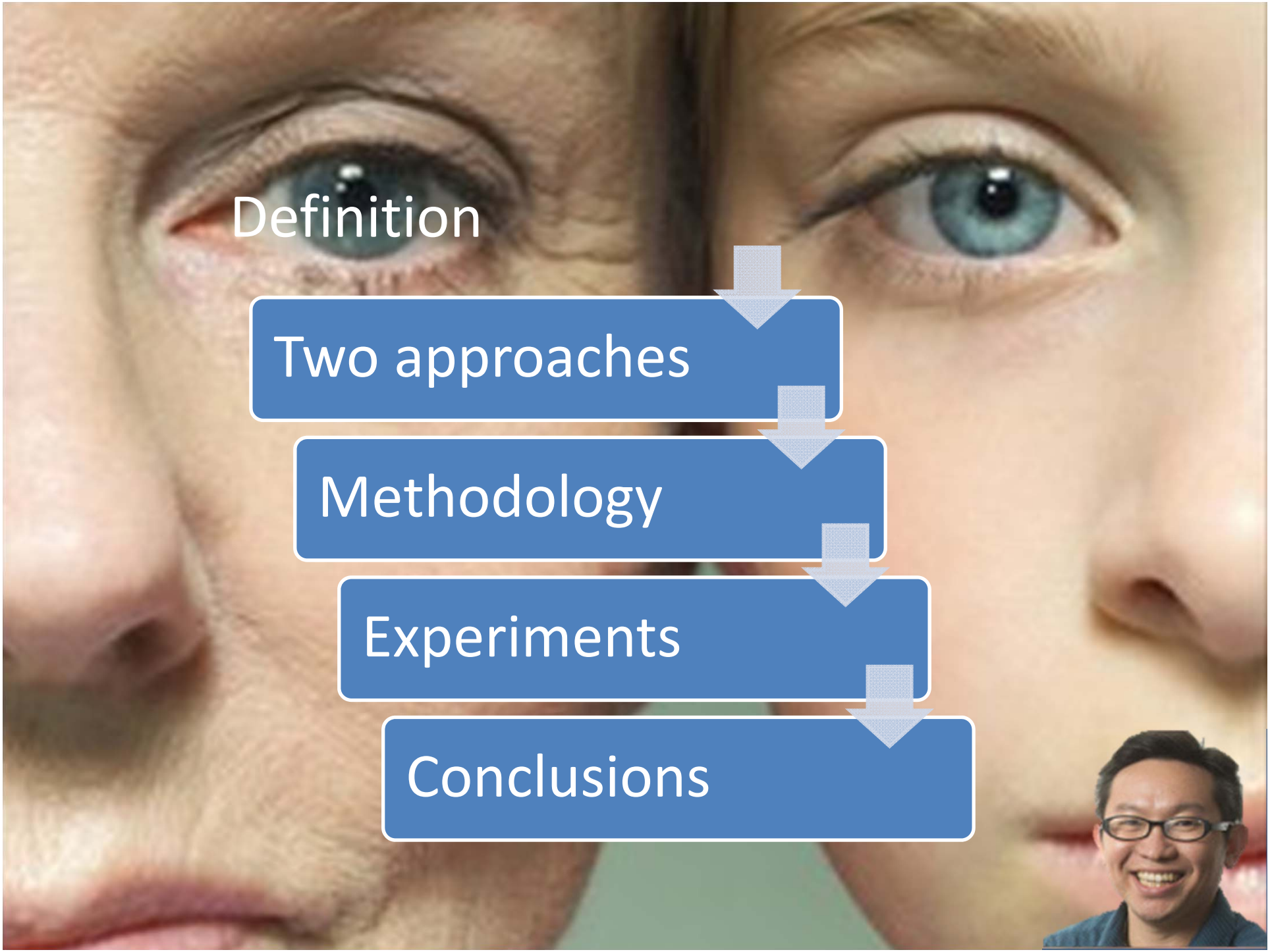
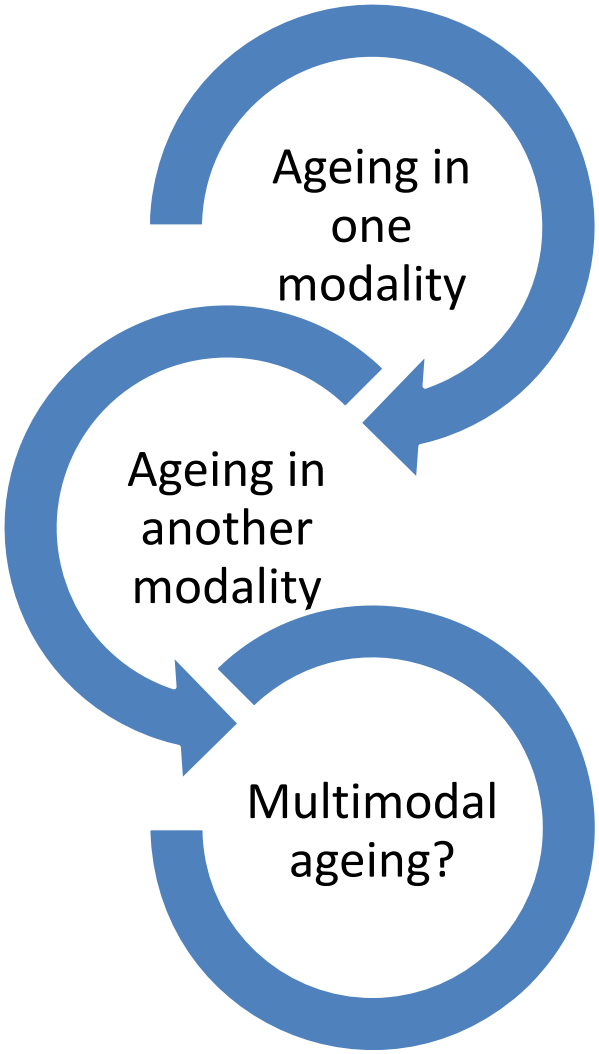
Multimodal ageing (and habituation)

Norman Poh n.poh@surrey.ac.uk University of Surrey, UK


Definition
Two approaches
Methodology
Experiments
Conclusions

Multimodal Ageing

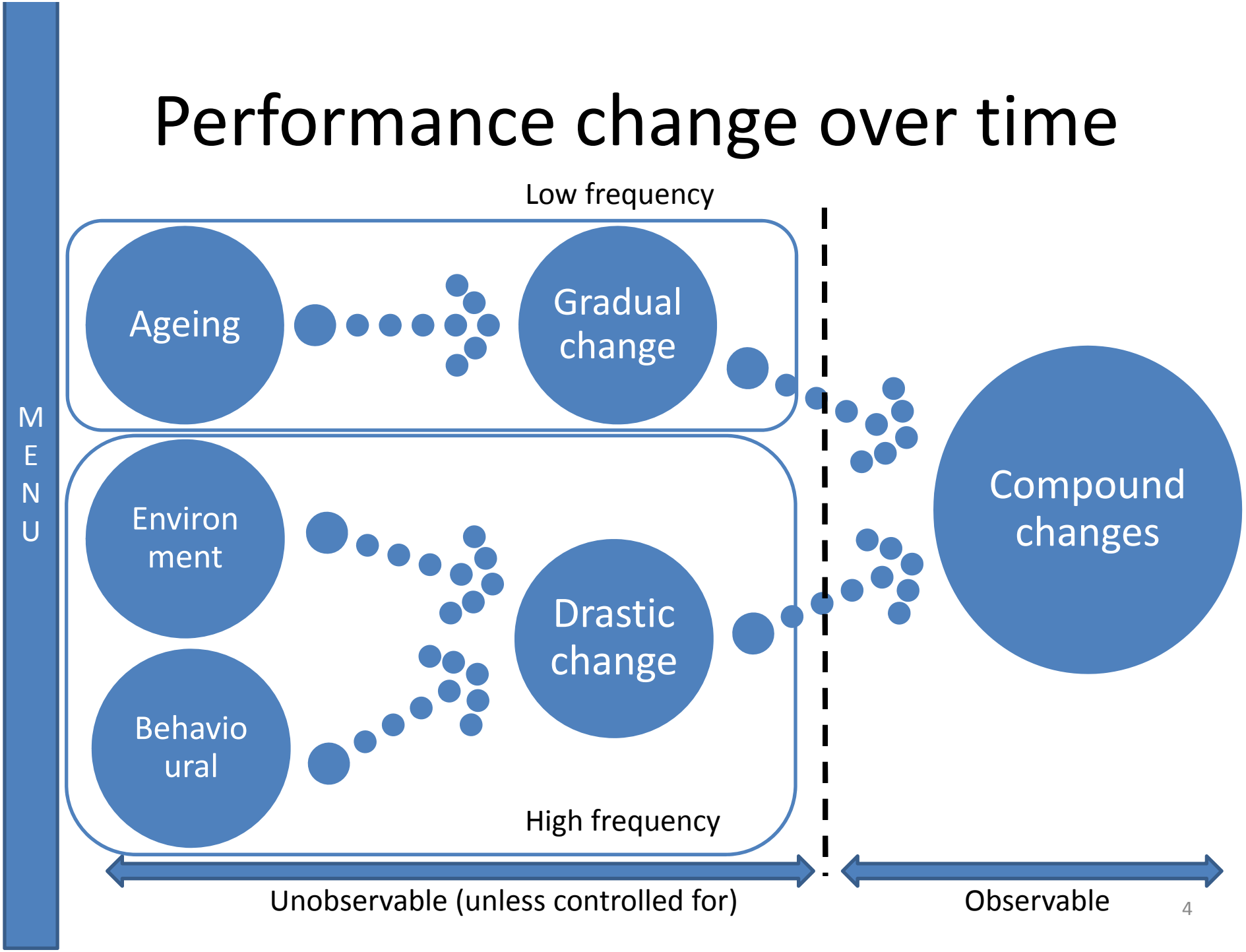


"Ageing is the accumulation of changes in a person over time"

