

Language Technology

<http://cs.lth.se/edan20/>
Chapter 19: Speech Recognition

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Speech Recognition

Conditions to take into account:

- Number of speakers
- Fluency of speech.
- Size of vocabulary
- Syntax
- Environment



Structure of Speech Recognition

Words:

$$W = w_1, w_2, \dots, w_n.$$

Acoustic symbols:

$$A = a_1, a_2, \dots, a_m,$$

$$\hat{W} = \arg \max_W P(W|A).$$

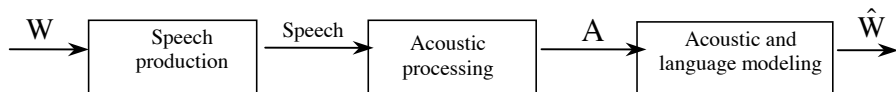
Using Bayes' formula,

$$P(W|A) = \frac{P(A|W)P(W)}{P(A)}.$$



Two-Step Recognition

$$\hat{W} = \arg \max_W P(A|W)P(W).$$



Speech Parameters

Recognition devices derive a set of acoustic parameters from speech frames.

Parameters should be related to “natural” features of speech: voiced or unvoiced segments.

A simple parameter giving a rough estimate of it: the energy: the darker the frame, the higher the energy.

$$E(F_k) = \sum_{n=m}^{m+N-1} s^2(n).$$

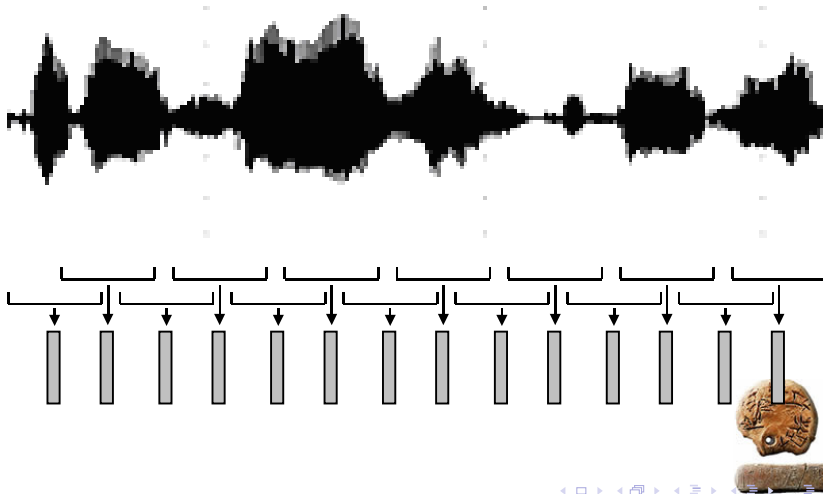
Linear prediction coefficients:

$$\hat{s}(n) = a(1)s(n-1) + a(2)s(n-2) + a(3)s(n-3) + \dots + a(m)s(n-m),$$



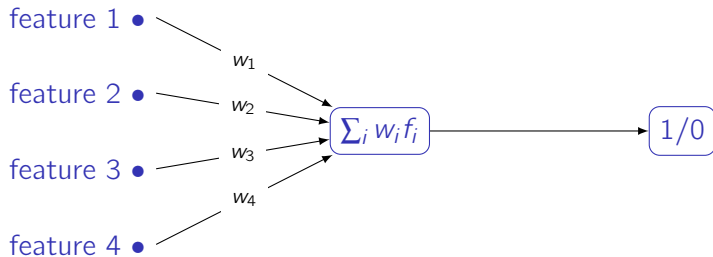
Extraction of Speech Parameters

Features are extracted every 10 ms over a 20 s frame



Neural Networks: Representation

Another representation of the perceptron:

