

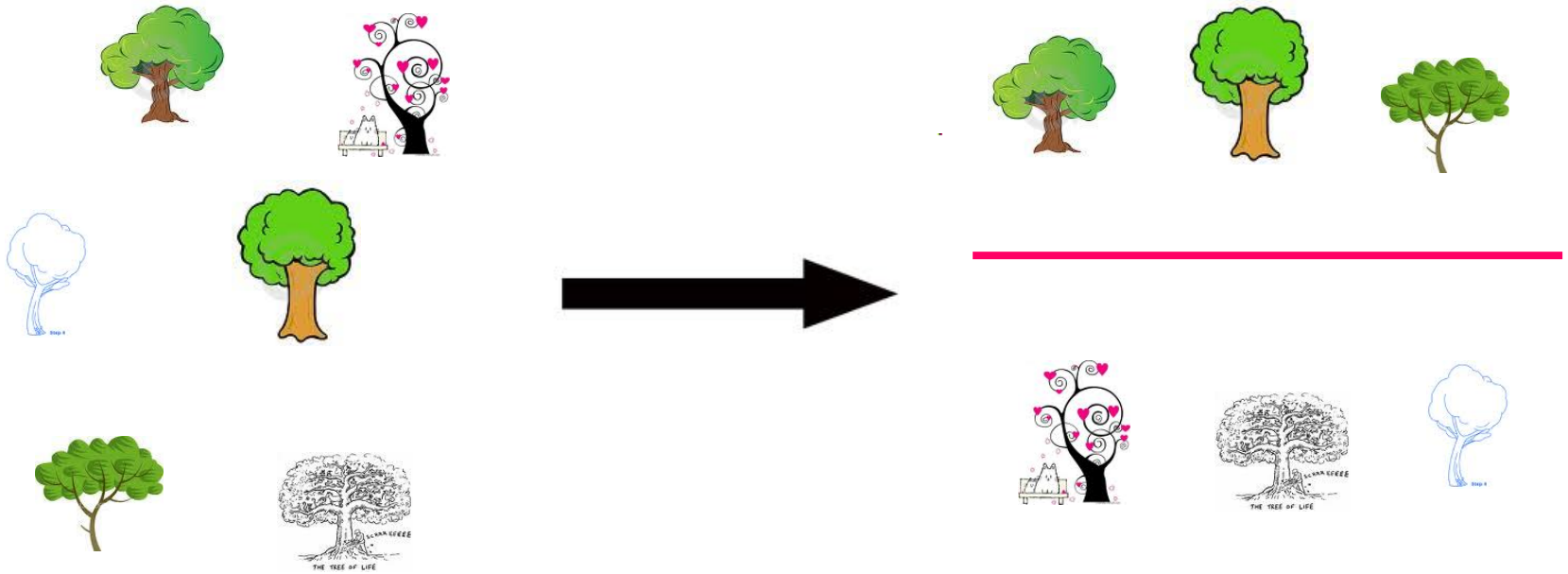
Latent Tree Models and Applications

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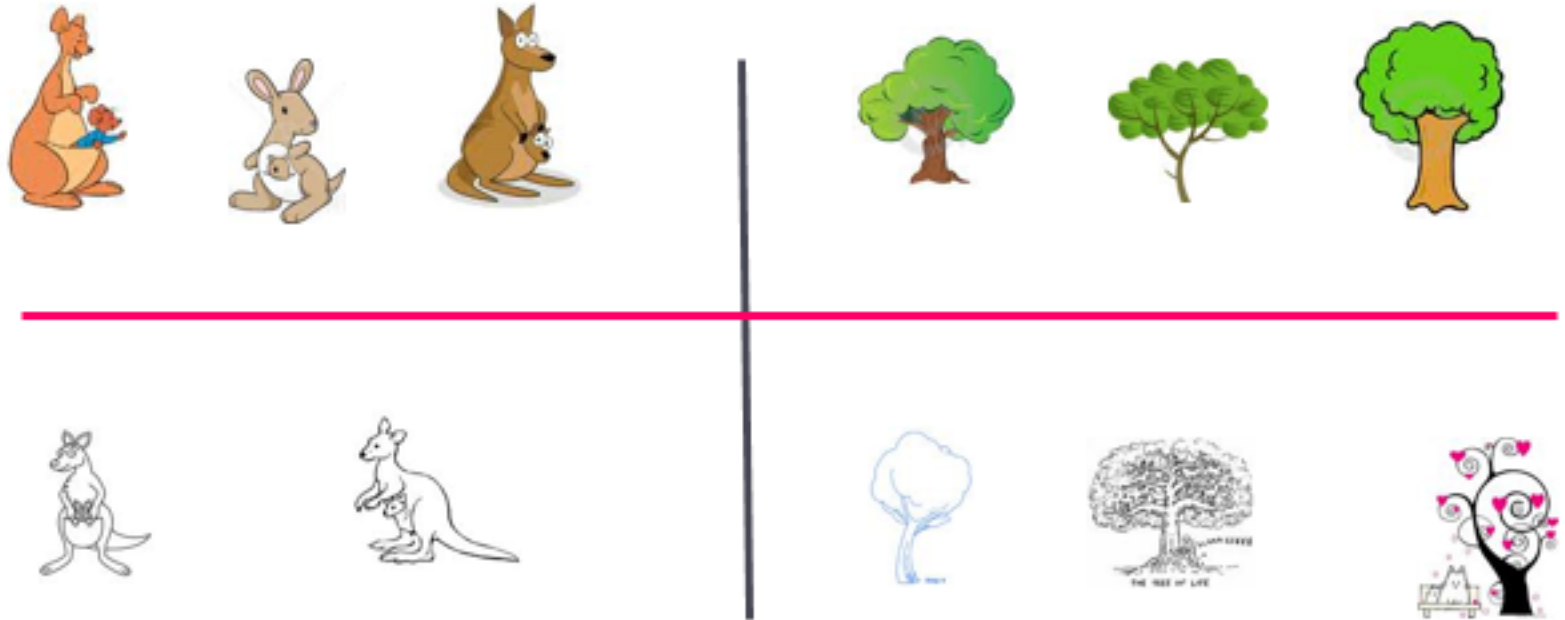
<http://www.cse.ust.hk/~lzhang>