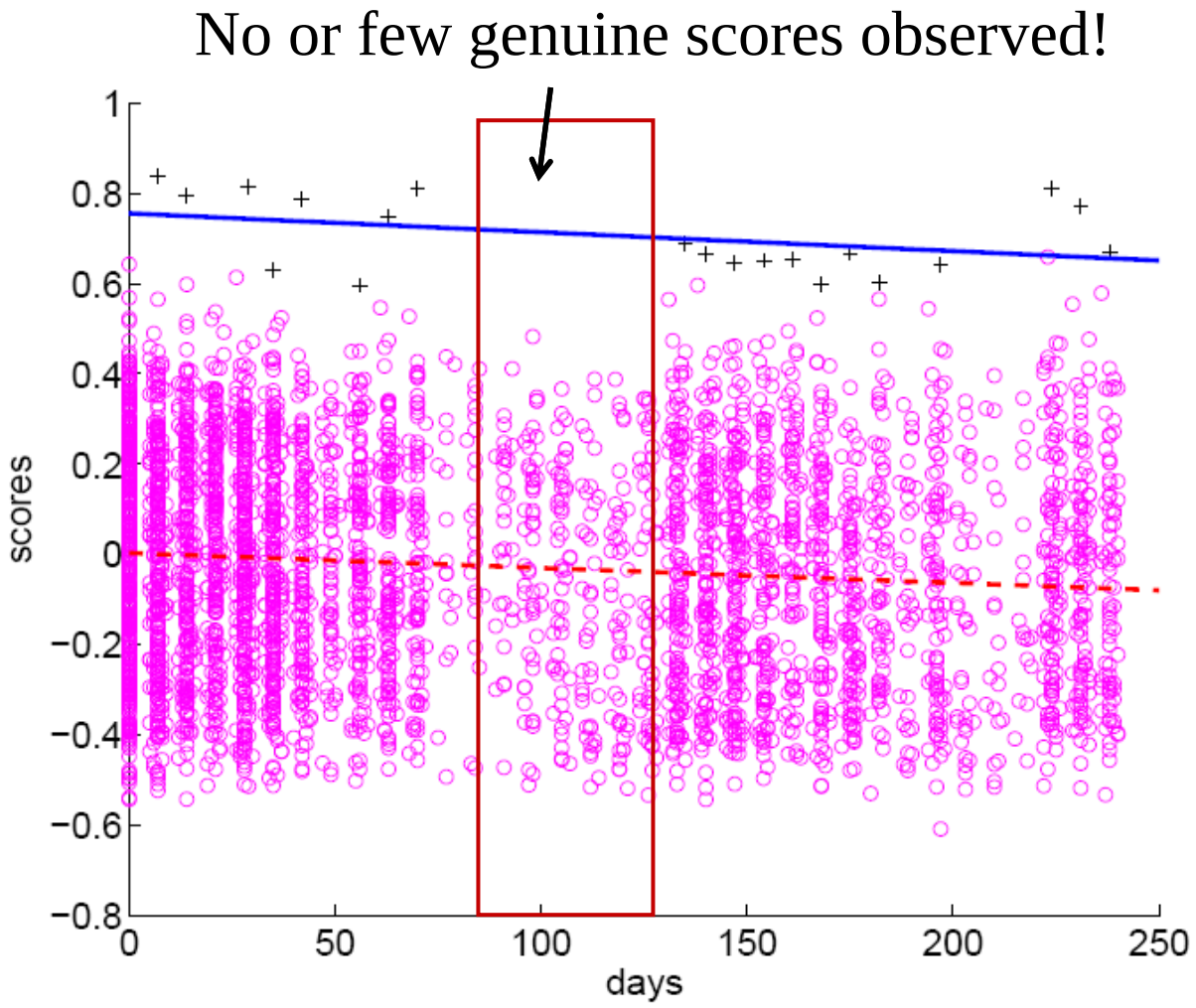
Irreversible process?

Bowen, Richard L.; Atwood, Craig S. (2004). "Living and Dying for Sex". *Gerontology* **50** (5): 265–90.

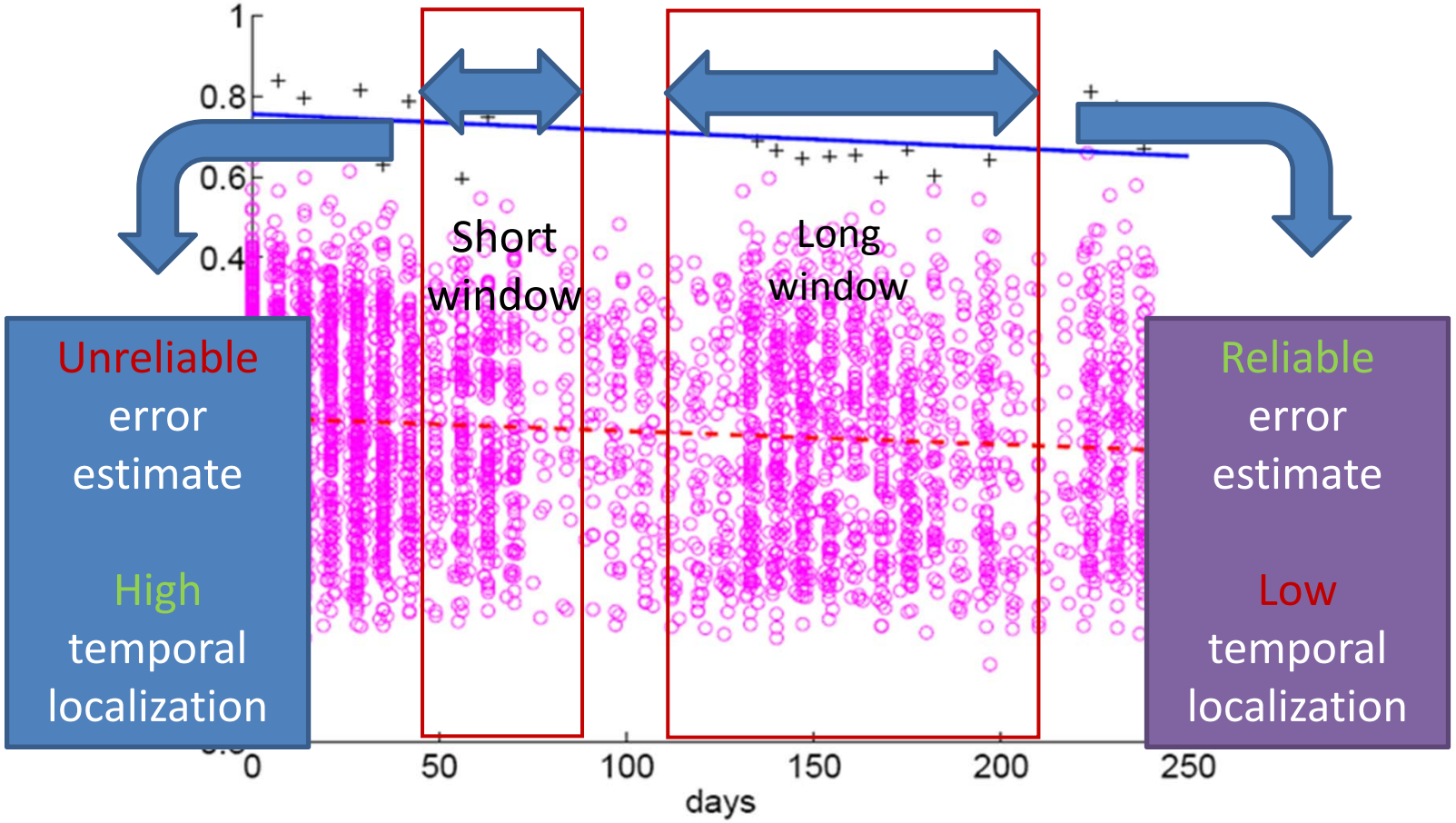
Performance change over time



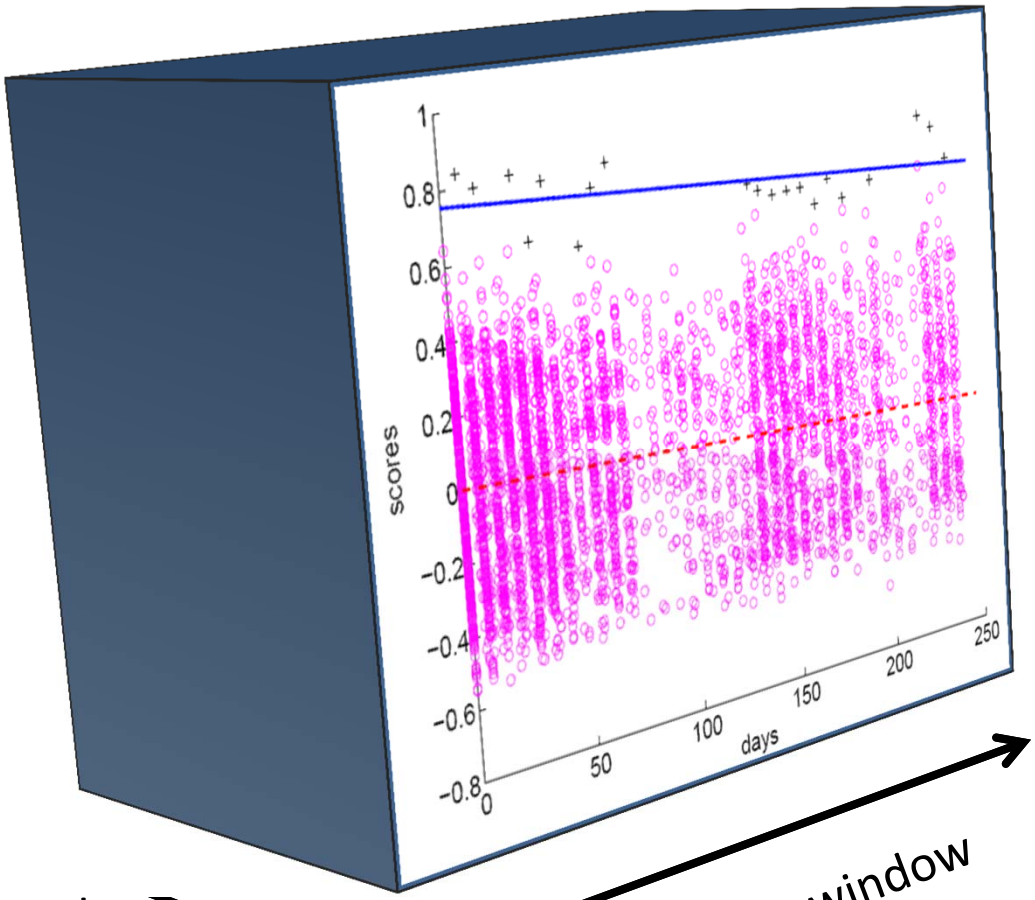
The windowing approach



Dilemma: Reliable error or finer temporal resolution?



