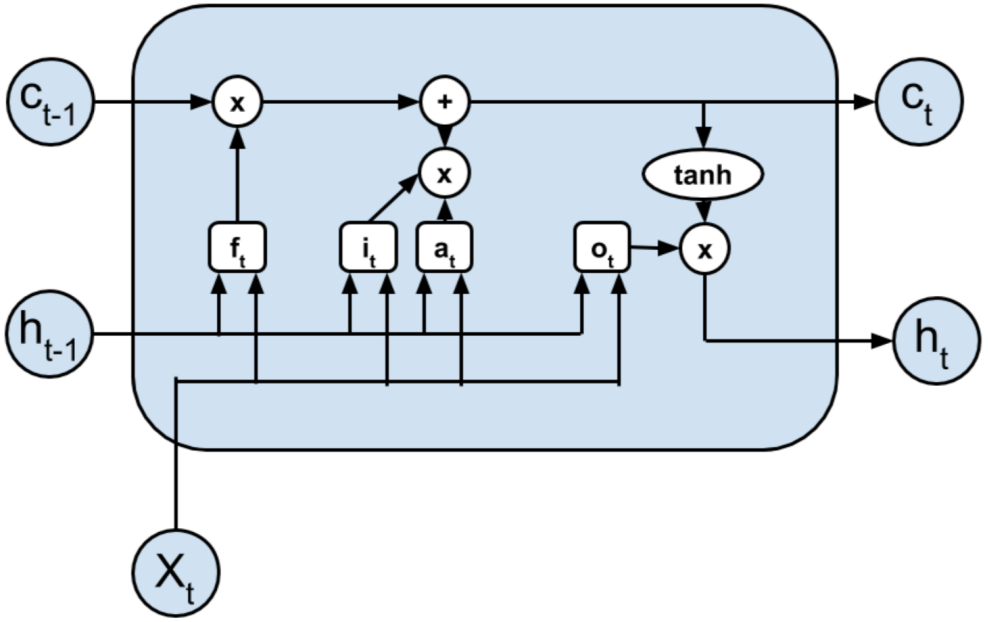
introduces input, forget, output gates





Long Short-term Memory (2/2)

Example: ignore '\n' & reset context for '.'



