10.3. LAB Meeting

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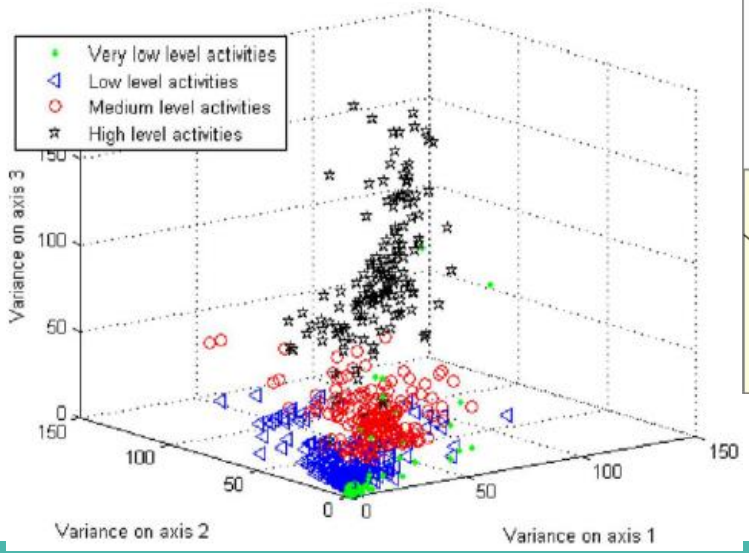
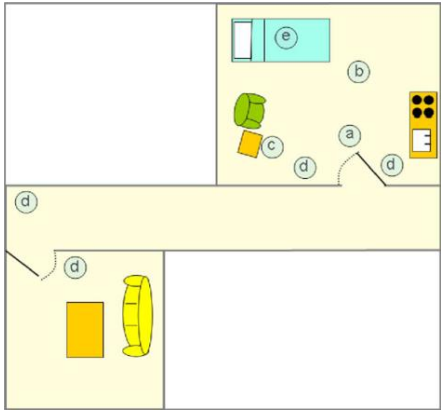
Motivation

- Ambient sensor is good at localization and capture global condition, earable sensor is good at recognize human body trace
- Daily lives data is not segmented, but grammar based model can find pattern in infinite stream conveniently
- Sensor with good segmentation,

Related work

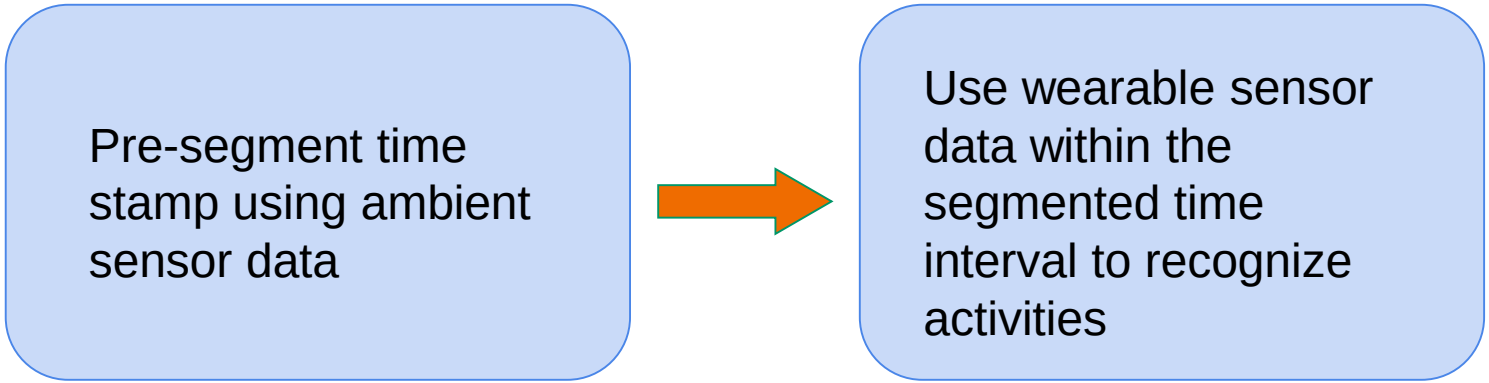
Activity level classes	*Activities*
1- Very Low Level Activities	Sleeping, sitting still and lying down
2- Low Level Activities	Reading, sitting, eating, measuring weight or blood pressure, drinking, watching television and talking
3- Medium Level Activities	Preparing food, walking, sitting down and getting up, wearing clothes, washing up, ironing, non-intense house-work, opening doors, lying down and getting up
4- High Level Activities	Running, sports and intense house-work