The windowing approach

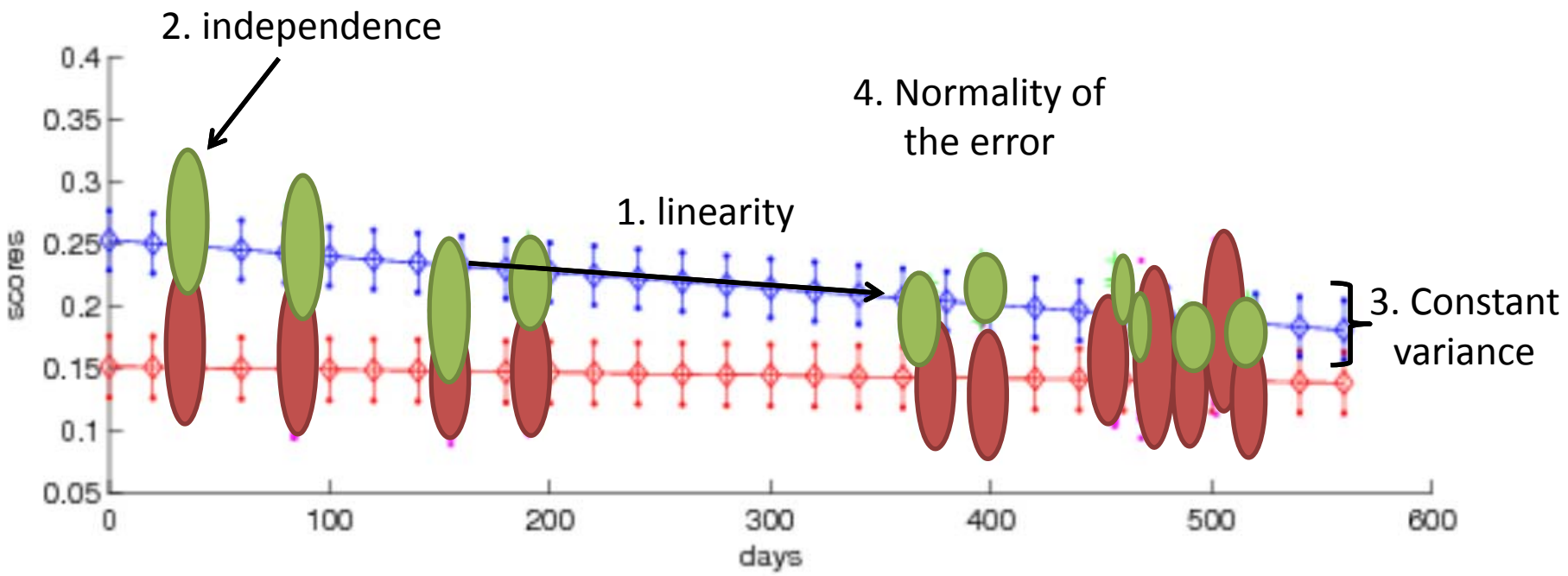


Cannot model subject-specific performance

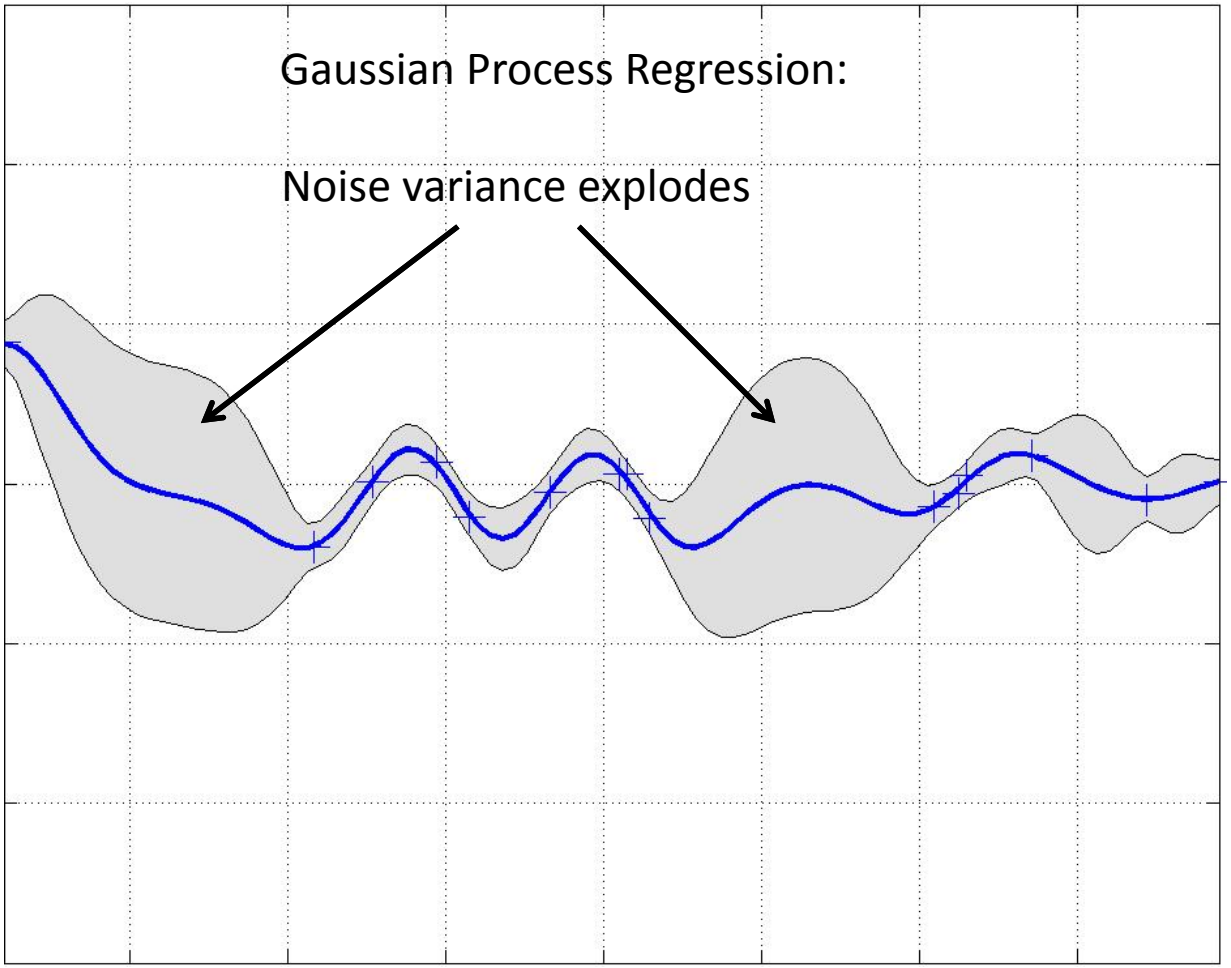
Stack the scores due to all templates together

Scan the window through time

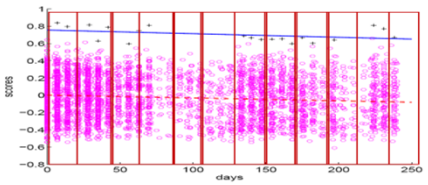
The regression approach



Choice of regression matters



windowing



Cannot model subject-specific performance

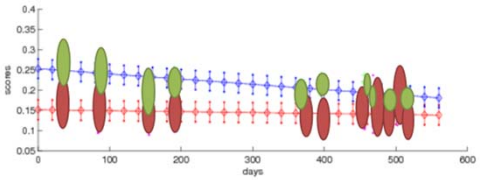
Dilemma between reliable error estimate & fine temporal resolution

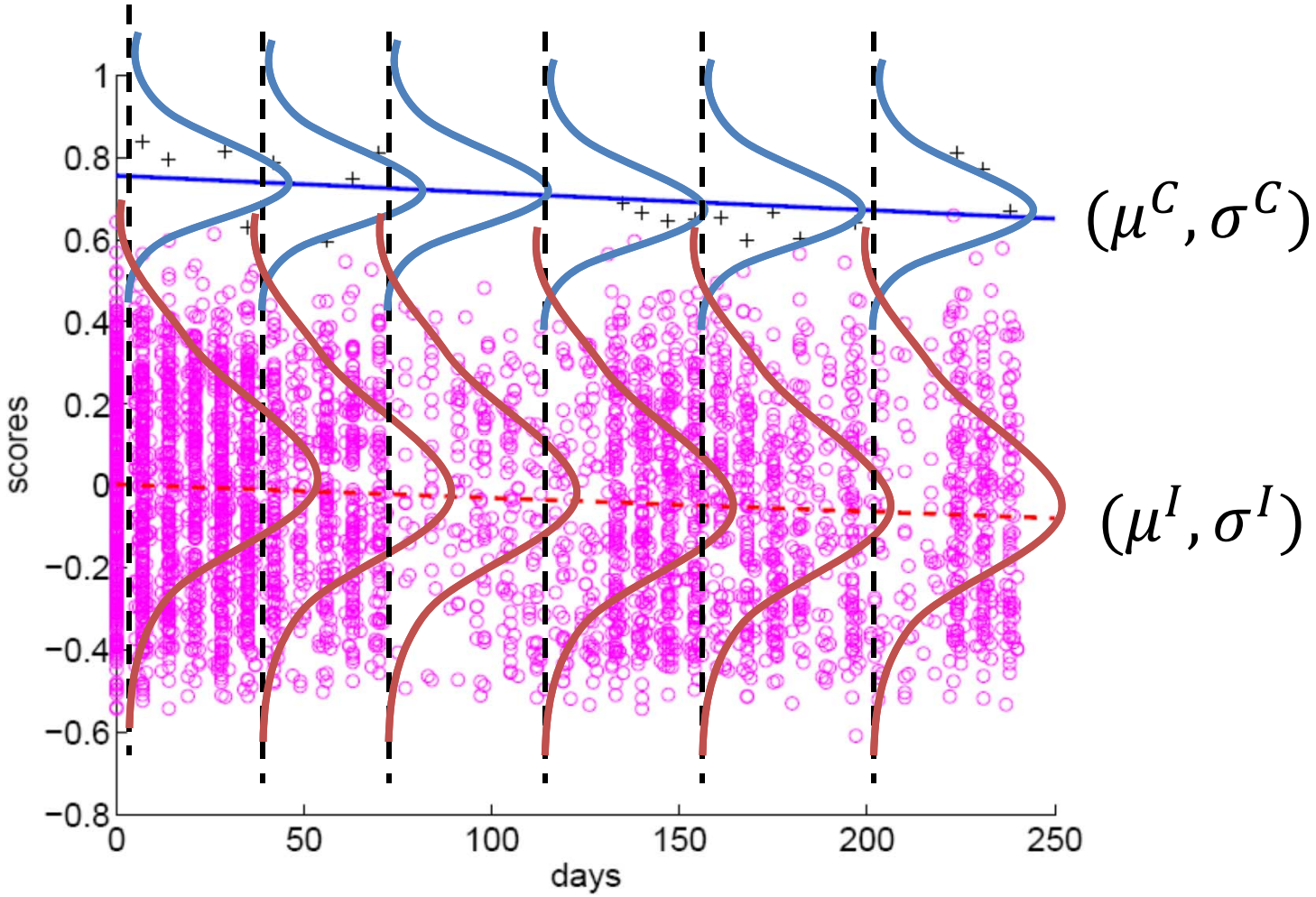
Subject-specific performance

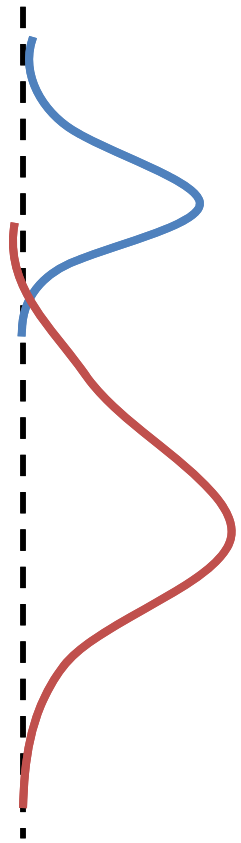
Parametric error model (sensitive to *minute* changes)

Rely on the smoothness assumption

regression




1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
scores
0
50
100
150
200
250
days
(μ^C, σ^C)
(μ^I, σ^I)