$$f_t = \sigma\left(W_f h_{t-1} + U_f x_t + b_f\right)$$

$$i_t = \sigma\left(W_i h_{t-1} + U_i x_t + b_i\right)$$

$$a_t = \tanh\left(W_c h_{t-1} + U_c x_t + b_c\right)$$

$$o_t = \sigma\left(W_o h_{t-1} + U_o x_t + b_o\right)$$

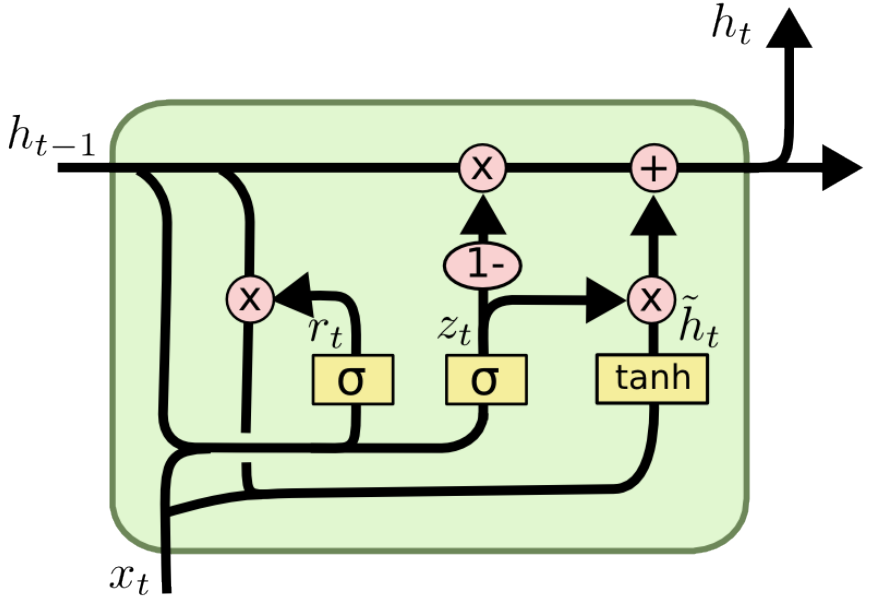
$$c_t = f_t * c_{t-1} + i_t * a_t$$

$$h_t = o_t * \tanh\left(c_t\right)$$

$(f_t, i_t)=(1,0)$ to maintain perfect memory

Gated Recurrent Unit

GRU is a simplified version of LSTM



$$z_t = \sigma\left(W_z \cdot [h_{t-1}, x_t]\right)$$

$$r_t = \sigma\left(W_r \cdot [h_{t-1}, x_t]\right)$$

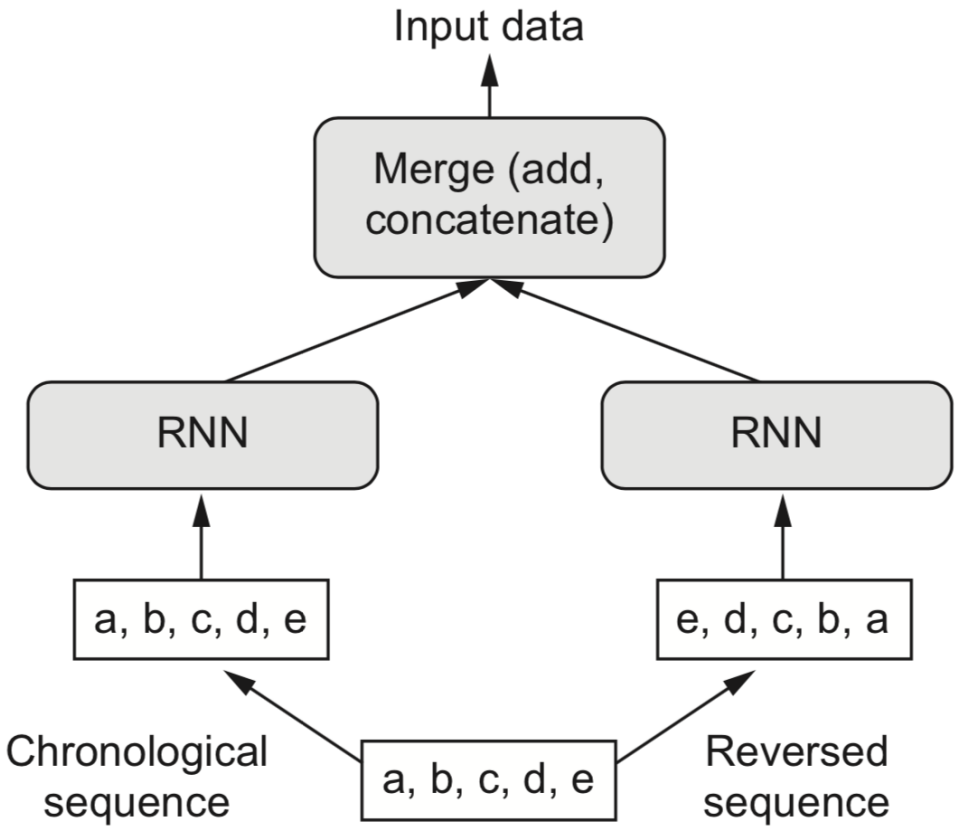
$$\tilde{h}_t = \tanh\left(W \cdot [r_t * h_{t-1}, x_t]\right)$$

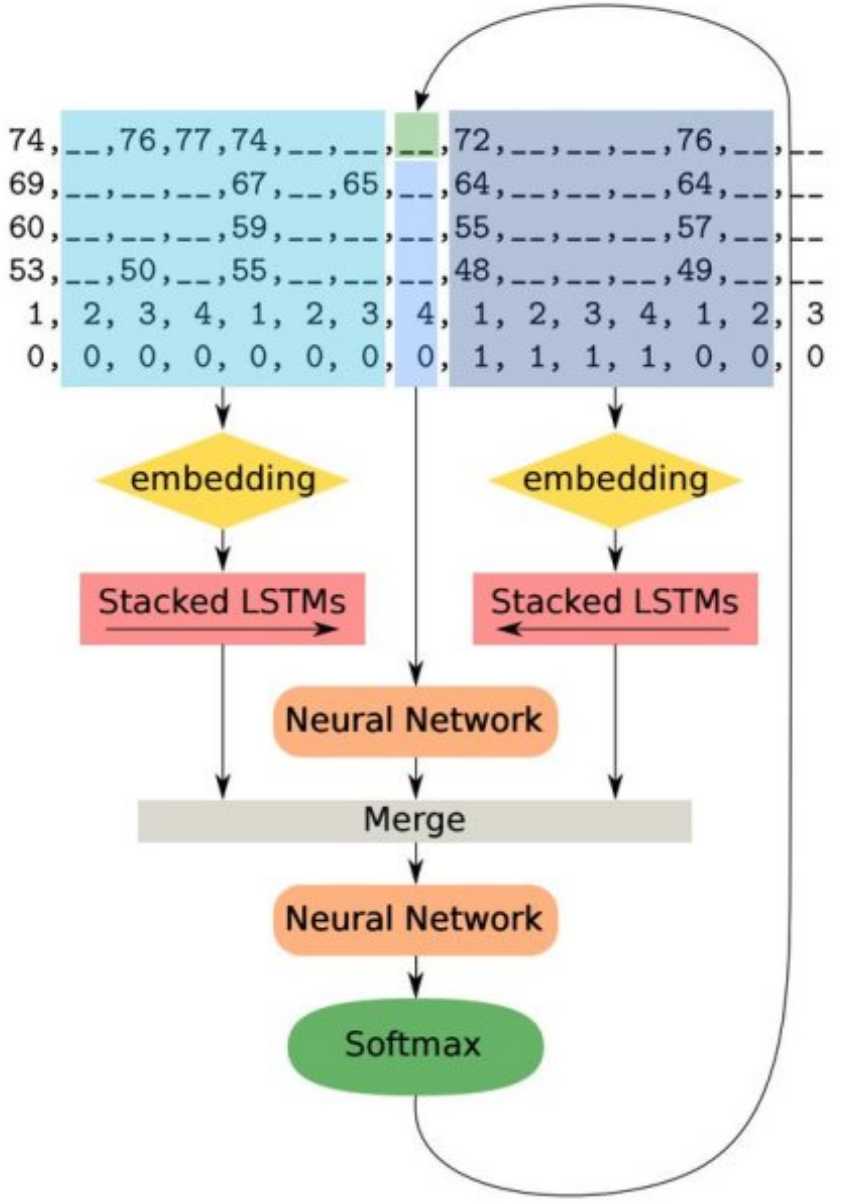
$$h_t = (1 - z_t) * h_{t-1} + z_t * \tilde{h}_t$$

