# Intelligent Data Analysis: Data Visualisation

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# Overview

1. Visualization
   - Visualising regional accents using LDA
   - Visualising structure in Neural Networks
   - Visualisation using t-SNE

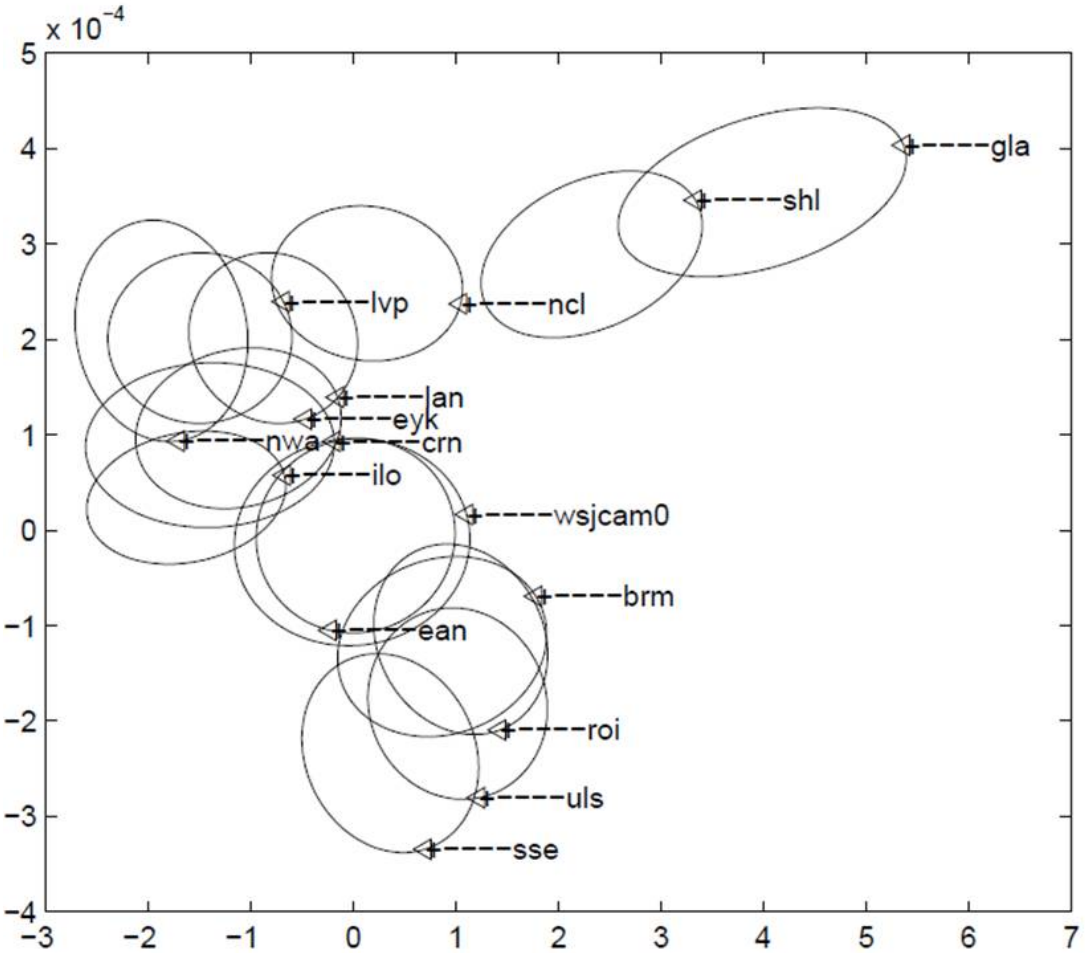
# Speaker characterisation

- In **speaker identification** subjects are represented as very high-dimensional **super-vectors**
- Dimension of the super-vector space may be $\approx 10,000$
- Covariance matrix has $\approx \frac{10,000 \times 10,000}{2} = 5 \times 10^7$ parameters!
- If $X = \{x_1, \cdots, x_N\}$ is the data set, typically $N << 10^7$
- Hence the covariance matrix cannot be reliably estimated (and PCA cannot be reliably used for dimension reduction)
- One solution is to replace maximum variance criterion with a **probability-based** criterion
- In speaker identification the resulting low-dimensional representation of a super-vector is called an **i-vector**