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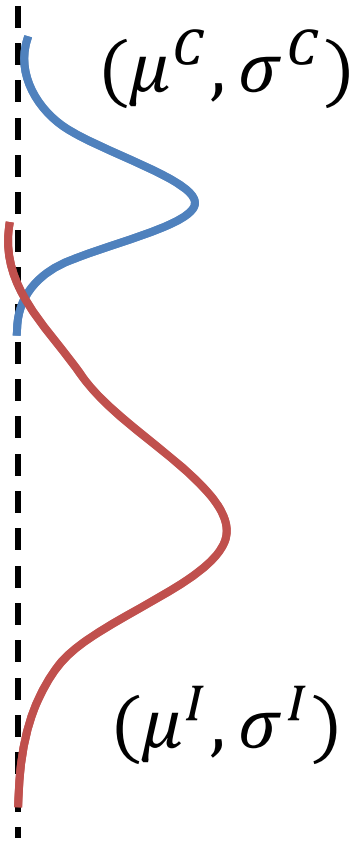
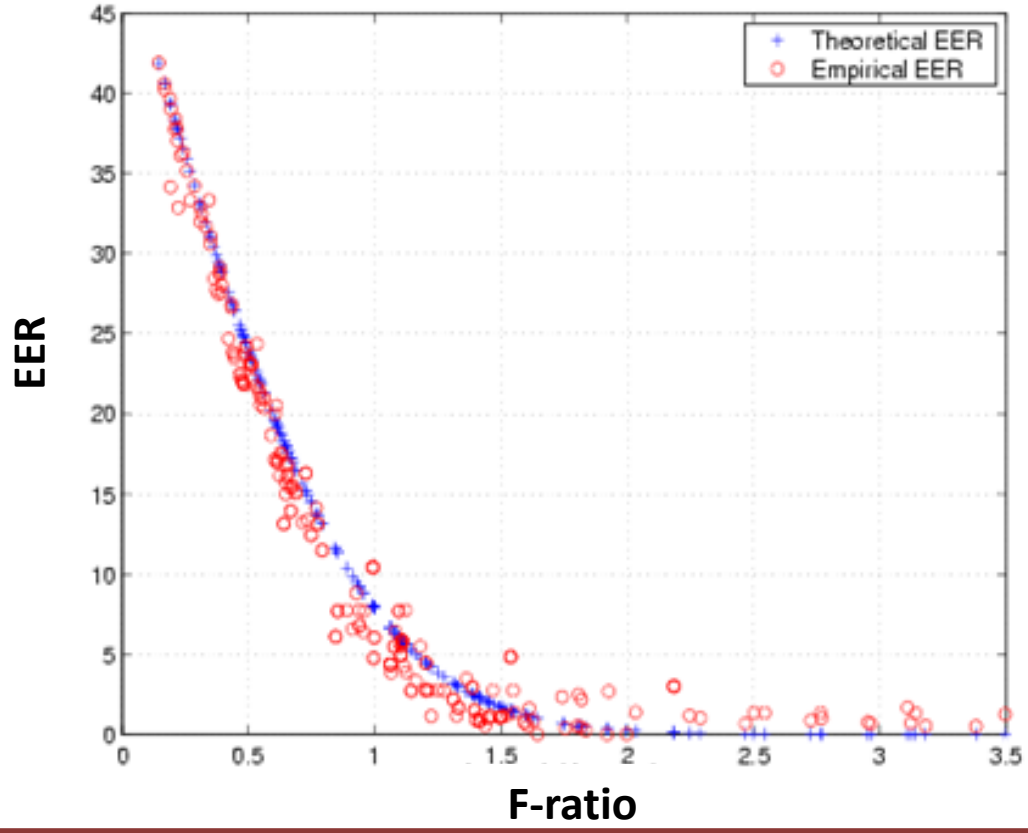
$$\text{F-ratio} = \frac{\mu^{\text{C}} - \mu^{\text{I}}}{\sigma^{\text{C}} + \sigma^{\text{I}}} \quad \Rightarrow \quad \text{EER} = \frac{1}{2} - \frac{1}{2}\text{erf}\left(\frac{\text{F-ratio}}{\sqrt{2}}\right)$$

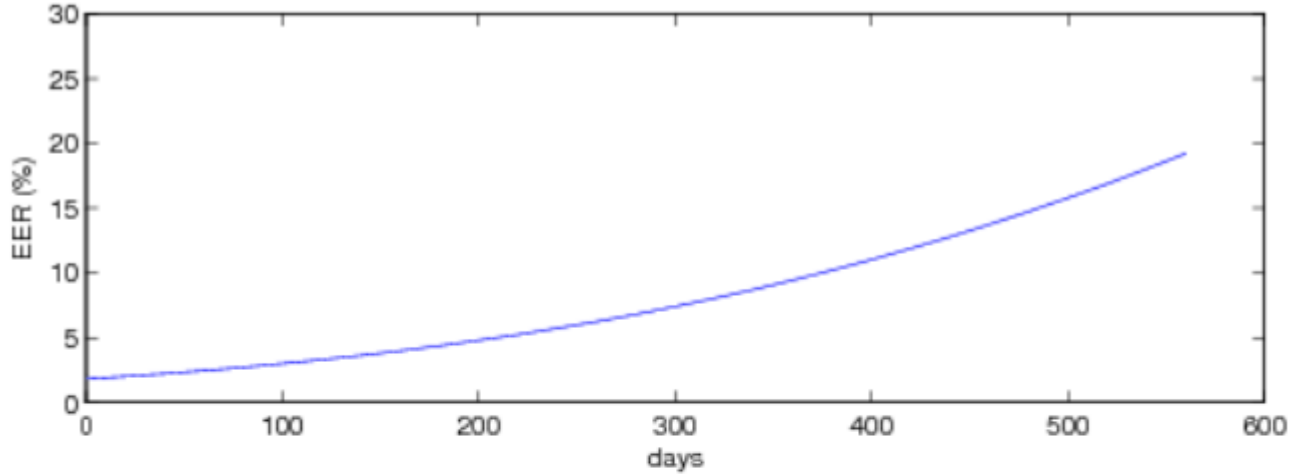
$$\text{erf}(z) = \frac{2}{\sqrt{\pi}} \int_0^z \exp\left[-x^2\right] dx$$



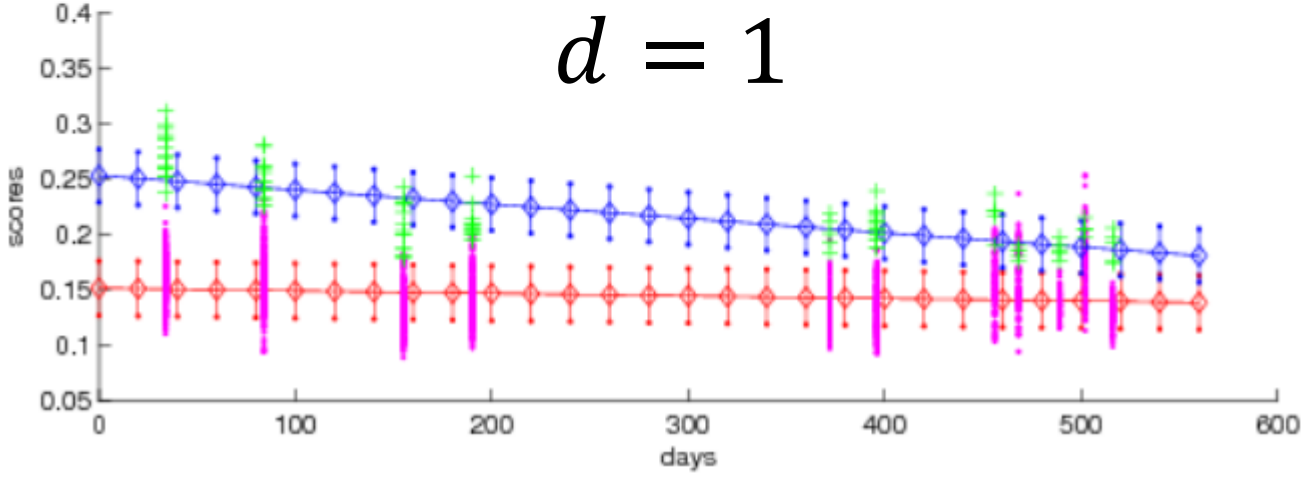


N. Poh and S. Bengio, **How Do Correlation and Variance of Base Classifiers Affect Fusion in Biometric Authentication Tasks?**, in IEEE Trans. on Signal Processing, Vol. 53(11), pages 4384-4396, Nov 2005