r_t = reset gate ; z_t = update gate

Bidirectional RNN

DeepBach being one example

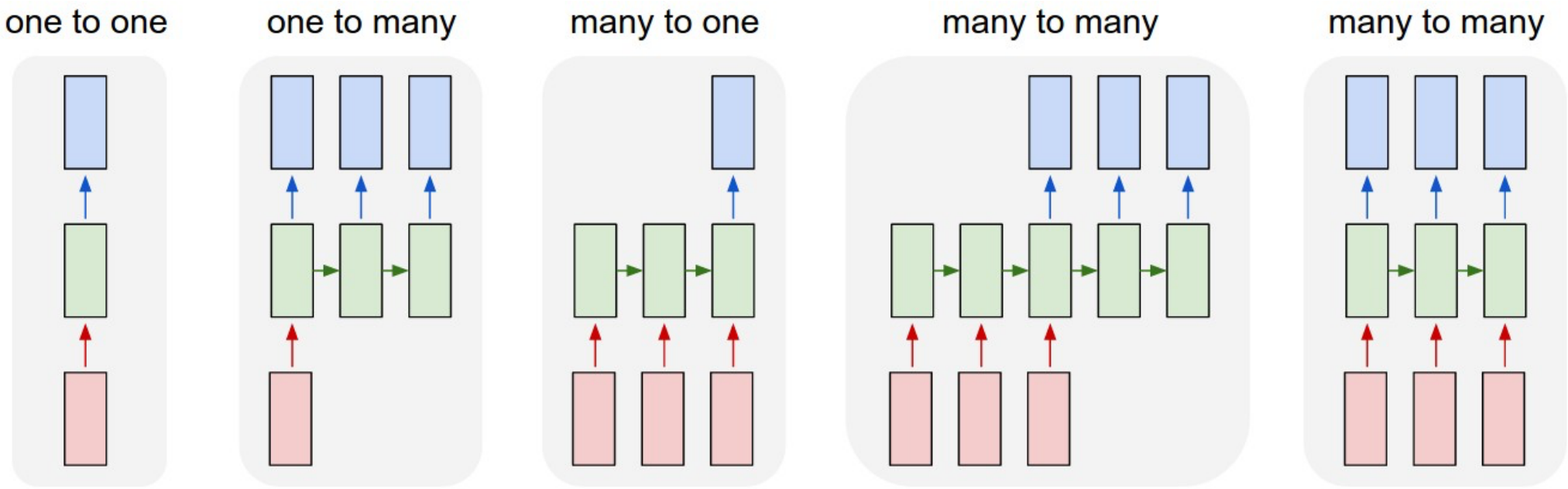




循環神經網路的應用
(RNN Applications)

Recurrent Neural Networks

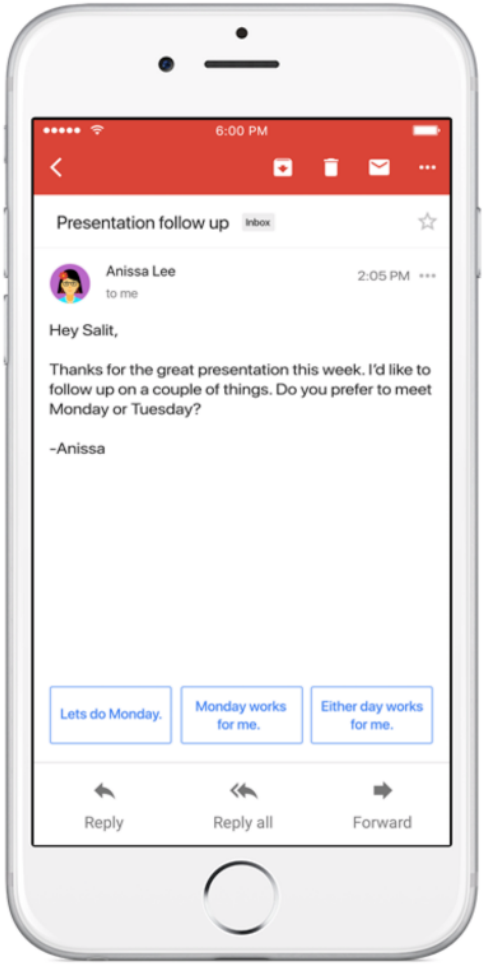
take many forms



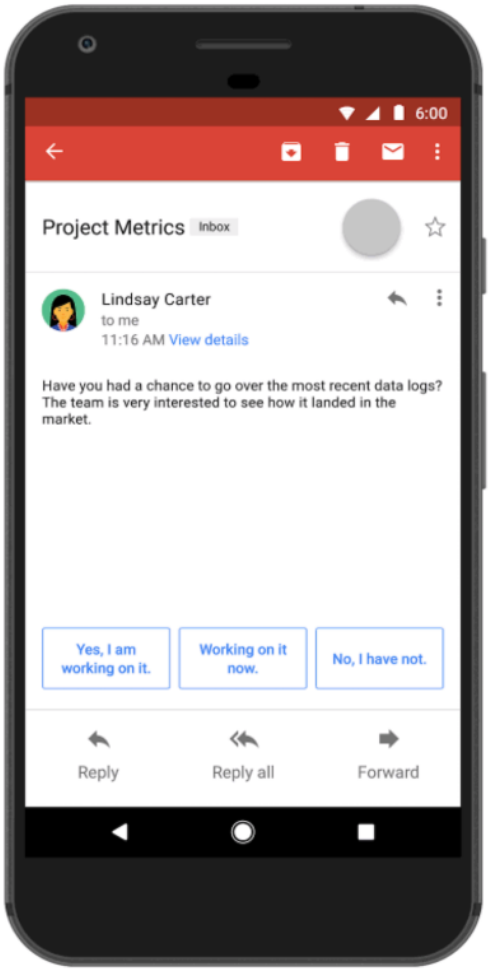
for image classification, image captioning, sentiment classification, language translation, speech recognition, etc.