Atallah, Louis, et al. "Real-time activity classification using ambient and wearable sensors." Information Technology in Biomedicine, IEEE Transactions on 13.6 (2009): 1031-1039.

Method



- Using model with low false negative rate to segment some possible time interval
- Using another model to do more accurate recognition on wearable sensor

Plan

- Use R324 PIR, Light, Magnetic sensors
- A person with 6-axis accelerometers on his/her hands and legs
- Recognize the following activities:
  - wandering, eating lunch, using computer, sleeping, sweeping, using cell phone, leaving, entering
- Label training data with cell phone

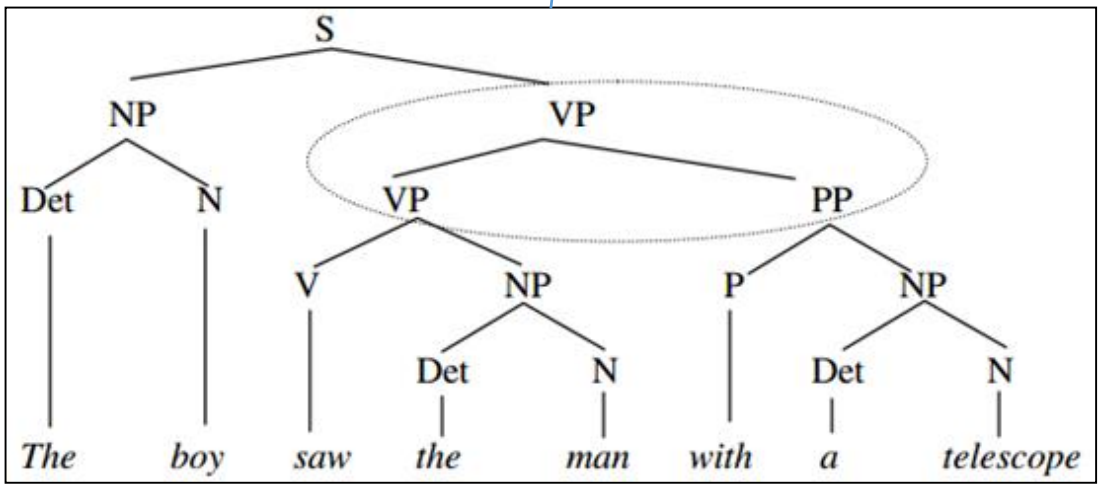
Feature-Based SCFG

SCFG, Merge, Chunk, GMM

Context-Free Grammar

- Nonterminal
  - S, NP, VP, …
- Terminal
  - The, boy, see…
- Rule
  - (VP, VP, PP)
  - (VP, V, NP)
  - …
- Start Symbol
  - S