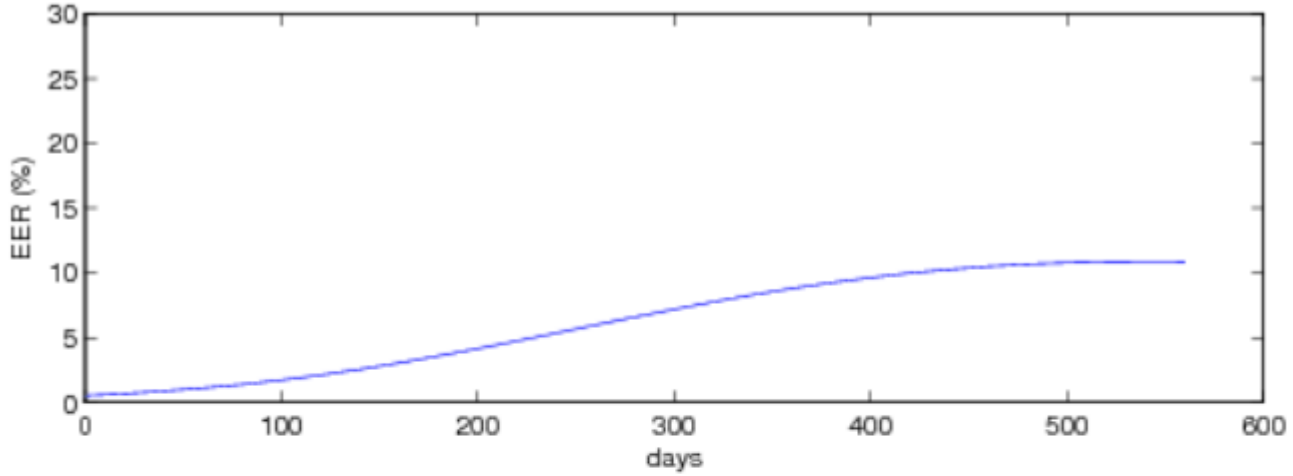
Polynomial regression



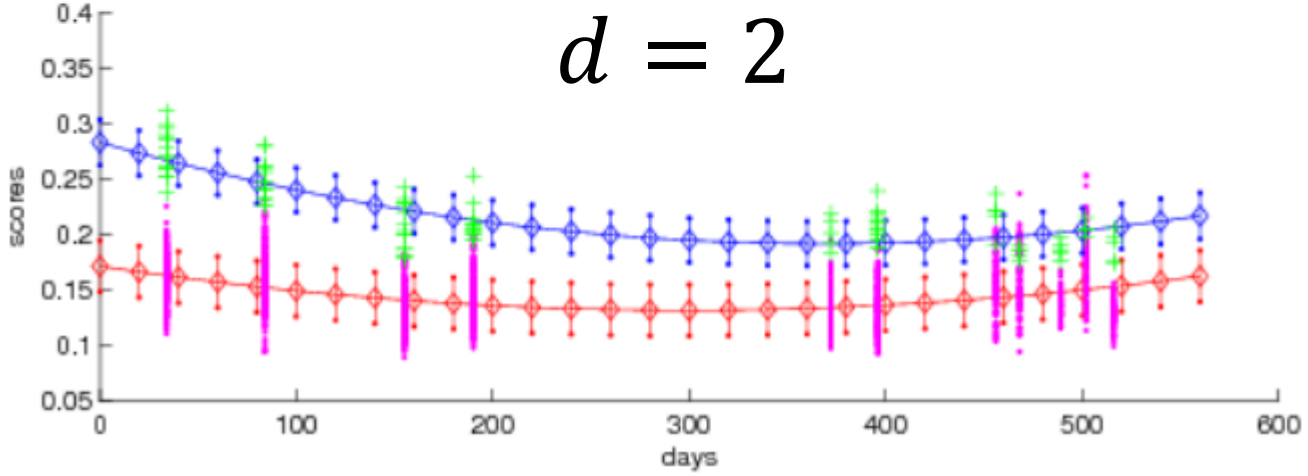
$d = 1$



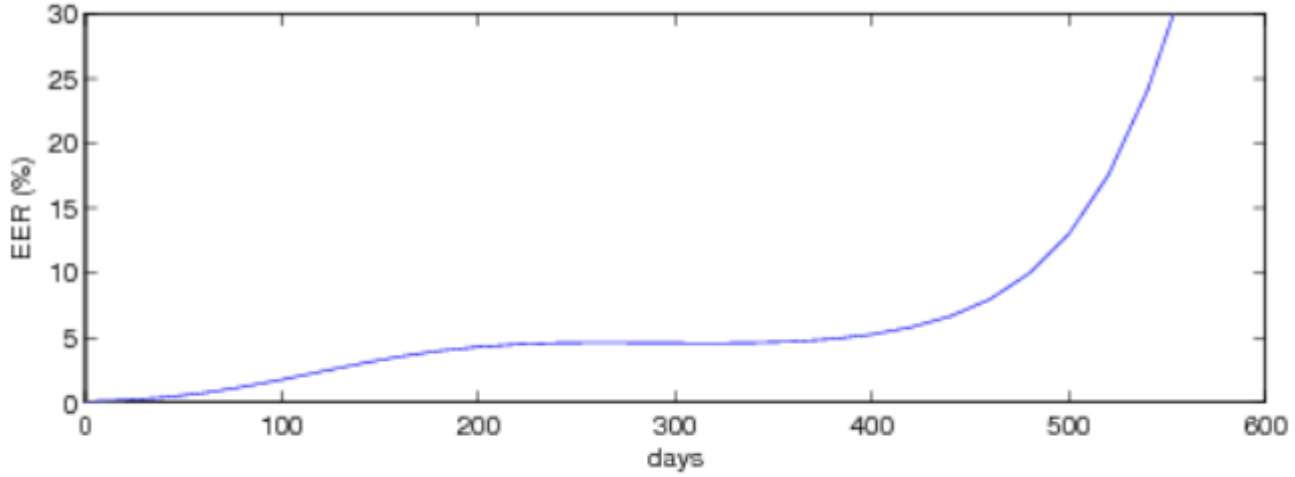
Polynomial regression



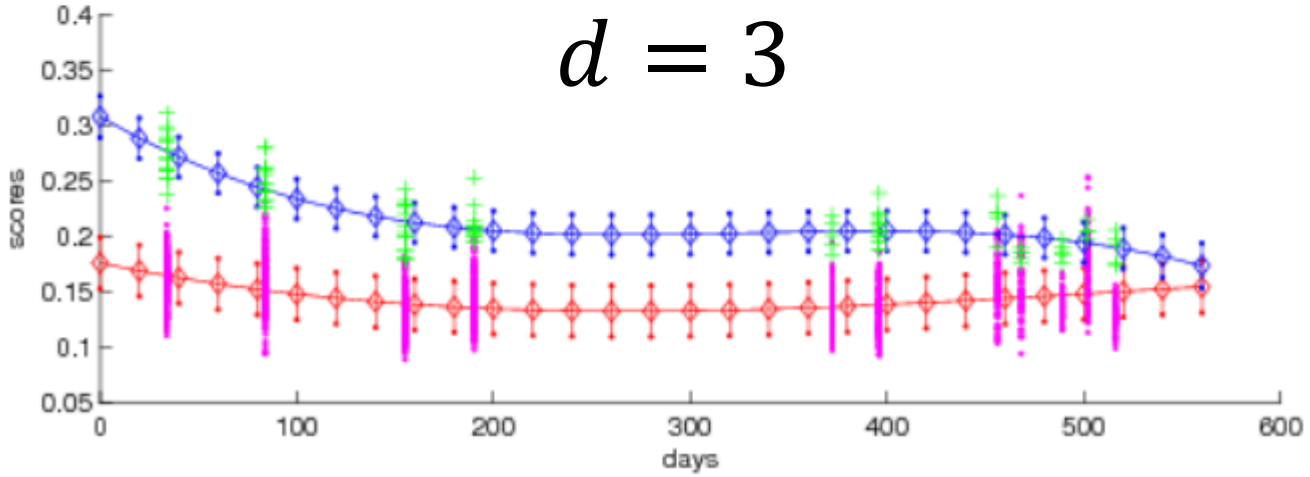
$d = 2$



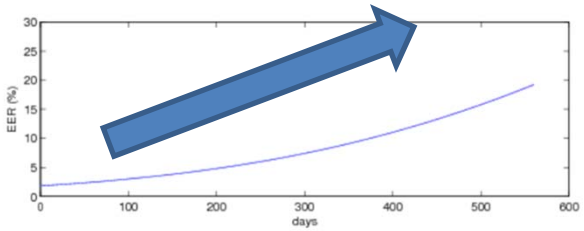
Polynomial regression

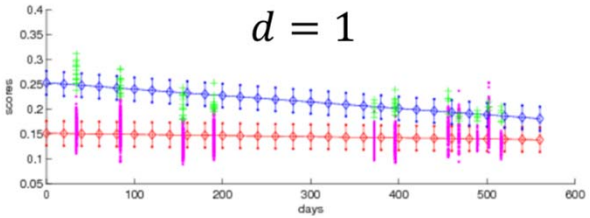


$d = 3$

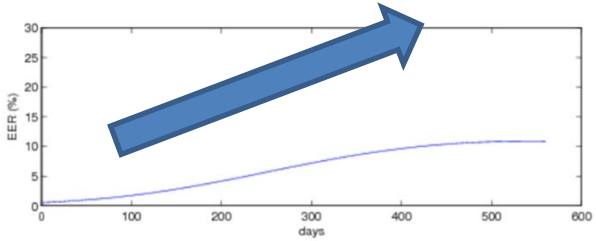


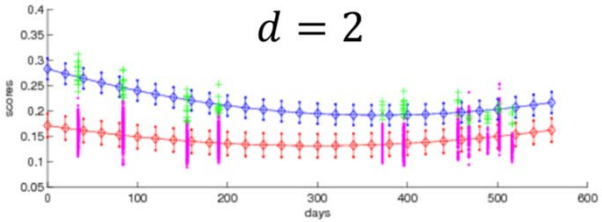
Detecting trends



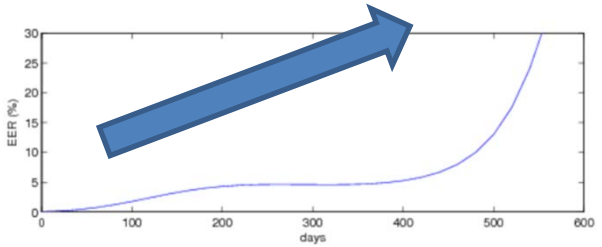


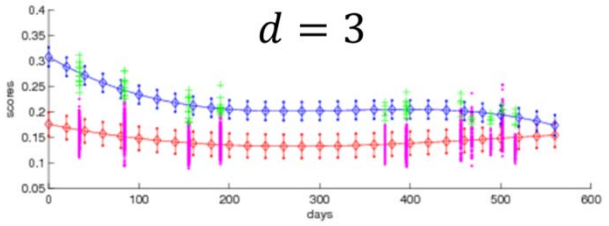
$d = 1$



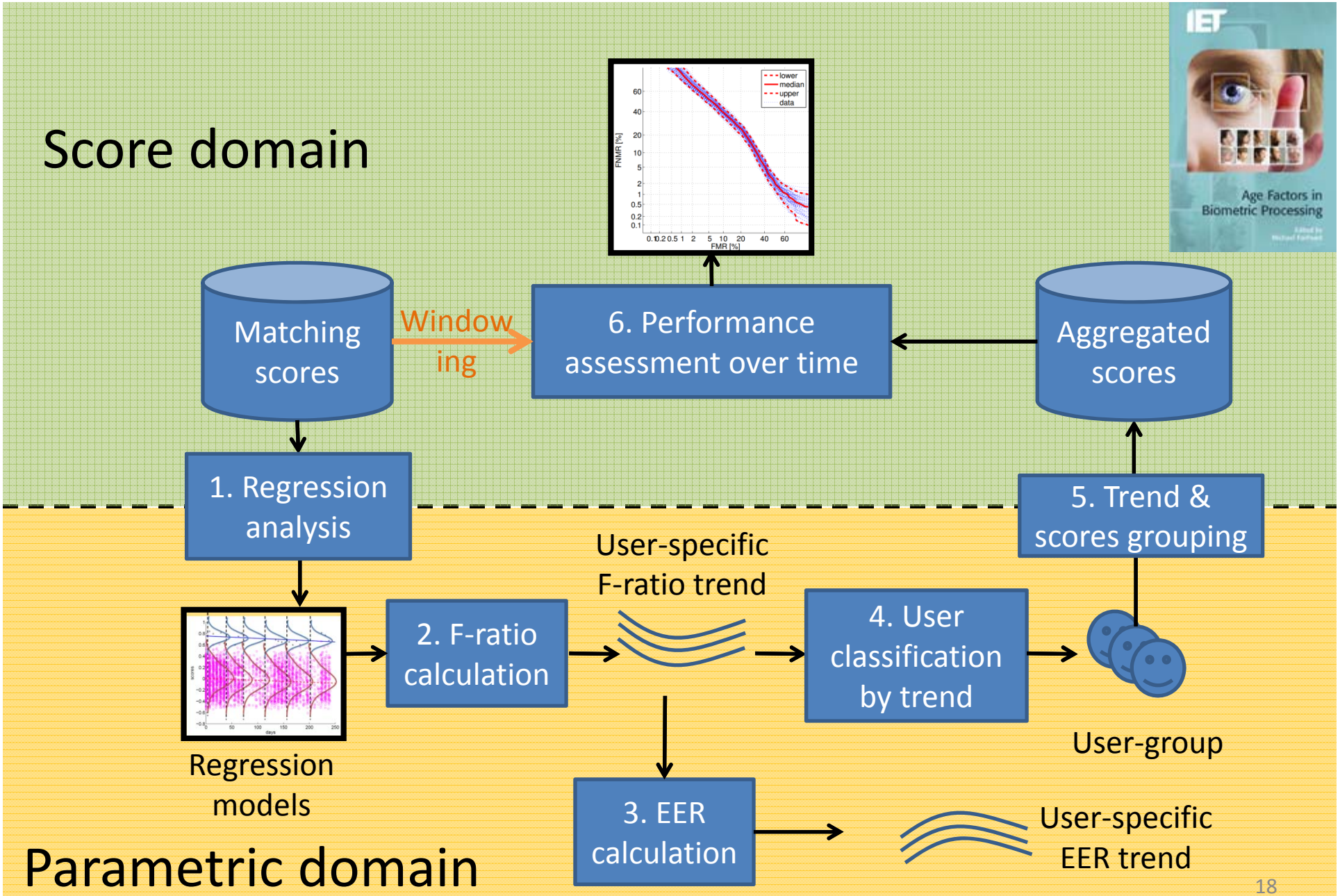


$d = 2$





$d = 3$



Poh et al, **An analysis of biometric performance change over time: a multimodal perspective**, Chapter 10, Age Factors in Biometric Processing, Michael Fairhurst (ed.) 2013.