Google SmartReply

Guessing what you want to reply

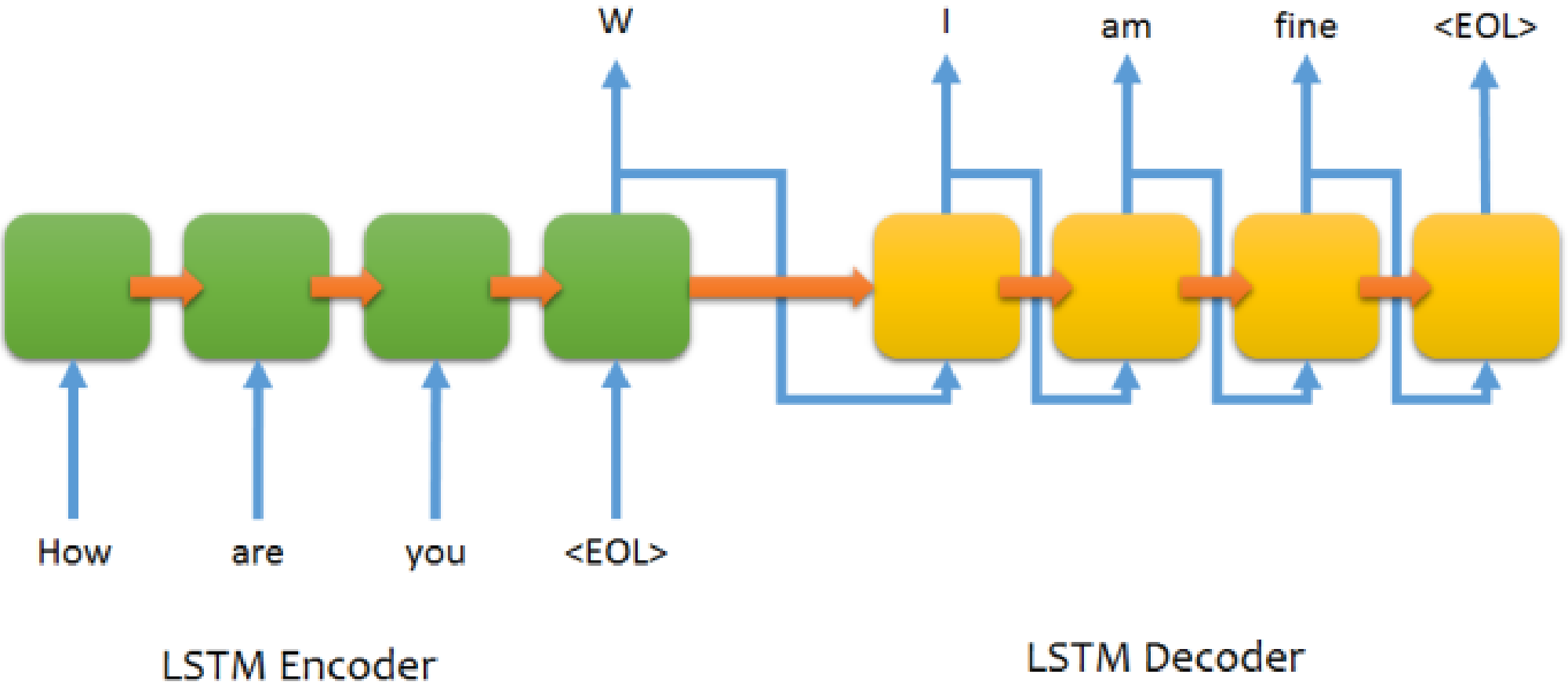


Smart Reply in Gmail



Chatbots (using Seq2Seq)

