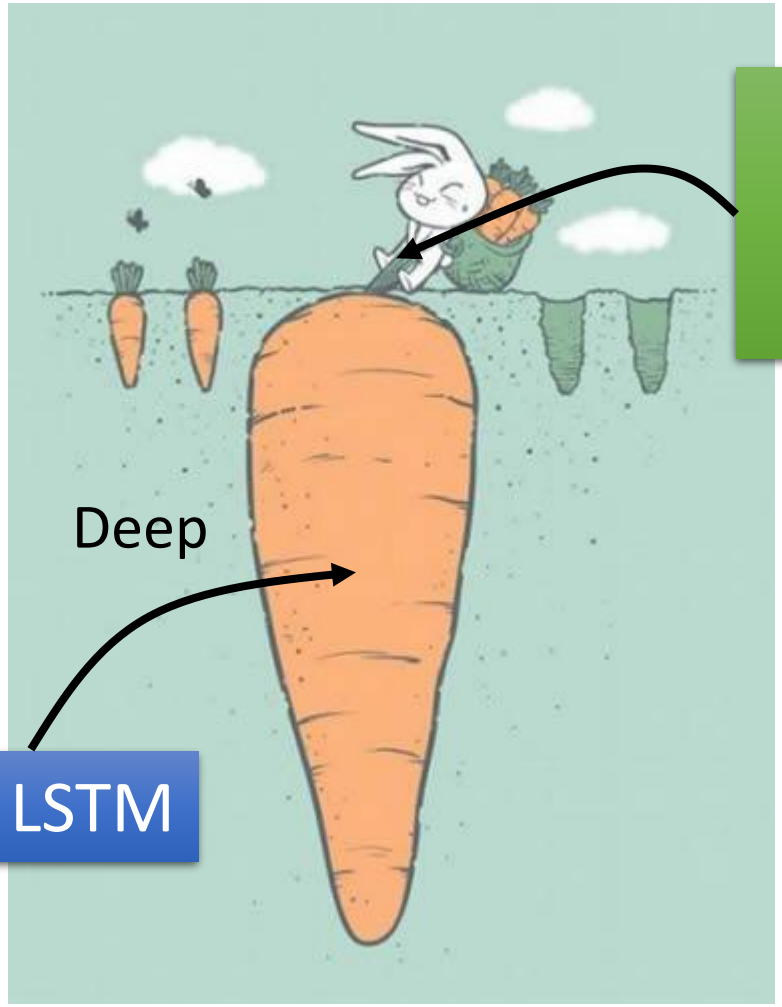
Deep & Structured

RNN v.s. Structured Learning

- RNN, LSTM
  - Unidirectional RNN does not consider the whole sequence
  - Cost and error not always related
  - Deep 勝

- HMM, CRF, Structured Perceptron/SVM
  - Using Viterbi, so consider the whole sequence 勝 ?
    - How about Bidirectional RNN?
  - Can explicitly consider the label dependency 勝
    - Cost is the upper bound of error 勝

Integrated Together



HMM, CRF, Structured Perceptron/SVM

RNN, LSTM

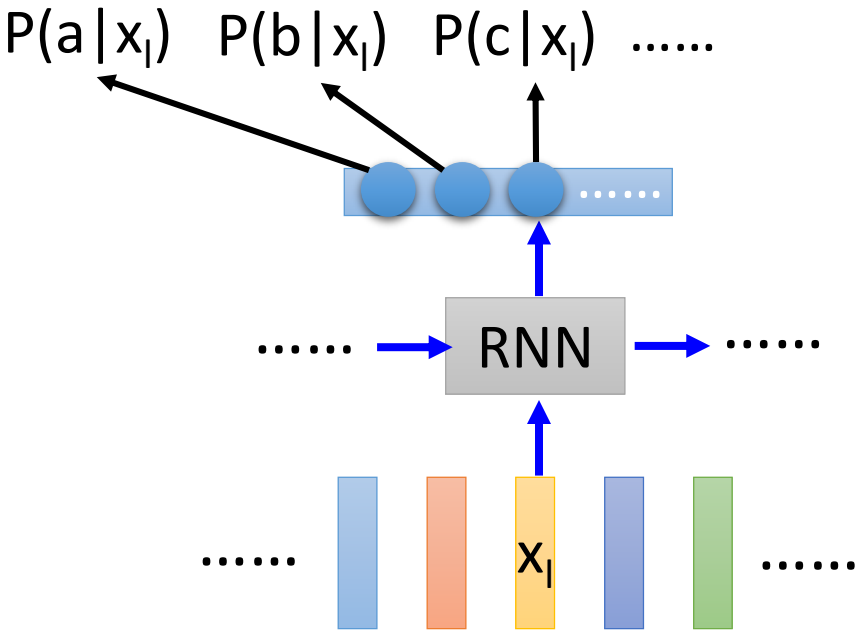
- Explicitly model the dependency
- Cost is the upper bound of error