# Visualising regional accents of British English

- Question: Do i-vectors capture accent information?
- Apply LDA to find the 2-dimensional plane in i-vector space that best separates accents
- Uses ABI corpus of recordings of regional accented British English
  - 14 different regional accents
  - 20 speakers per accent

# Visualization of regional accent data using LDA

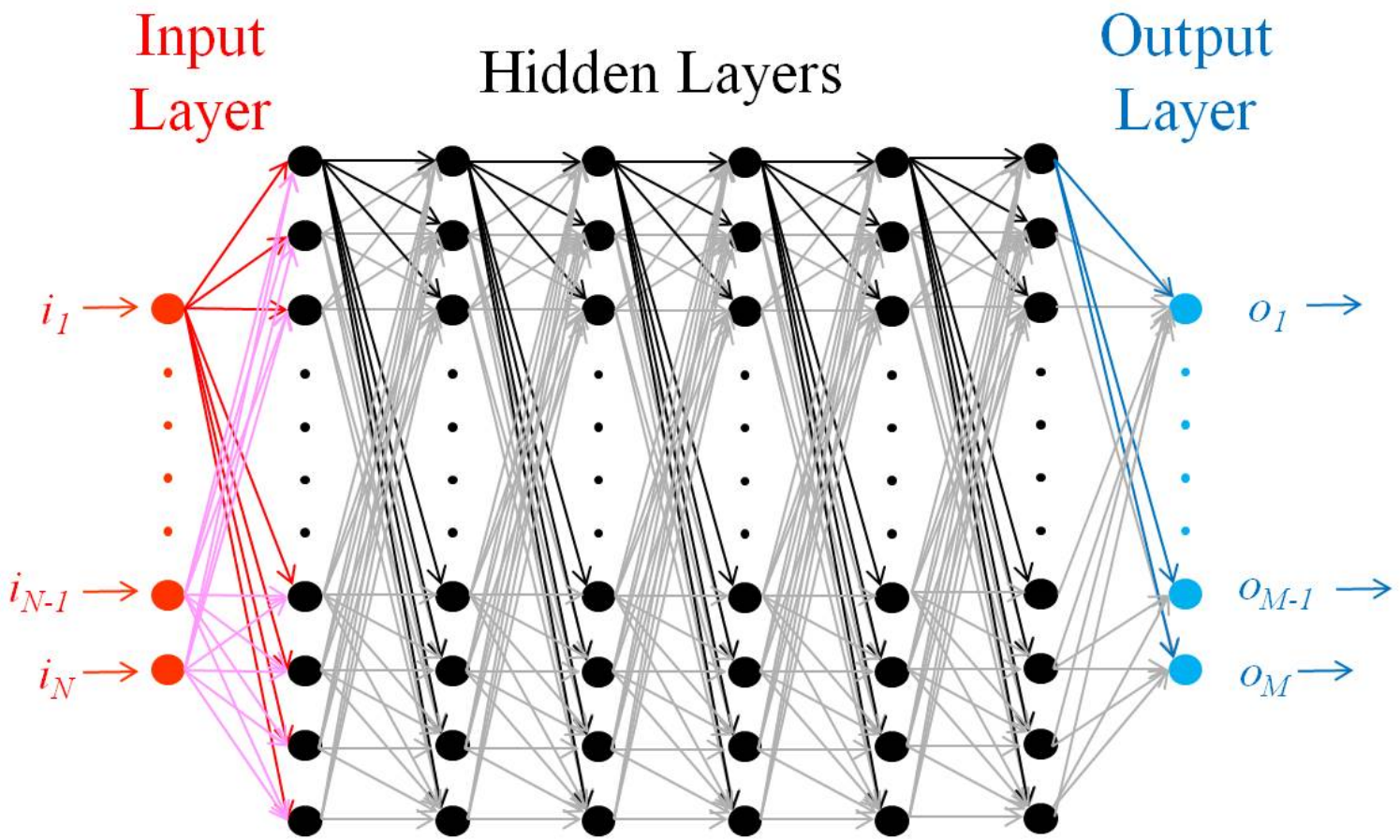



*2D LDA projection of i-vector AID space*

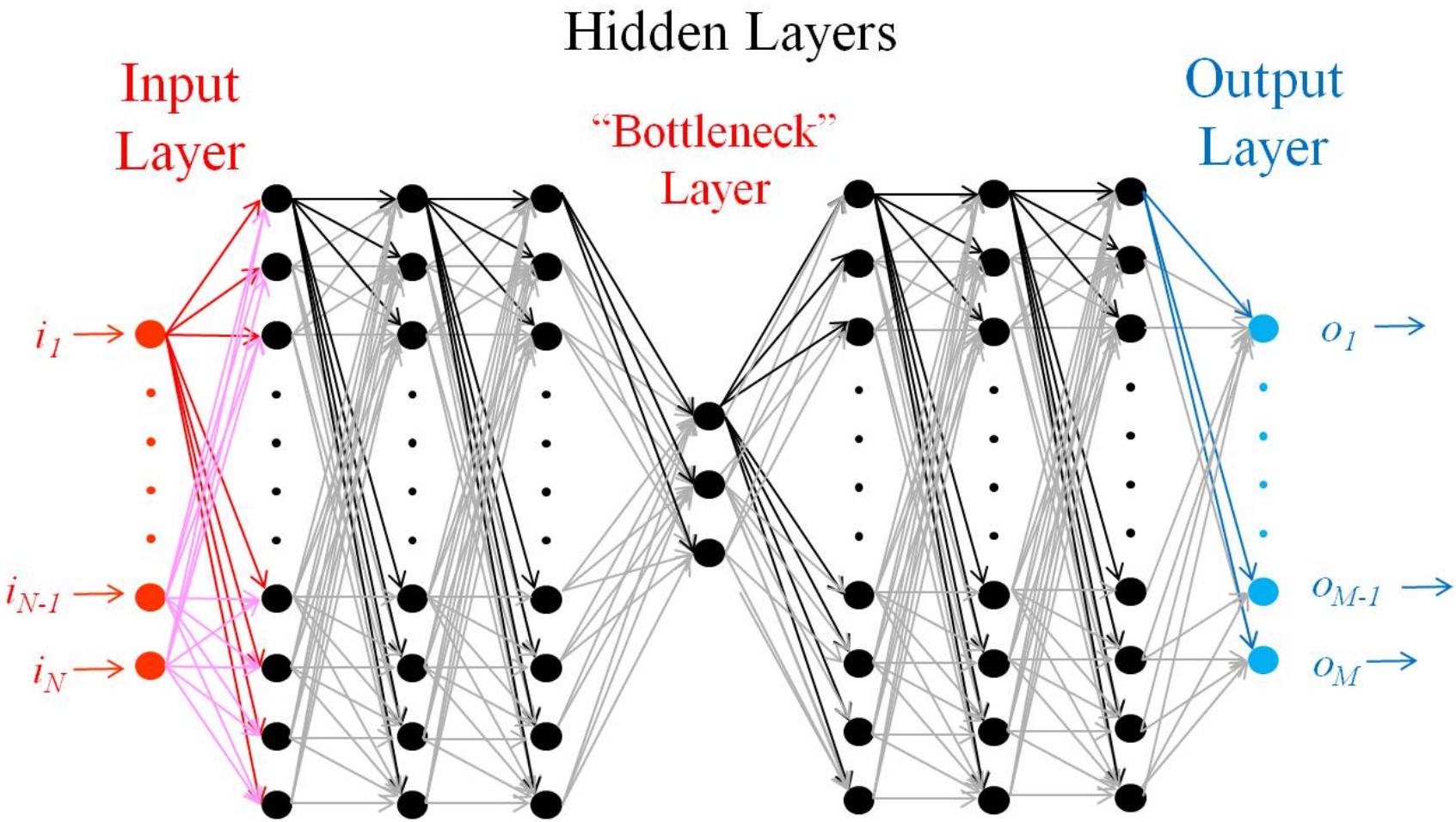
# Artificial neural networks

- Artificial neural networks are pervasive in AI
- Often used as "black box" solutions
- How can we understand the strategies that they use, for example to classify data?