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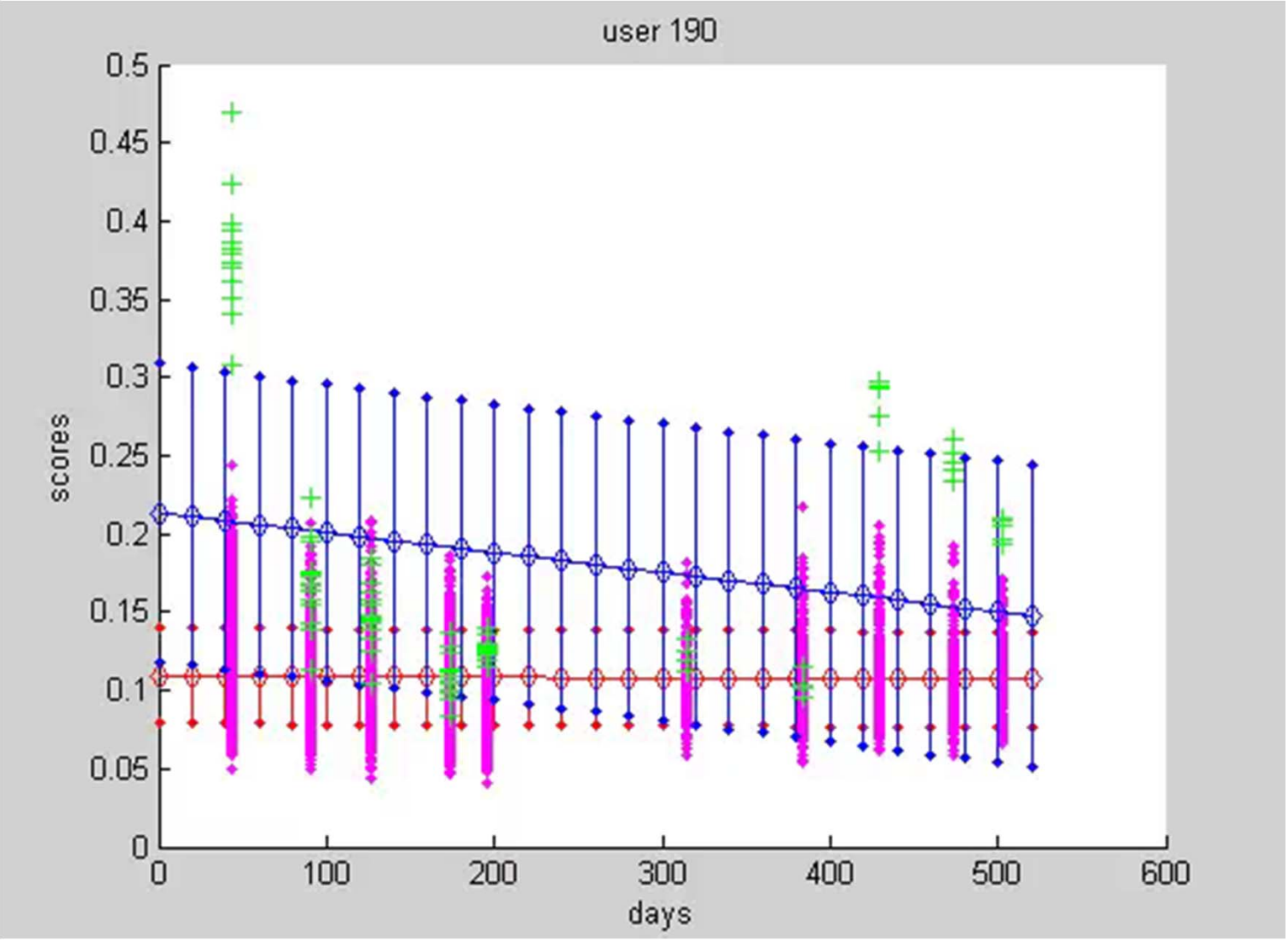

user 190
scores
days
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
100
200
300
400
500
600

Mobio Dataset

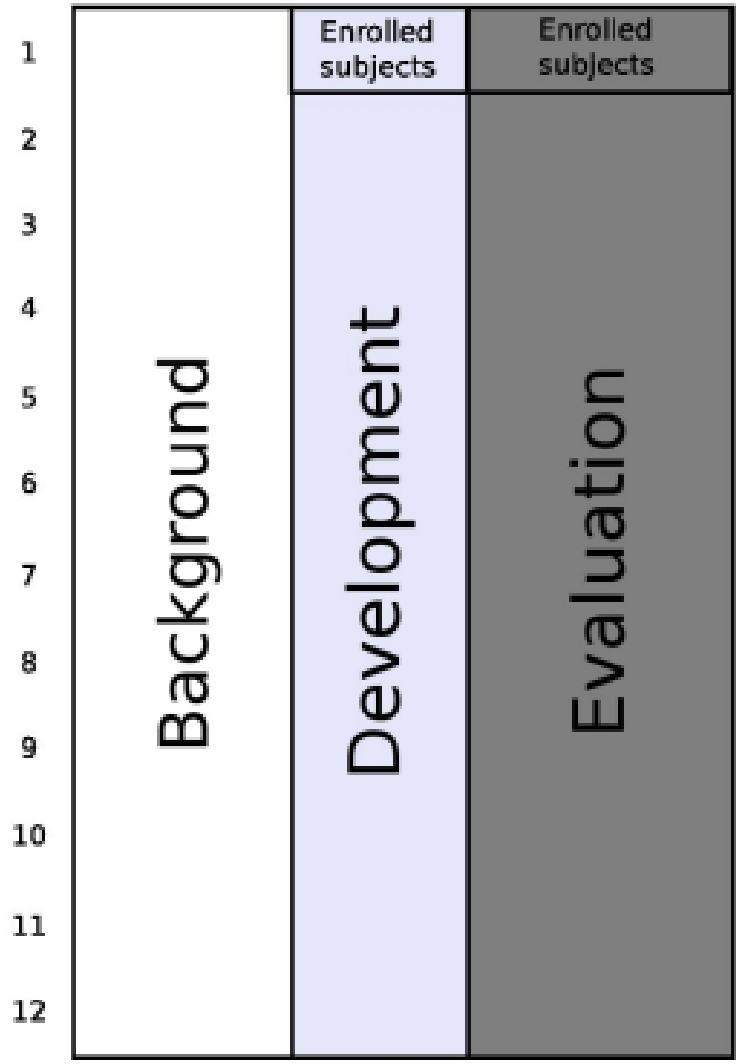
Population size	• 150 subjects (6 locations)
Samples per subject	• 192 videos
Device	• Nokia device
Days covered	• 500-600 days
Setting	• Office environment (unconstrained)

P. Tresadern, et al, **Mobile Biometrics: Combined Face and Voice Verification for a Mobile Platform**, Pervasive Computing, IEEE 12, no. 1 (2013): 79-87.