http://photo30.bababian.com/upload1/20100415/42E9331A6580A46A5F89E98638B8FD76.jpg

Integrated together

- Speech Recognition: CNN/LSTM/DNN + HMM

$$P(x,y) = P(y_1|start)\prod_{l=1}^{L-1} P(y_{l+1}|y_l)\, P(end|y_L)\prod_{l=1}^{L} P(x_l|y_l)$$



$$P(x_l|y_l) = \frac{P(x_l,y_l)}{P(y_l)}$$

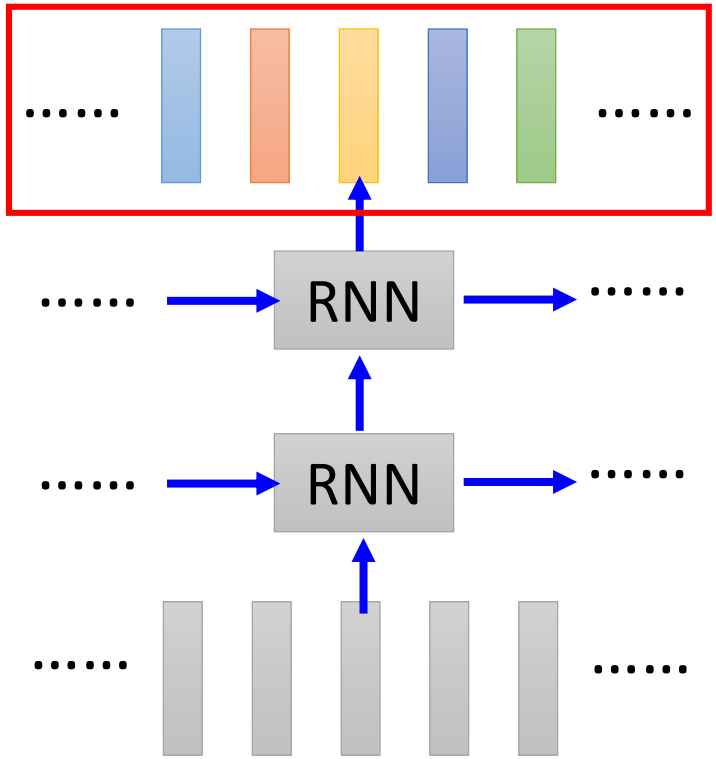
RNN