Guessing what you want to know



Generating Scripts for Movies

Here is the Chinese version of Sunspring

Speech Synthesis

The reverse problem of Speech Recognition

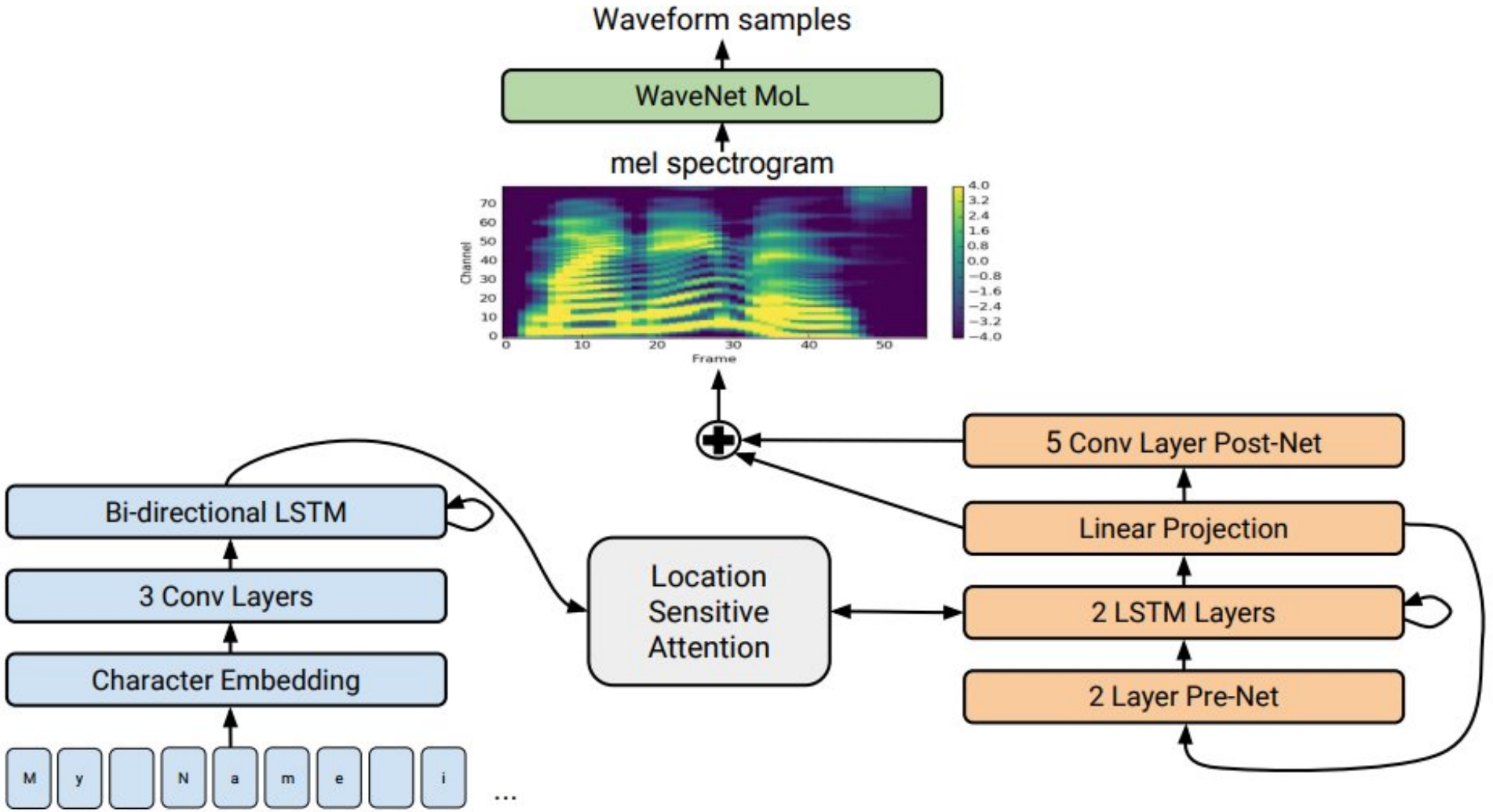
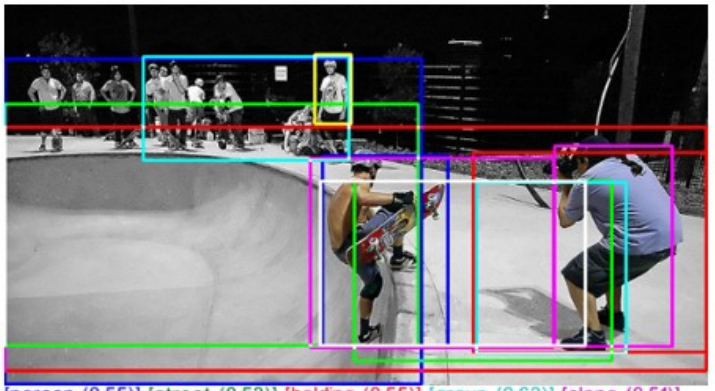


Image Captioning

Image to text

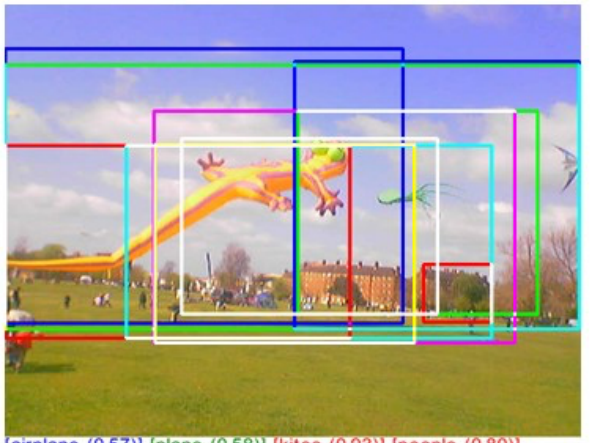
[men (0.59)] [group (0.66)] [woman (0.64)]
[people (0.89)] [holding (0.60)] [playing (0.61)] [tennis (0.69)]
[court (0.51)] [standing (0.59)] [skis (0.58)] [street (0.52)]
[man (0.77)] [skateboard (0.67)]

a group of people standing next to each other
people stand outside a large ad for gap featuring a young boy



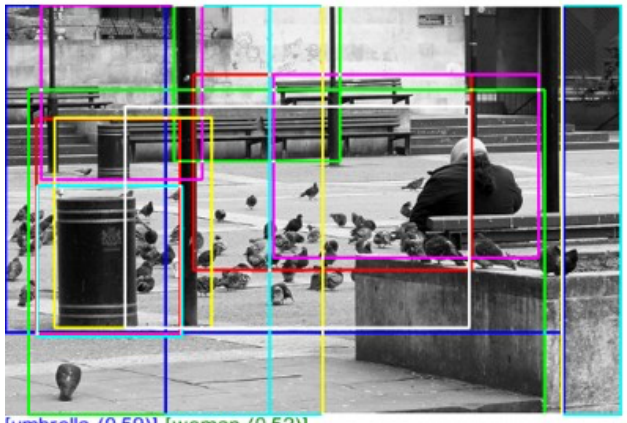
[person (0.55)] [street (0.53)] [holding (0.55)] [group (0.63)] [slope (0.51)]
[standing (0.62)] [snow (0.91)] [skis (0.74)] [player (0.54)]
[people (0.85)] [men (0.57)] [skiing (0.51)]
[skateboard (0.89)] [riding (0.75)] [tennis (0.74)] [trick (0.53)] [skate (0.52)]
[woman (0.52)] [man (0.86)] [down (0.61)]

a group of people riding skis down a snow covered slope
a guy on a skate board on the side of a ramp