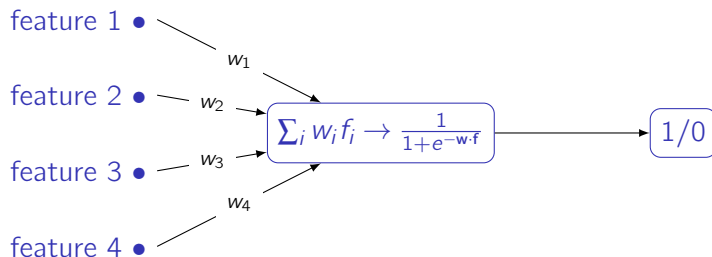


The base network: An input layer and an output layer



Neural Networks: Activation Function

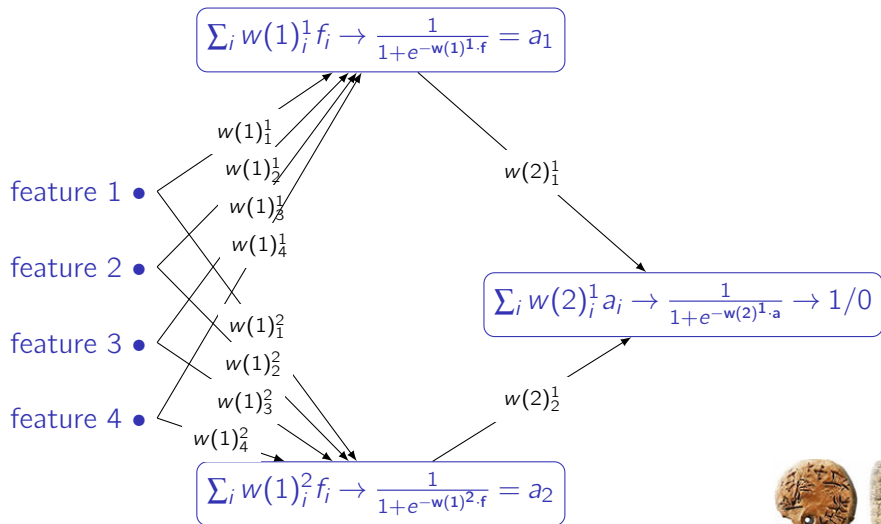
And logistic regression:



The logistic function is the activation function of the node



Neural Networks: Hidden Layers

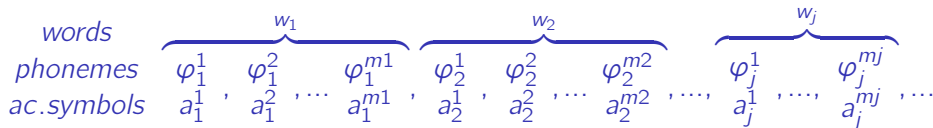


Word Decoding

Markov models are a probabilistic mapping of a string of acoustic symbols a_1, a_2, \dots, a_m onto a string of phonemes $\varphi_1, \varphi_2, \dots, \varphi_m$.

A language model applies a second probability to a word sequence.

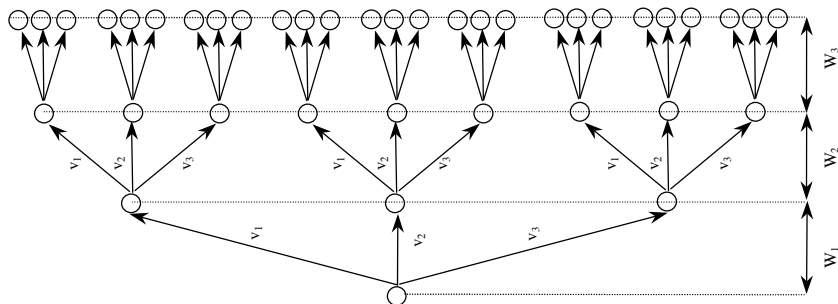
The complete speech recognition then consists in decoding word sequences w_1, w_2, \dots, w_n from phonemic strings and weighting them using the language model.



Searching Words

A hypothesis search.

If the vocabulary contains k words v_1, v_2, \dots, v_k , w_1 is to be selected amongst k possibilities, w_2 amongst k possible choices again and so on.

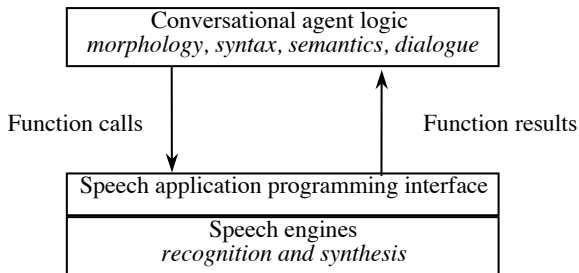


Decoding uses the A^* algorithm



Commercial Systems

Speech recognition systems are accessible using an API



In addition to a language model, speech engines often give the possibility to use a phrase-structure grammar