How to Cluster?



Multidimensional Clustering



- Complex data usually have **multiple facets** and can be meaningfully partitioned in multiple ways.

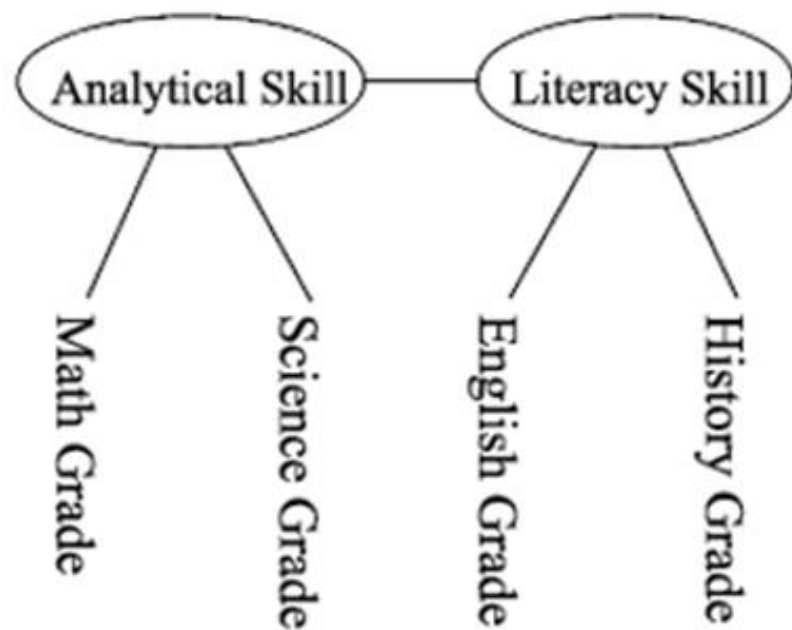


Latent Tree Models (LTMs)