$$= \frac{P(y_l|x_l)\cancel{P(x_l)}}{P(y_l)}$$

Count

Integrated together

- Semantic Tagging: Bi-directional LSTM + CRF/Structured SVM



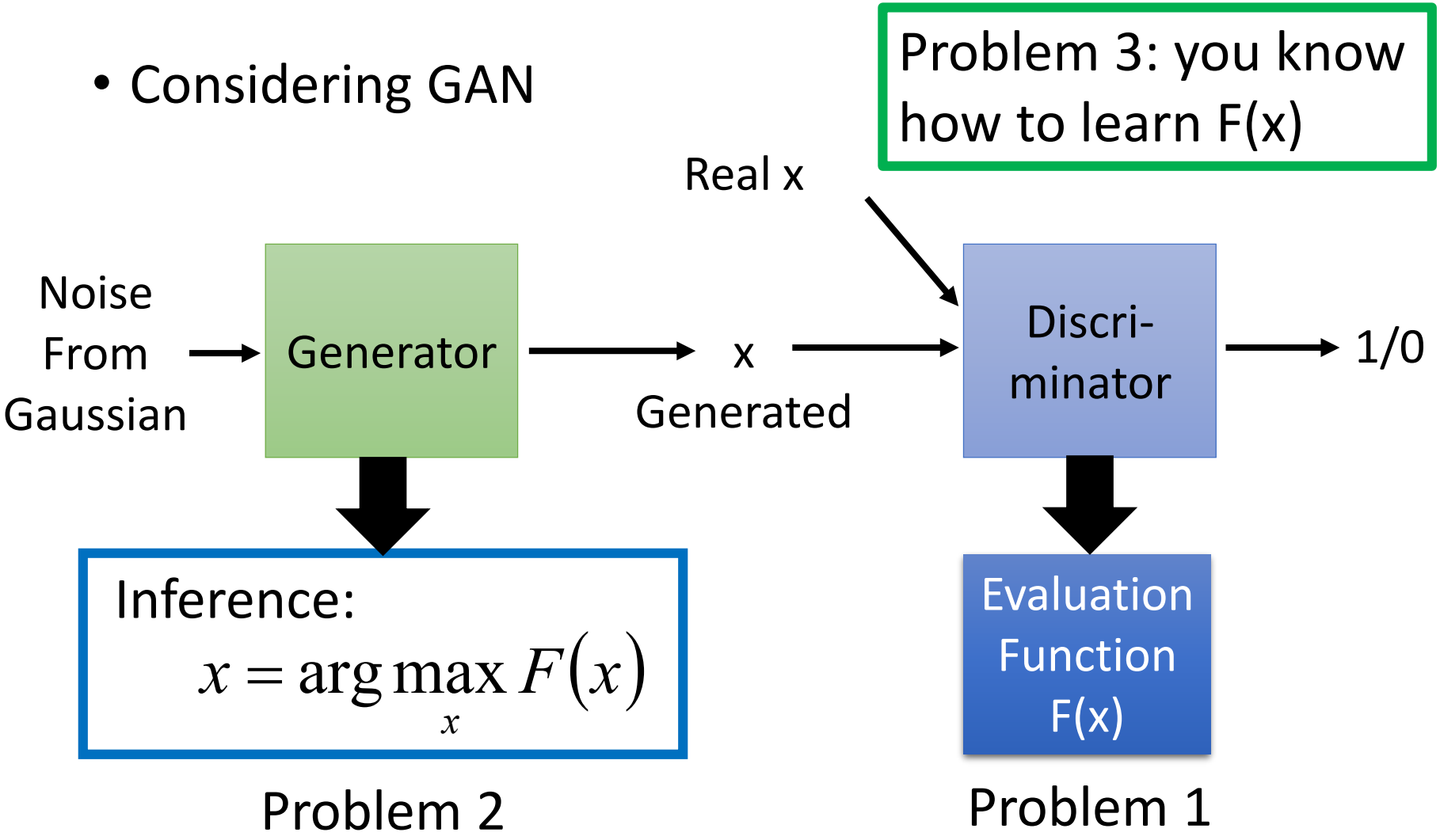
$w \cdot \phi(x, y)$

Testing:

$$\tilde{y} = \arg\max_{y \in \mathbb{Y}} w \cdot \phi(x, y)$$

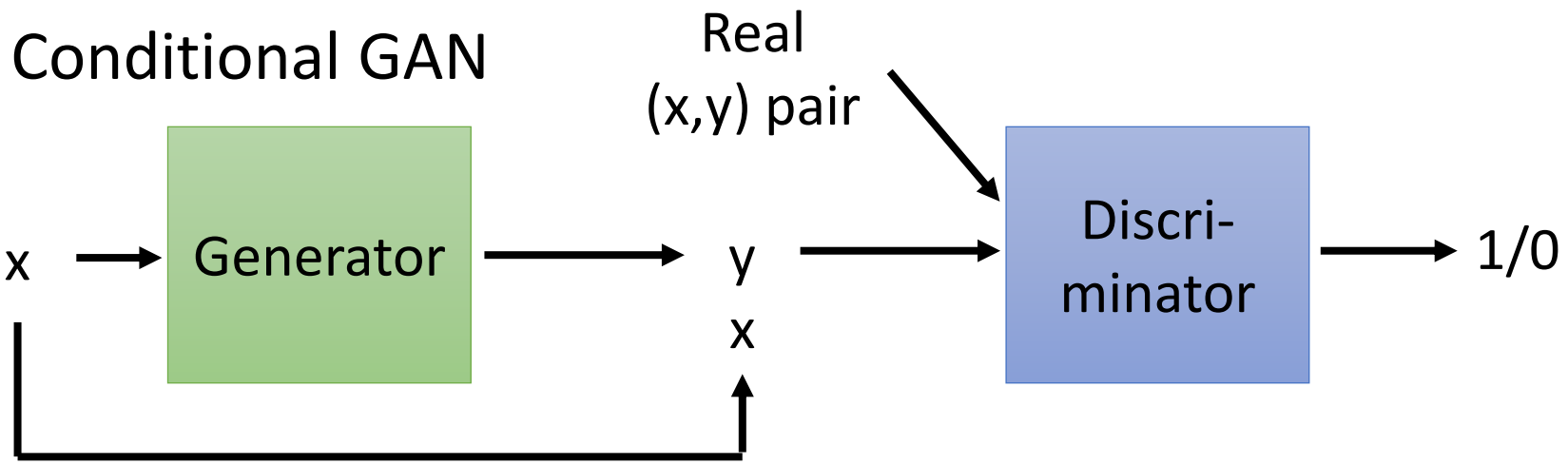
Is structured learning practical?