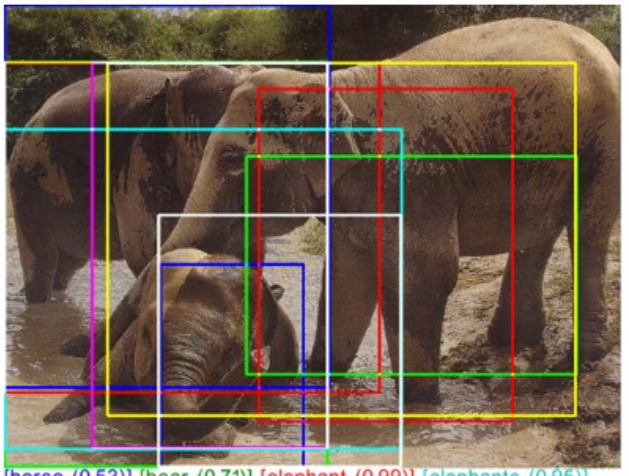
[airplane (0.57)] [plane (0.58)] [kites (0.93)] [people (0.80)]
[flying (0.93)] [man (0.57)] [beach (0.84)] [wave (0.61)]
[sky (0.61)] [kite (0.74)] [field (0.75)]

a couple of people flying kites in a field
people in a field flying different styles of kites



[umbrella (0.59)] [woman (0.52)]
[fire (0.96)] [hydrant (0.96)] [street (0.79)] [old (0.50)]
[bench (0.81)] [building (0.75)] [standing (0.57)] [baseball (0.55)]
[white (0.82)] [sitting (0.65)] [people (0.79)] [photo (0.53)]
[black (0.84)] [kitchen (0.54)] [man (0.72)] [water (0.56)]

a black and white photo of a fire hydrant
a courtyard full of poles pigeons and garbage cans also has benches on either side of it one of which shows the back of a large person facing in the direction of the pigeons



[horse (0.53)] [bear (0.71)] [elephant (0.99)] [elephants (0.95)]
[brown (0.68)] [baby (0.62)] [walking (0.57)] [laying (0.61)]
[man (0.57)] [standing (0.79)] [field (0.65)]
[water (0.83)] [large (0.71)] [dirt (0.65)] [river (0.58)]

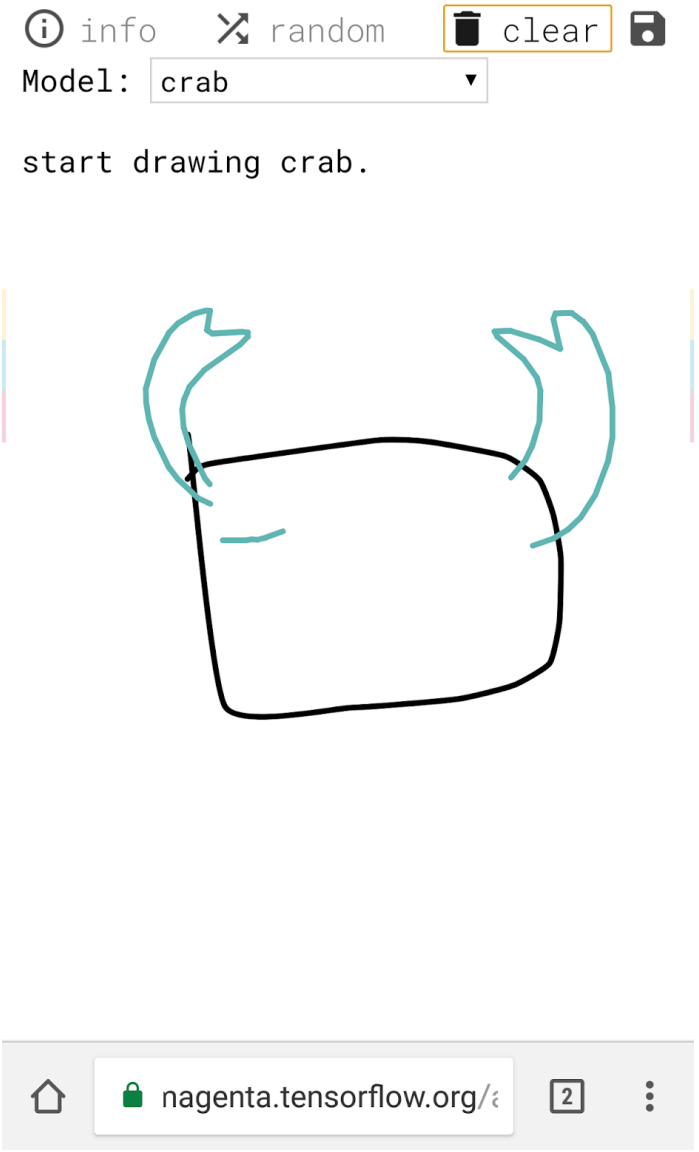
a baby elephant standing next to each other on a field
elephants are playing together in a shallow watering hole

[man (0.59)] [beach (0.54)] [sky (0.53)] [bird (0.50)] [field (0.88)]
[snow (0.86)] [mountain (0.59)] [standing (0.81)] [white (0.64)]
[people (0.51)] [dog (0.60)] [cows (0.55)]
[sheep (0.97)] [black (0.84)] [grass (0.64)] [horse (0.60)]
[elephants (0.57)] [bear (0.81)]

a black bear standing on top of a grass covered field
a couple of sheep standing up on a small hill