- ▶ Probabilistic graphical models with **multiple latent variables**

(Zhang, JMLR 2004)

Latent

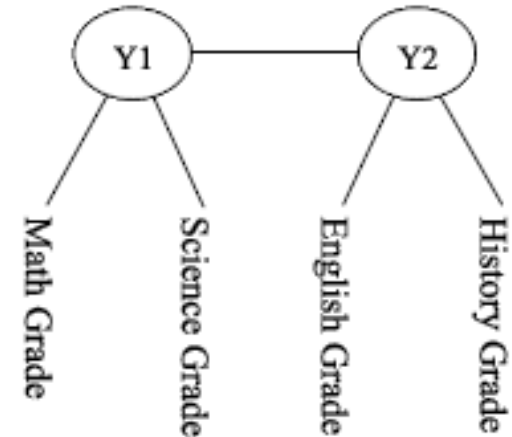


Observed

Probability parameters quantify relationships

Learning Latent Tree Models

Student	Math	Science	English	History
Anna	B	B	A	B
Ben	A	B	B	B
Fred	A	A	B	A
Marry	B	A	A	A
...



Learning latent tree models: Determine

- Number of latent variables
- Numbers of possible states for latent variables
- Connections among nodes
- Probability distributions

Difficult, but doable. Generations of algorithms developed.

Hierarchy of Topics

1. [0.22] mixture gaussian mixtures em covariance

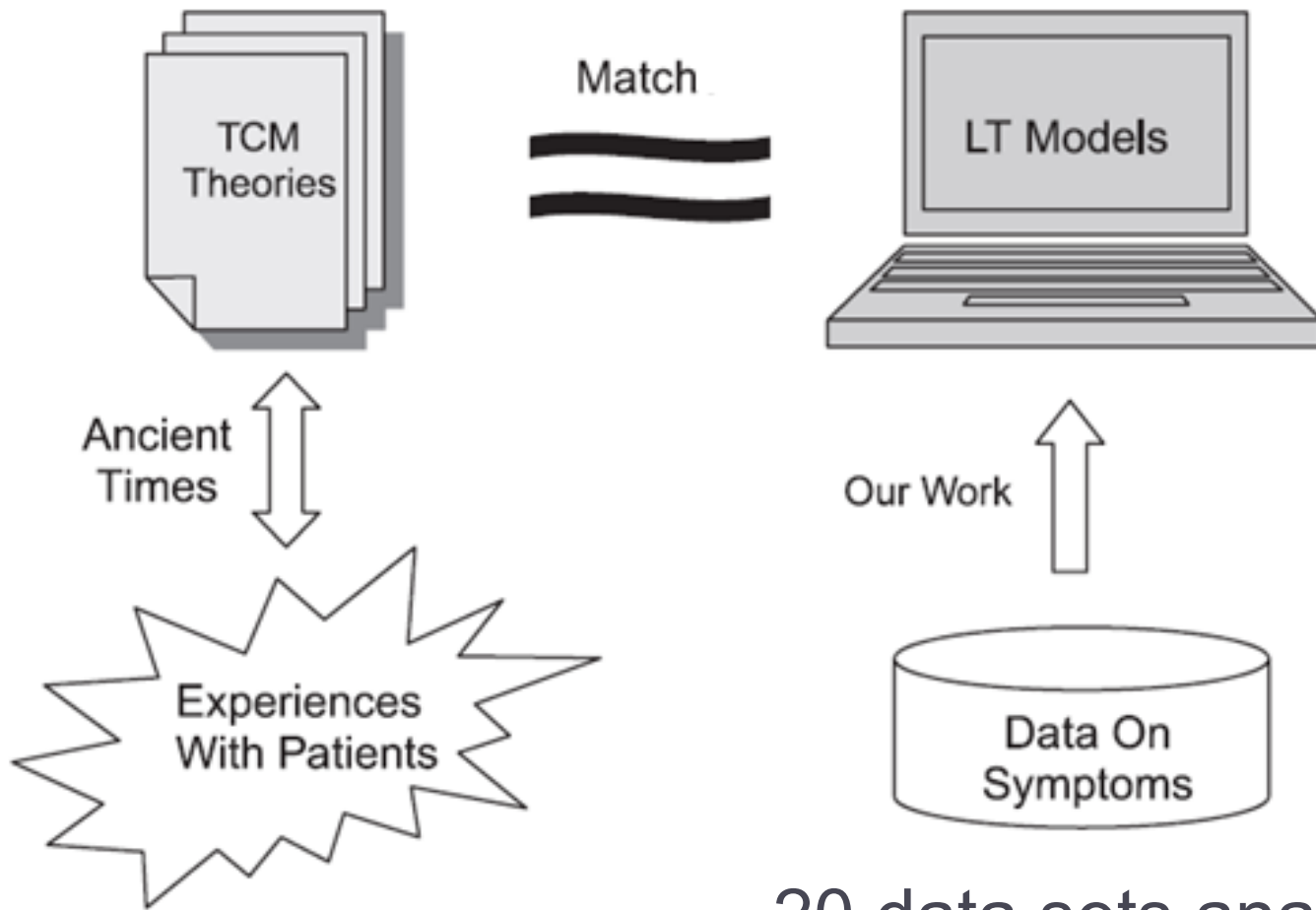
- 1.1. [0.23] em maximization ghahramani expectation
- 1.2. [0.23] mixture gaussian mixtures covariance
- 1.3. [0.23] generative dis generafive generarive
- 1.4. [0.27] variance noise exp variances deviation
 - 1.4.1. [0.28] variance exp variances deviation cr
 - 1.4.2. [0.44] noise noisy robust robustness mean