Dataset | Protocols | Classifiers | Results

Dataset | Protocols | Classifiers | Results

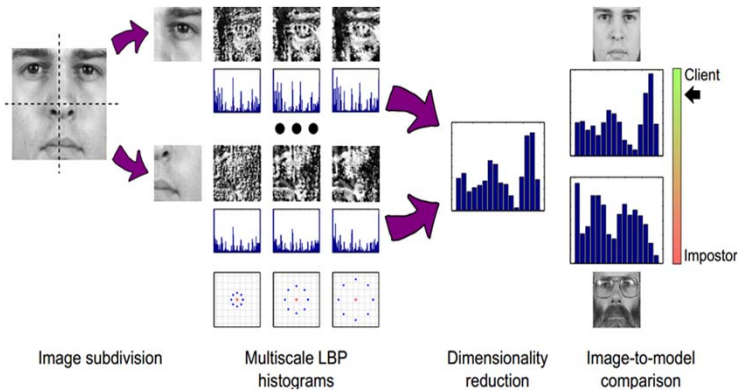
Sessions



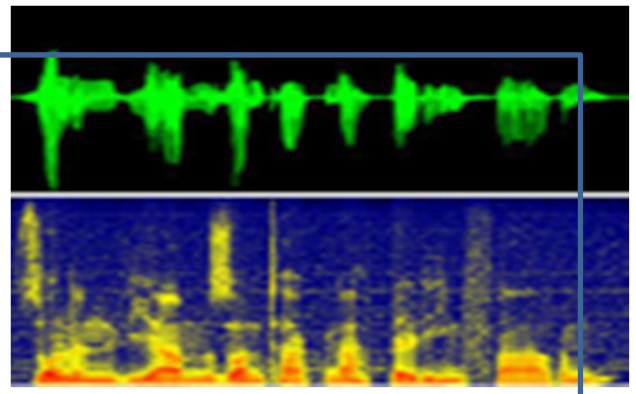
To train PCA, UBM

For tuning classifier parameters

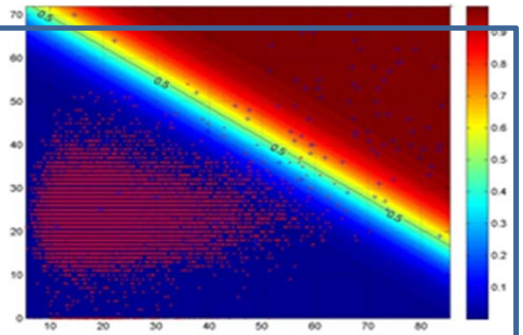
For measuring performance



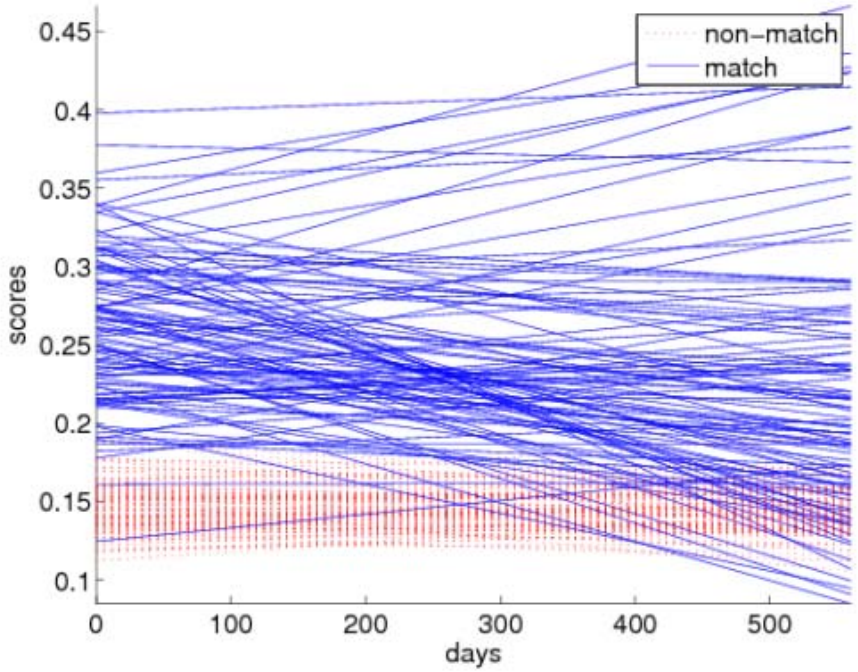
Face – LBP & LPQ

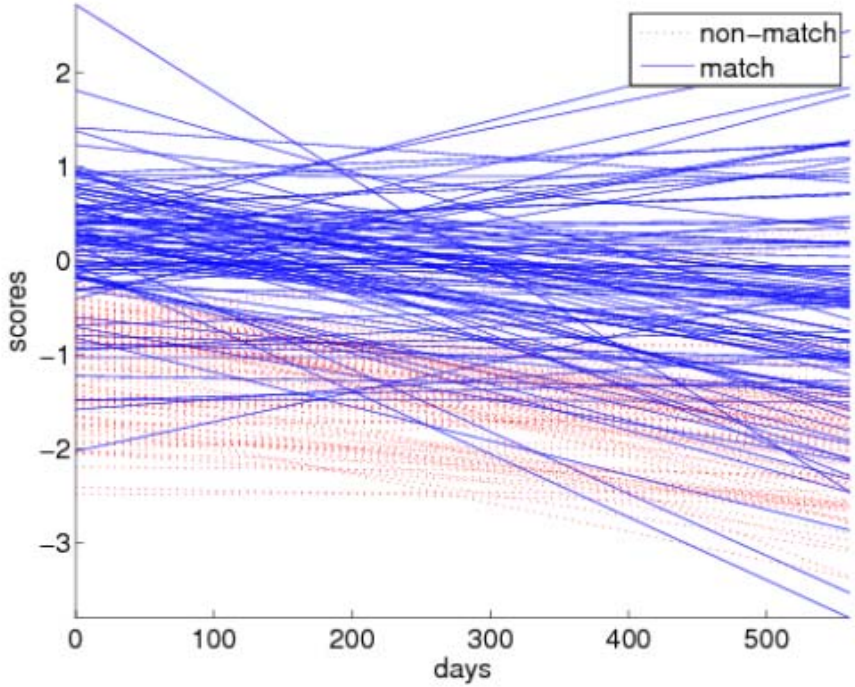


Speech – GMM



Fusion – logistic regression



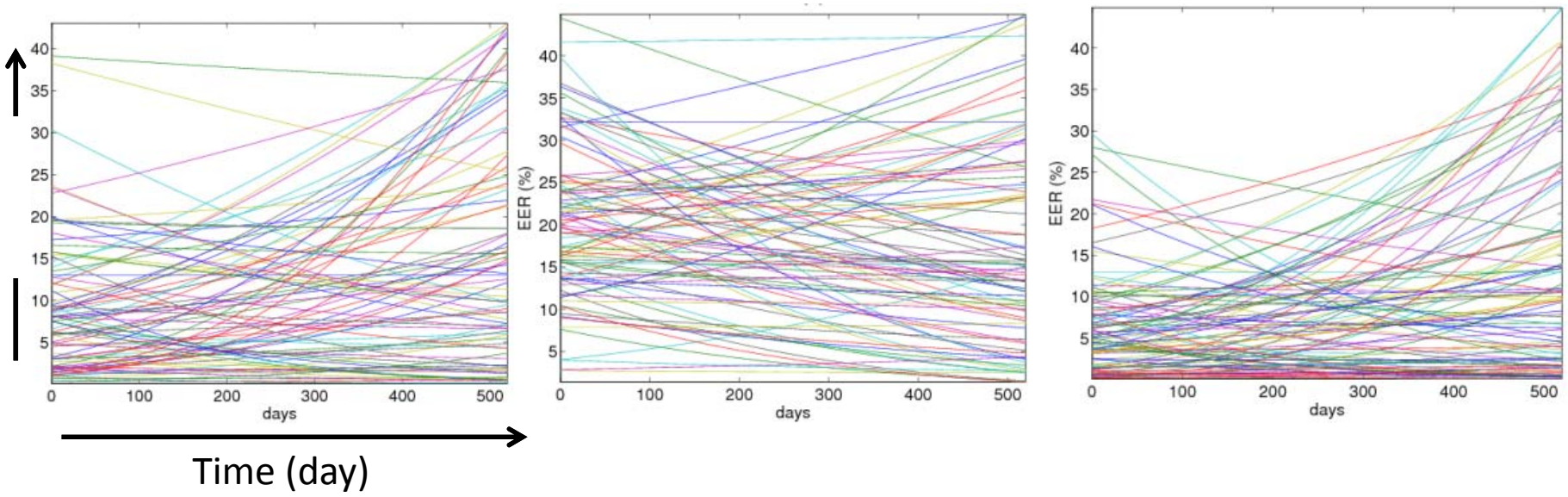


Face1: MLBP

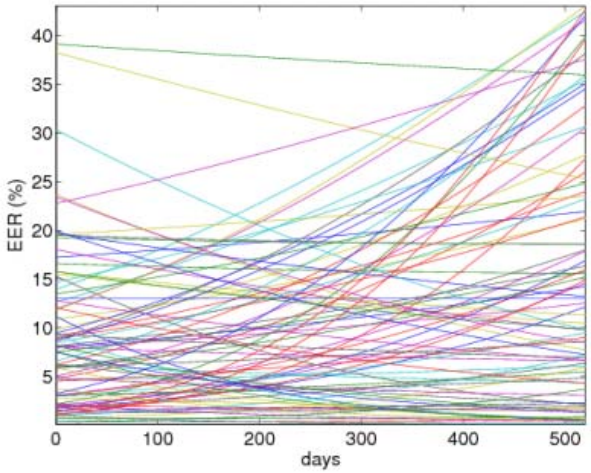
Speech (GMM)

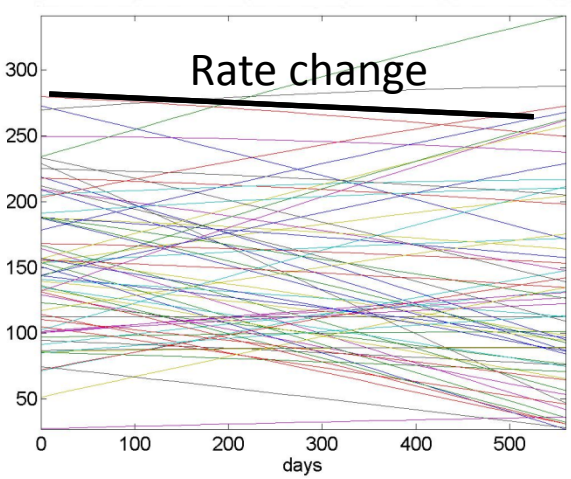
(Similar for Face2: MLPQ)

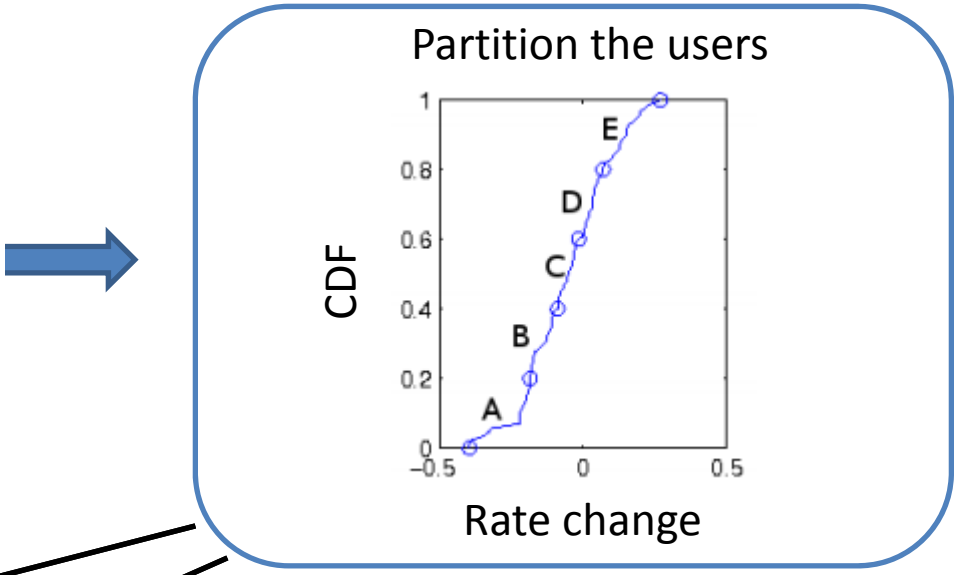
Dataset > Protocol > Classifiers > Results