# Visualization using Neural Networks



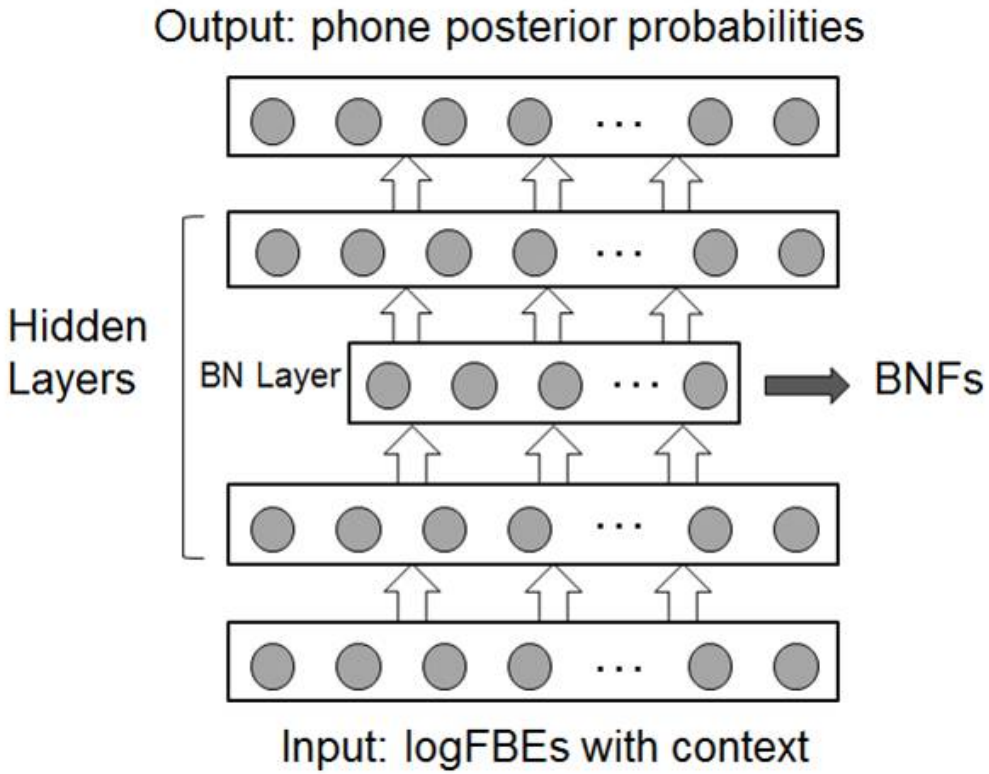
# Visualization using NNs - "Bottleneck" features



# Experiments on the TIMIT corpus

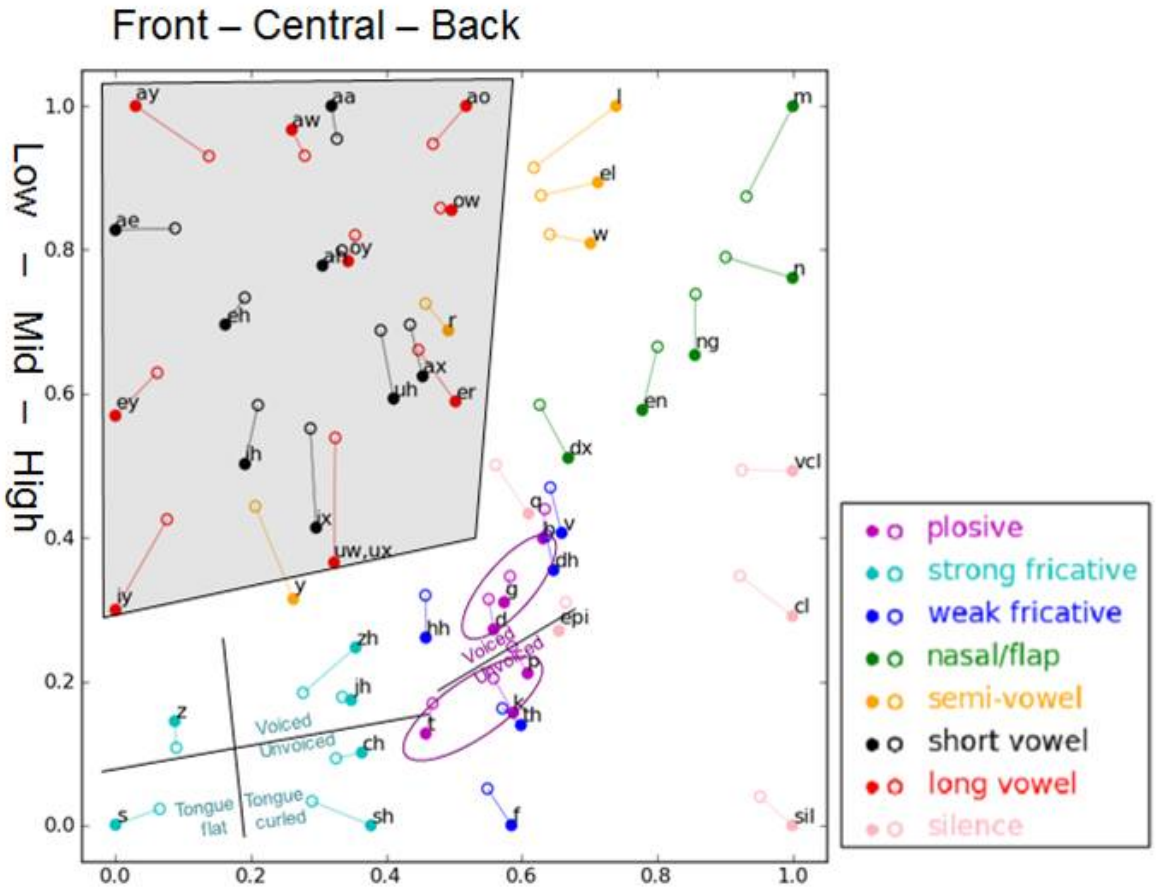
- TIMIT is a publicly available speech corpus collected in the 1990s
- Recordings of read speech
- Phonetically rich and balanced sentences
- Hand-labelled at the phone-level