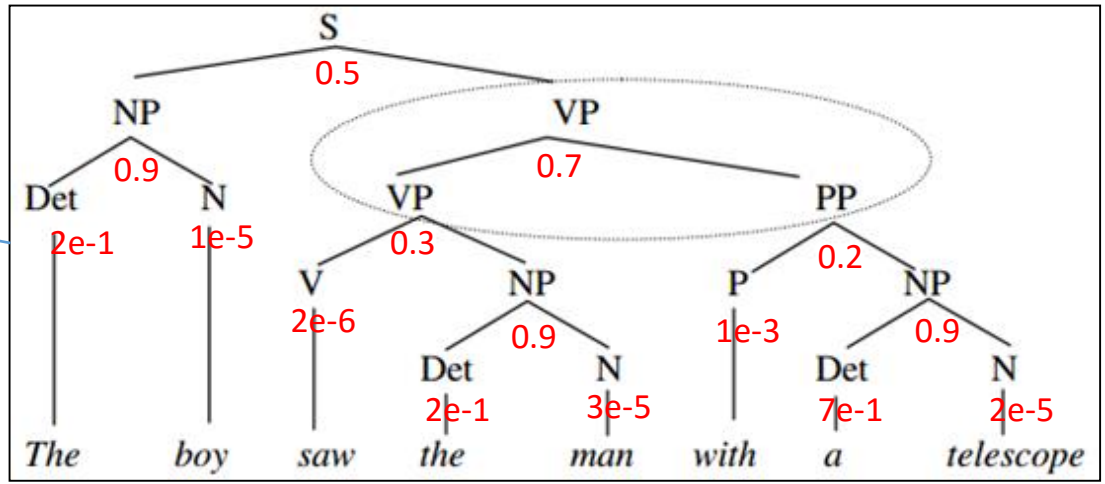
A parse (tree) of some CFG



Stochastic CFG

- CFG rules of VP = {(VP, VP, PP), (VP, VP, NP)}
- SCFG rules of VP = {(VP, VP, PP): 0.7, (VP, VP, NP): 0.3}

The probability of the parse:
0.5*0.9*0.7*…



Learning A Grammar Structure

- Corpus
  - I ate a cat
  - Bob drank blood
  - …
- Naïve rules
  - Add (S, I, ate, a, cat), (S, Bob, drank, blood), …
  - 我的grammar都沒有片語，改成記錄所有看到的句子，用起來跟KNN有90%像
- Merge and chunk
  - Add (VP, ate), (VP, drank)
  - Add (NP, a, cat), (NP, blood)
  - Add (NEW, VP, NP)

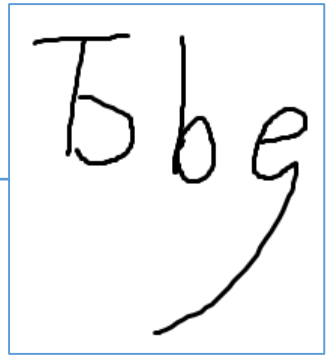
Uncertainties in Input Symbols

	Capital	Letters	Height
The	1	3	2
Boy	0	3	3
	0.7	3	3

- Feature vectors as symbols
  - The = [1,3,2]
  - boy = [0,3,3]
  - Input = [0.7,3,3]

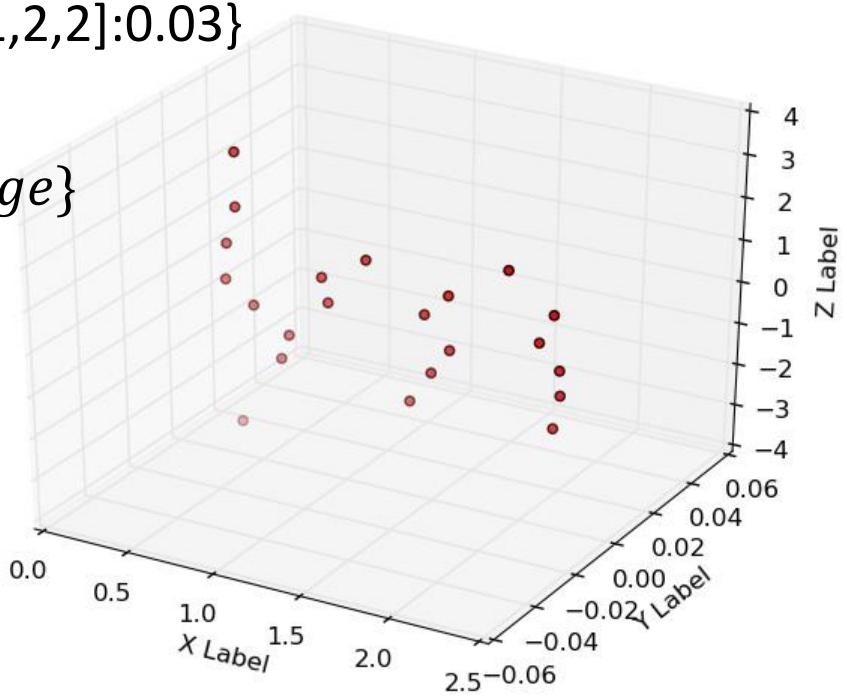
- Scan probability
  - Cosine similarity
  - Gaussian distribution