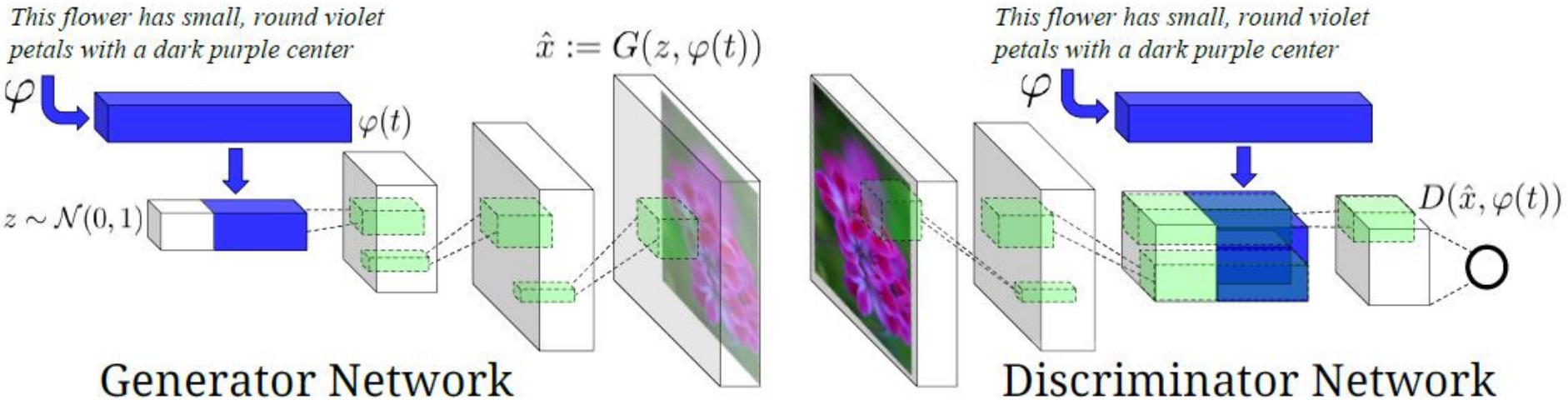
- Considering GAN



Is structured learning practical?

- Conditional GAN





Sounds crazy?
People do think in this way …

Deep and Structured will be the future.

- Connect Energy-based model with GAN:
  - A Connection Between Generative Adversarial Networks, Inverse Reinforcement Learning, and Energy-Based Models
  - Deep Directed Generative Models with Energy-Based Probability Estimation
  - ENERGY-BASED GENERATIVE ADVERSARIAL NETWORKS
- Deep learning model for inference
  - Deep Unfolding: Model-Based Inspiration of Novel Deep Architectures
  - Conditional Random Fields as Recurrent Neural Networks

Machine learning and having it deep and structured (MLDS)

- 和 ML 的不同
  - 在這學期 ML 中有提過的內容 (DNN, CNN …)，在 MLDS 中不再重複，只做必要的復習
- 教科書：“Deep Learning” (http://www.deeplearningbook.org/)
  - Part II 是講 deep learning 、Part III 就是講 structured learning