Sketch-RNN

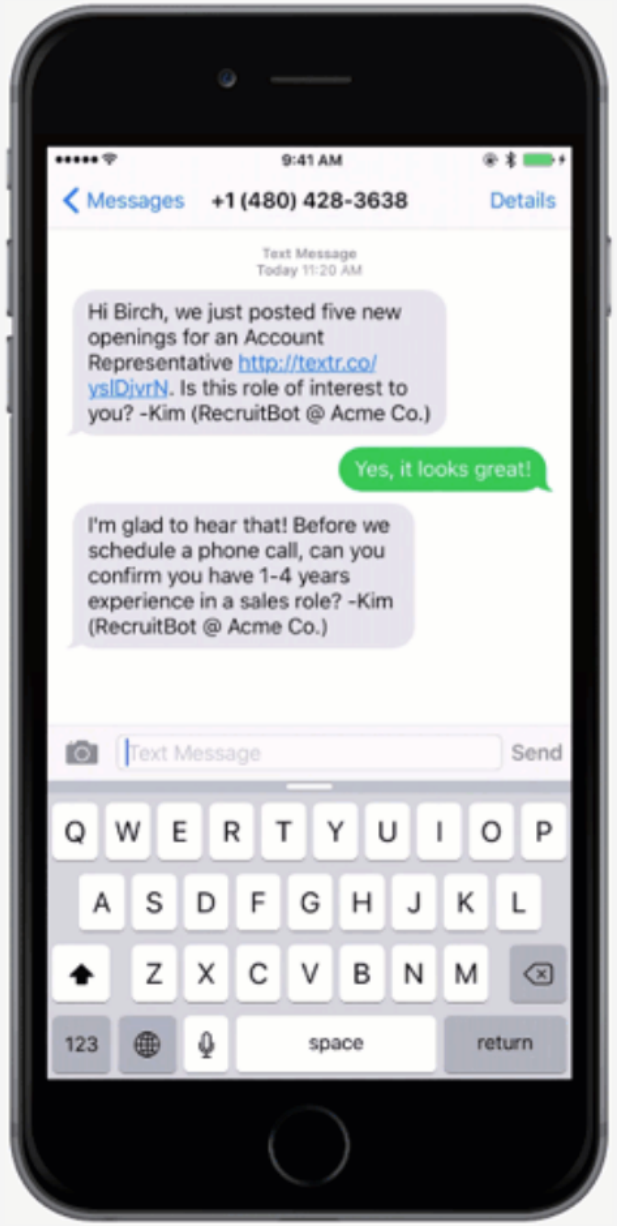
Guessing what you want to draw



聊天機器人
(ChatBots)

Example 1: TextRecruit

幫忙招聘 / 面試潛在員工



Example 2: CBTPsych

能有效減緩口吃

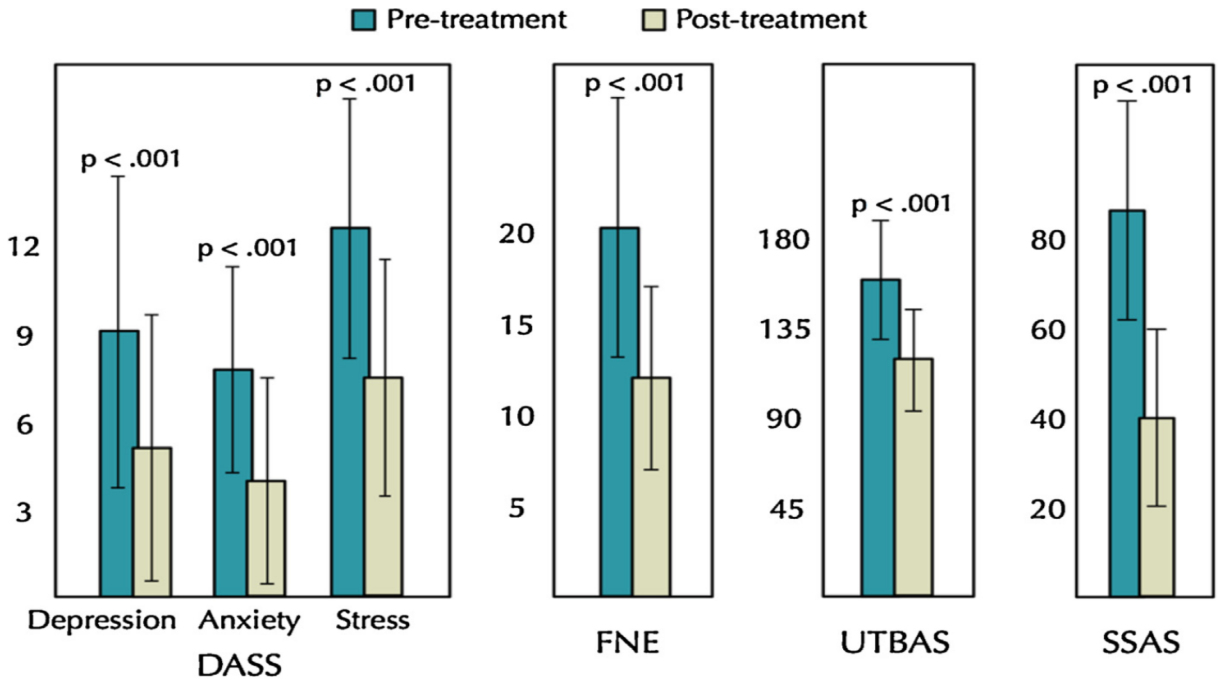
Contents lists available at ScienceDirect

Journal of Fluency Disorders

International Phase II clinical trial of CBTPsych: A standalone Internet social anxiety treatment for adults who stutter