# Visualization using NNs (Linxue Bai)



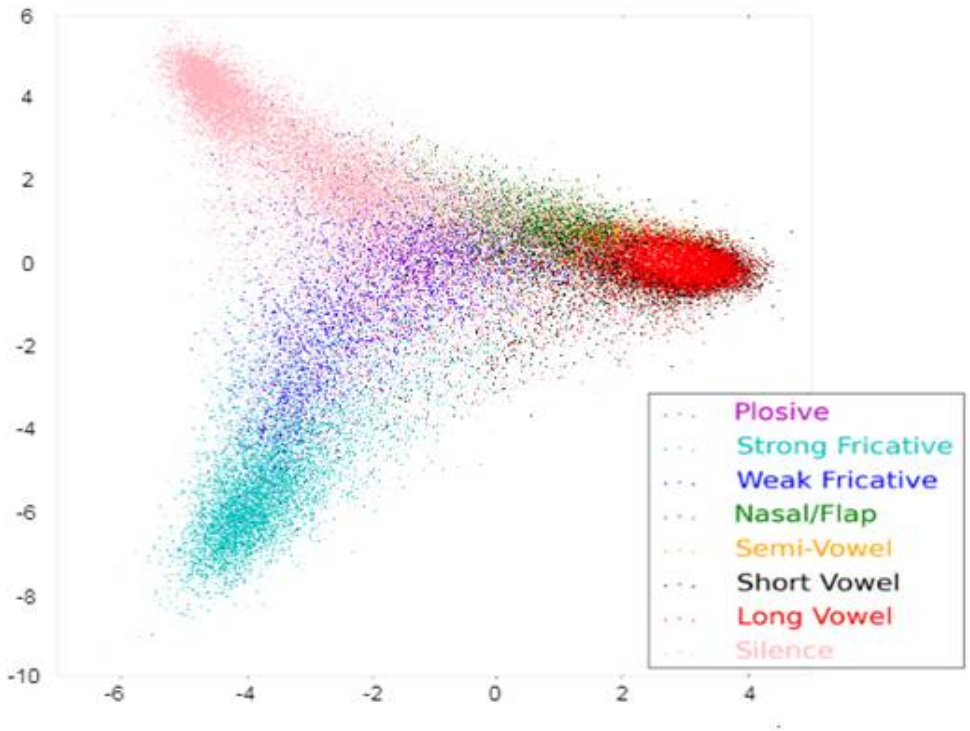
# Visualization of speech data using NNs (Linxue Bai)

Visualisation of speech using 2-dimensional bottleneck features



# LDA Visualization of NN hidden layer activation (Linxue Bai)

Visualisation of speech using 2-dimensional bottleneck features



# t-SNE

- **t-Distributed Stochastic Neighbor Embedding (t-SNE)** is currently a popular method for visualization of high-dimensional data
- **Homework!** - find out about t-SNE

# Visualisation of 9D speech BNFs using *t-SNE*