2. [0.26] images image pixel pixels object

- 2.1. [0.25] images image features detection face
 - 2.2. [0.24] camera video imaging false tracked
 - 2.3. [0.24] pixel pixels intensity intensities
 - 2.4. [0.17] object objects shape views plane
 - 2.5. [0.20] rotation invariant translation
 - 2.6. [0.26] nearest neighbor kohonen neighbors
-



Traditional Chinese Medicine: Validation



20 data sets analyzed



TCM: Practical Problem

- ▶ Parents with a disease (**depression**) classified into several **TCM classes (syndrome types)**
 - ▶ **Liver-Qi Stagnation** (肝气郁结). Treatment principle: 疏肝解郁 , Prescription: 柴胡疏肝散
 - ▶ **Deficiency of Liver Yin and Kidney Yin** (肝肾阴虚) : Treatment principle: 滋肾养肝 , Prescription: 逍遥散合六味地黄丸
 - ▶ **Vacuity of both heart and spleen** (心脾两虚). Treatment principle: 益气健脾, Prescription: 归脾汤
- ▶ Important: different types treated differently.
- ▶ Currently, classification based on experts.
- ▶ **Evidence-based TCM syndrome classification?**

Vascular Mild Cognitive Impairment (VMCI)

Qi deficiency (.39)

- ▶ **Scores:** Lack of strength (3.1), short of breath (3.1), chest oppression (2.9), palpitation (2.9), lassitude of limbs or body (2.6.....**Threshold:** 12.1

Yin deficiency (.44)

- ▶ **Scores:** Sore waist or knees (3.9), blurred vision (3.1), tinnitus resemble cicada (3.0), dry eyes (2.8), expectoration (2.4....**Threshold:** 9.2

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With: Beijing Dong Fang Hospital