Ross Menzies, Sue O'Brian, Robyn Lowe, Ann Packman, Mark Onslow*

Australian Stuttering Research Centre, The University of Sydney, Australia



Example 3: WoeBot

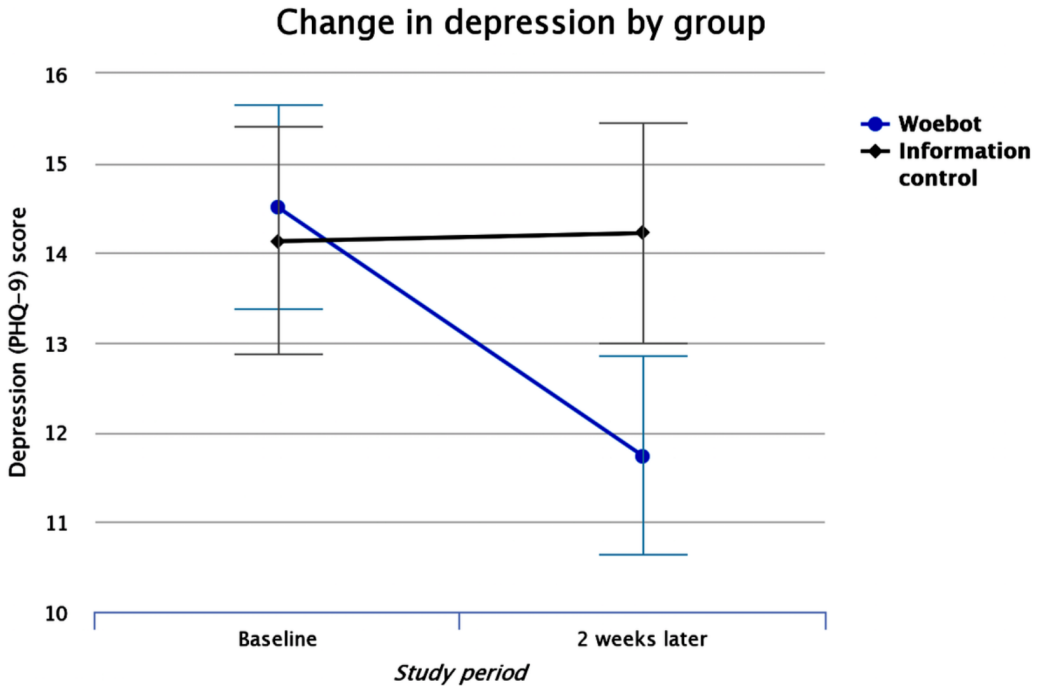
能有效減緩一般性的憂鬱與焦慮

JMIR MENTAL HEALTH

Original Paper

Delivering Cognitive Behavior Therapy to Young Adults With Symptoms of Depression and Anxiety Using a Fully Automated Conversational Agent (Woebot): A Randomized Controlled Trial

Kathleen Kara Fitzpatrick[1*], PhD; Alison Darcy[2*], PhD; Molly Vierhile[1], BA



Platforms

有些平台可以不寫程式開發出 chatbots

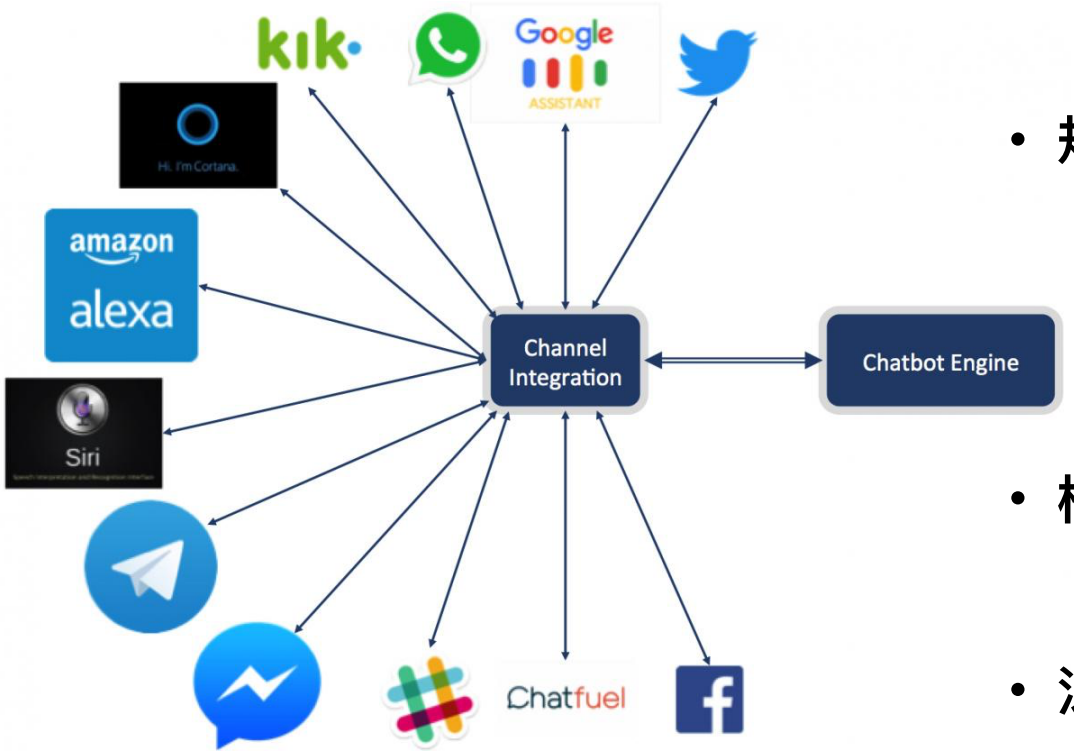
ManyChat

Chatfuel

但不寫程式 chatbots 的能力相對來說比較受限

Conversation Engines

聊天引擎才是 chatbot 的靈魂



- **規則法:**
  - AIML (Artificial Intelligence Markup Language)
  - 此方法曾贏得多次的最人性電腦獎 (Loebner prize for "most human computer")
- **檢索法:**
  - 詞彙、語料的蒐集、分析
  - 資訊檢索：相似比對、排序
- **深度神經網路生成法:**
  - Word/emotion embedding
  - Sequence to sequence generation
  - deep reinforcement learning
  - end-to-end dialog systems

但也要花一些時間處理聊天介面

Game Over