The or boy?

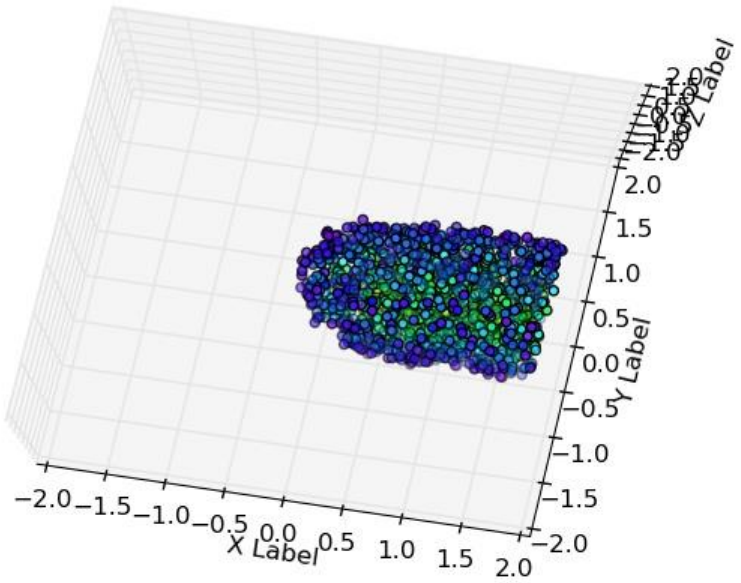


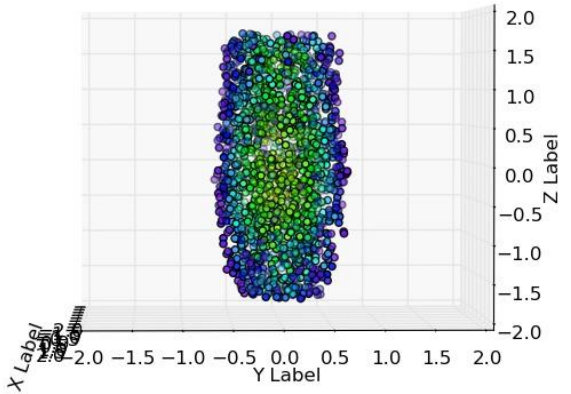
Gaussian Mixture Model

- The = {[1,3,2]:0.86, [0.7,3,2.5]:0.11, [1,2,2]:0.03}
- X_POS = { ◦ : 0. xx| ◦ ∈ $Dotted\_image$}



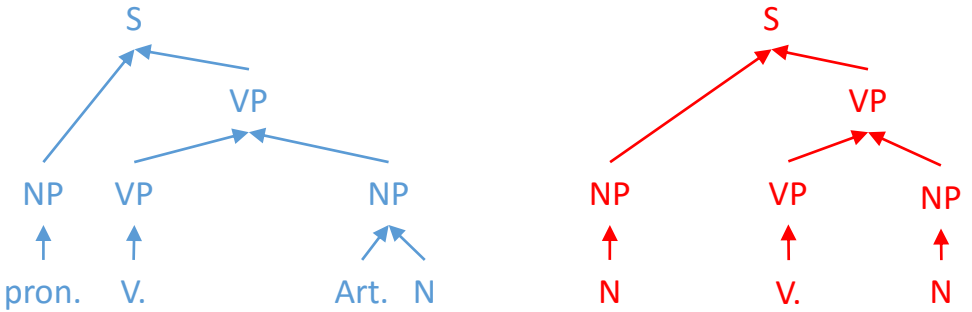
Probability Contour of X_POS





Time Series Data

- Recognize legitimate sentences in indefinitely long data stream



Guts kneed I ate glasses a cat high Bob a drank blood saw YOLO…

```
FSCFG:
    terminal list:
        [t34] weight=-0.915332
            -0.01 -1.33 -2.23 [2]
            -0.01  1.40 -1.75 [8]
        [t16] weight=-0.683536
            -1.40  0.00 -0.74 [25]
            -1.33  0.00  1.66 [11]
            -1.36  0.00  0.36 [25]
            -1.51  0.00  0.90 [16]
            -1.44  0.00 -1.74 [7]
            -1.38  0.00 -0.22 [22]
        [t6] weight=-0.722681
            -0.01 -1.45  1.11 [17]
            -0.01 -1.43  0.37 [15]
            -0.01 -1.34 -0.72 [16]
            -0.01 -1.39  1.64 [11]
            -0.01 -1.42 -0.20 [28]
            -0.01 -1.33 -2.23 [2]
            -0.01 -1.42 -1.41 [15]
        [t0] weight=-0.63464
            -0.01  1.44  0.20 [23]
            -0.01  1.43 -1.00 [17]
            -0.01  1.37  1.57 [14]
            -0.01  1.36 -0.47 [25]
            -0.01  1.40  0.74 [19]
        [t12] weight=-0.804574
             1.32  0.00 -0.96 [19]
             1.35  0.00  2.30 [8]
             1.47  0.00  1.24 [13]
             1.54  0.00 -1.95 [10]
             1.41  0.00  0.26 [22]
             1.43  0.00  0.78 [14]
             1.40  0.00 -0.30 [20]
    nonterminal list:
        [N085] cnt=98
        [N080] cnt=104
        [N087] cnt=106
        [N083] cnt=106
        [N067] cnt=10
        [N000] cnt=106
    start symbol:
        [N000] cnt=106
    rule:
        [  98    0.00 ] N085 -> t0

        [ 104    0.00 ] N080 -> t6

        [ 106    0.00 ] N087 -> t16

        [ 106    0.00 ] N083 -> t12

        [  10    0.00 ] N067 -> t34

        [  16   -1.89 ] N000 -> N083 N080 N087 N085
        [   1   -4.66 ] N000 -> N083 N067 N087 N085
        [   1   -4.66 ] N000 -> N080 N087 N067 N083
        [   2   -3.97 ] N000 -> N087 N067 N083 N080
        [   1   -4.66 ] N000 -> N083 N067 N087 N067
        [   2   -3.97 ] N000 -> N067 N083 N080 N087
        [  27   -1.37 ] N000 -> N087 N085 N083 N080
        [  27   -1.37 ] N000 -> N085 N083 N080 N087
        [   2   -3.97 ] N000 -> N083 N080 N087 N067
        [  27   -1.37 ] N000 -> N080 N087 N085 N083

        119882328 function calls (113851494 primitive calls) in 71.683 seconds
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References

- Stolcke, A. (1995). An efficient probabilistic context-free parsing algorithm that computes prefix probabilities. *Computational linguistics*, *21*(2), 165-201.

- Stolcke, A. (1994). *Bayesian learning of probabilistic language models*(Doctoral dissertation, University of California, Berkeley).

- Ivanov, Y., & Bobick, A. F. (2000). Recognition of visual activities and interactions by stochastic parsing. *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, *22*(8), 852-872.

- Sadeghipour, A., & Kopp, S. (2014, June). A Hybrid Grammar-Based Approach for Learning and Recognizing Natural Hand Gestures. In *Proceedings of the 28th AAAI conference on artificial intelligence*.