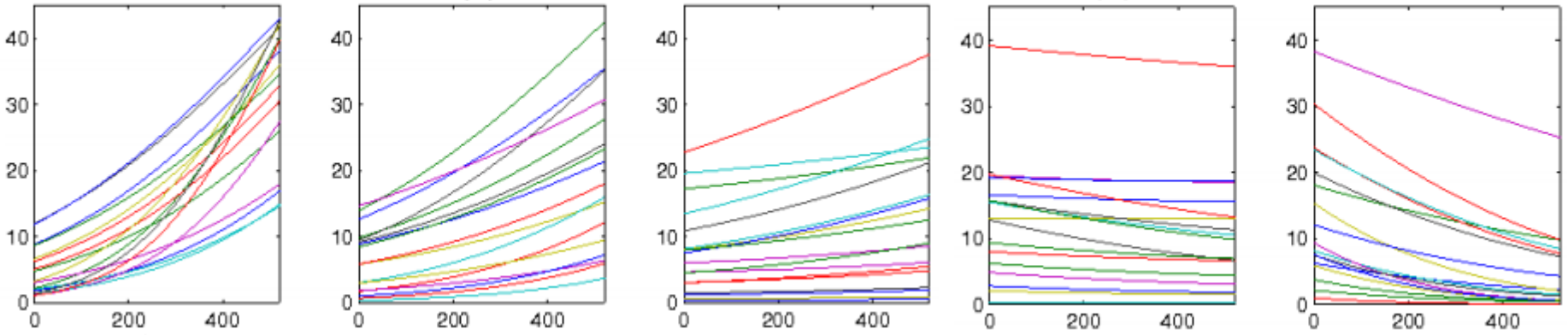


Face1 Speech Face1+Face2+Speech

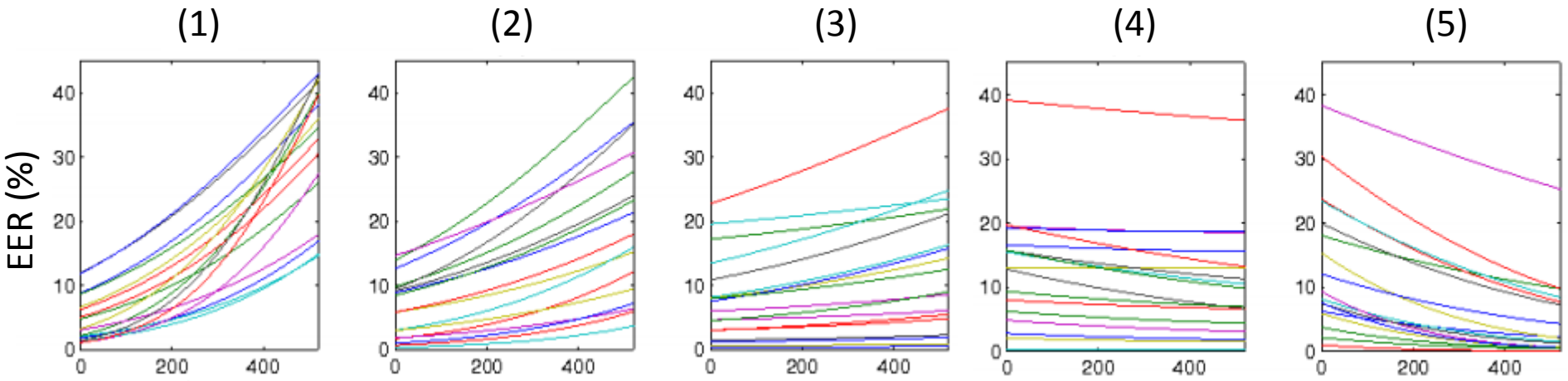

EER (%)
40
35
30
25
20
15
10
5
0
100
200
300
400
500
days


Rate change
300
250
200
150
100
50
0
100
200
300
400
500
days

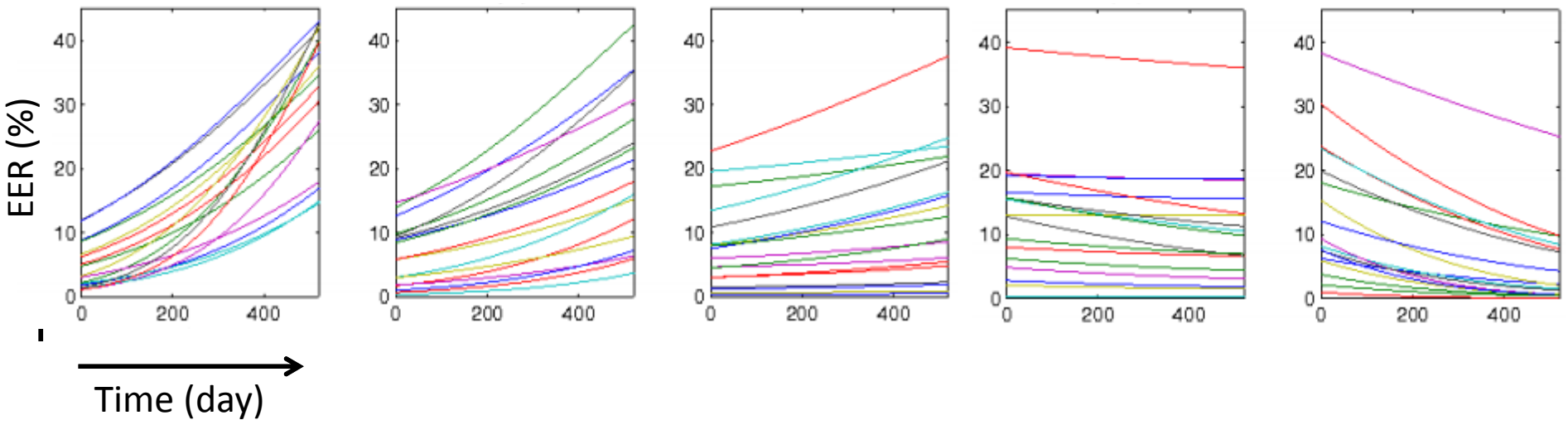

Partition the users
CDF
1
0.8
0.6
0.4
0.2
0
−0.5
0
0.5
A
B
C
D
E
Rate change


40
30
20
10
0
0
200
400

Dataset > Protocol > Classifiers > **Results**

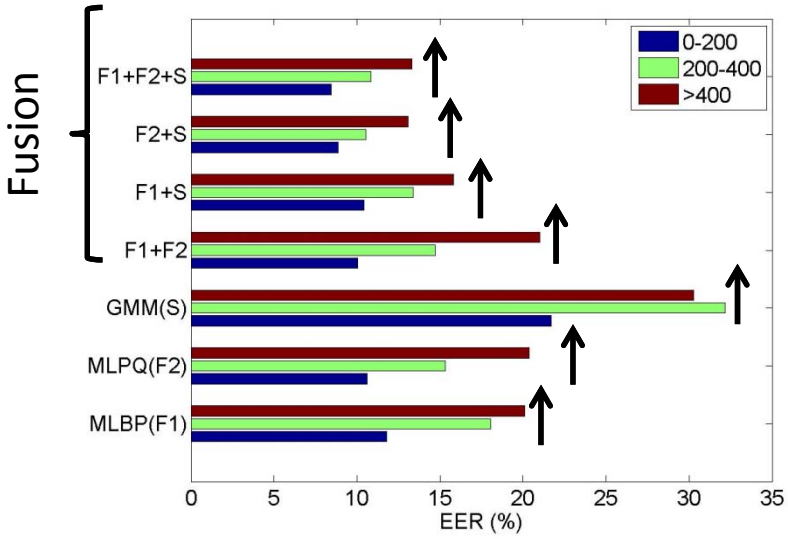


Dataset | Protocol | Classifiers | Results



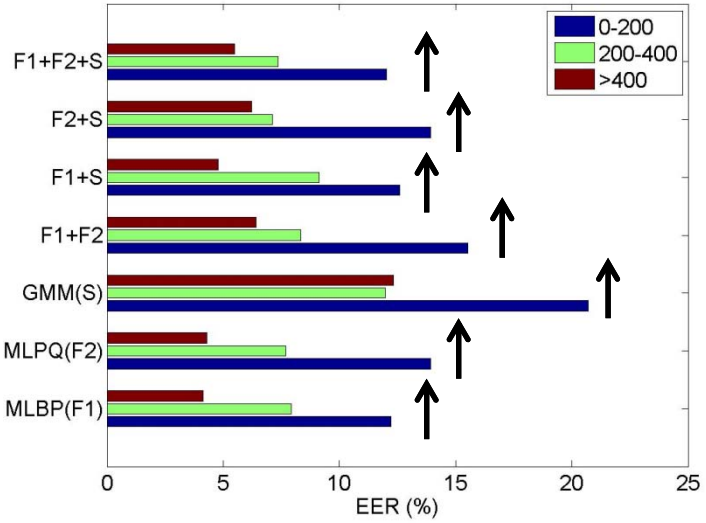
Dataset | Protocol | Classifiers | Results

(1)



Getting worse

(5)

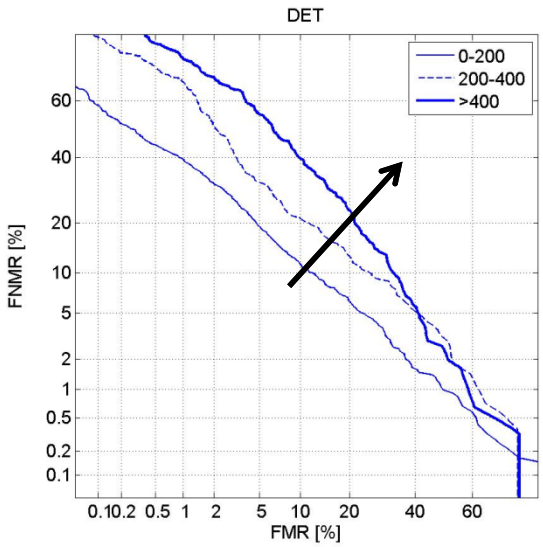


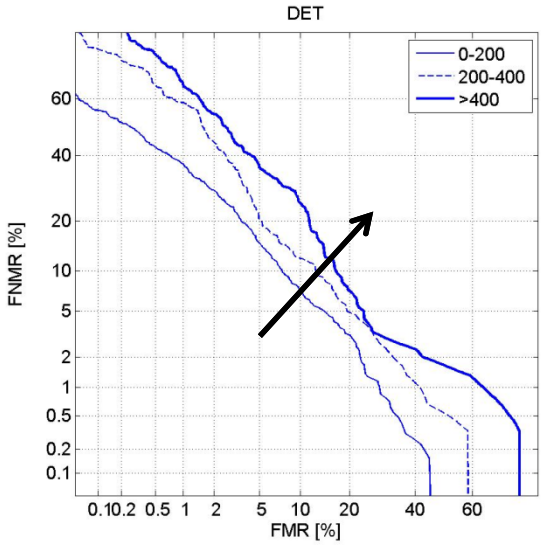
Getting better

Face (MLPQ)

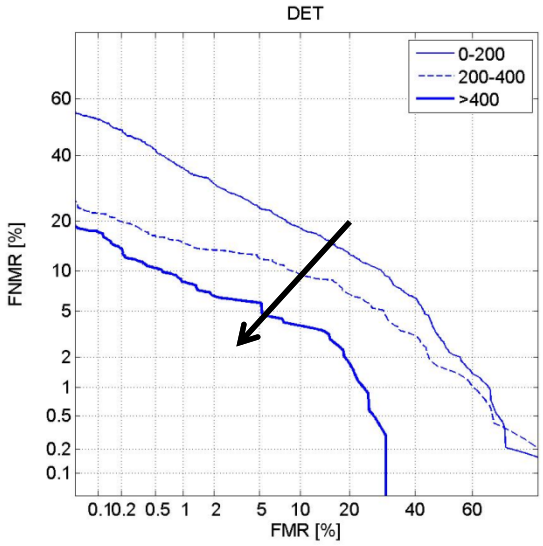
Face 1 +
Face 2 +
Speech

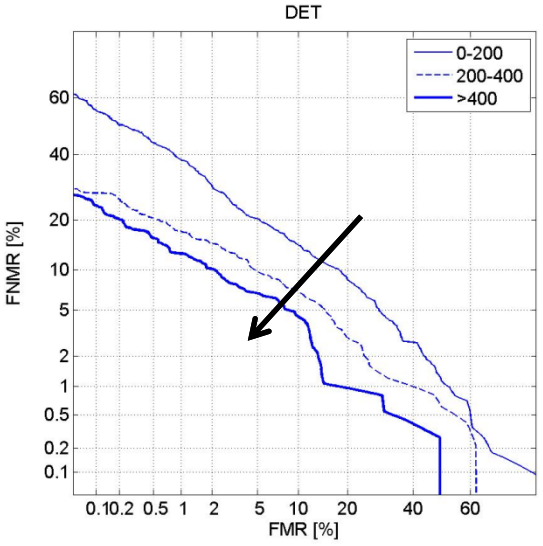
Partition 1 (getting worse)



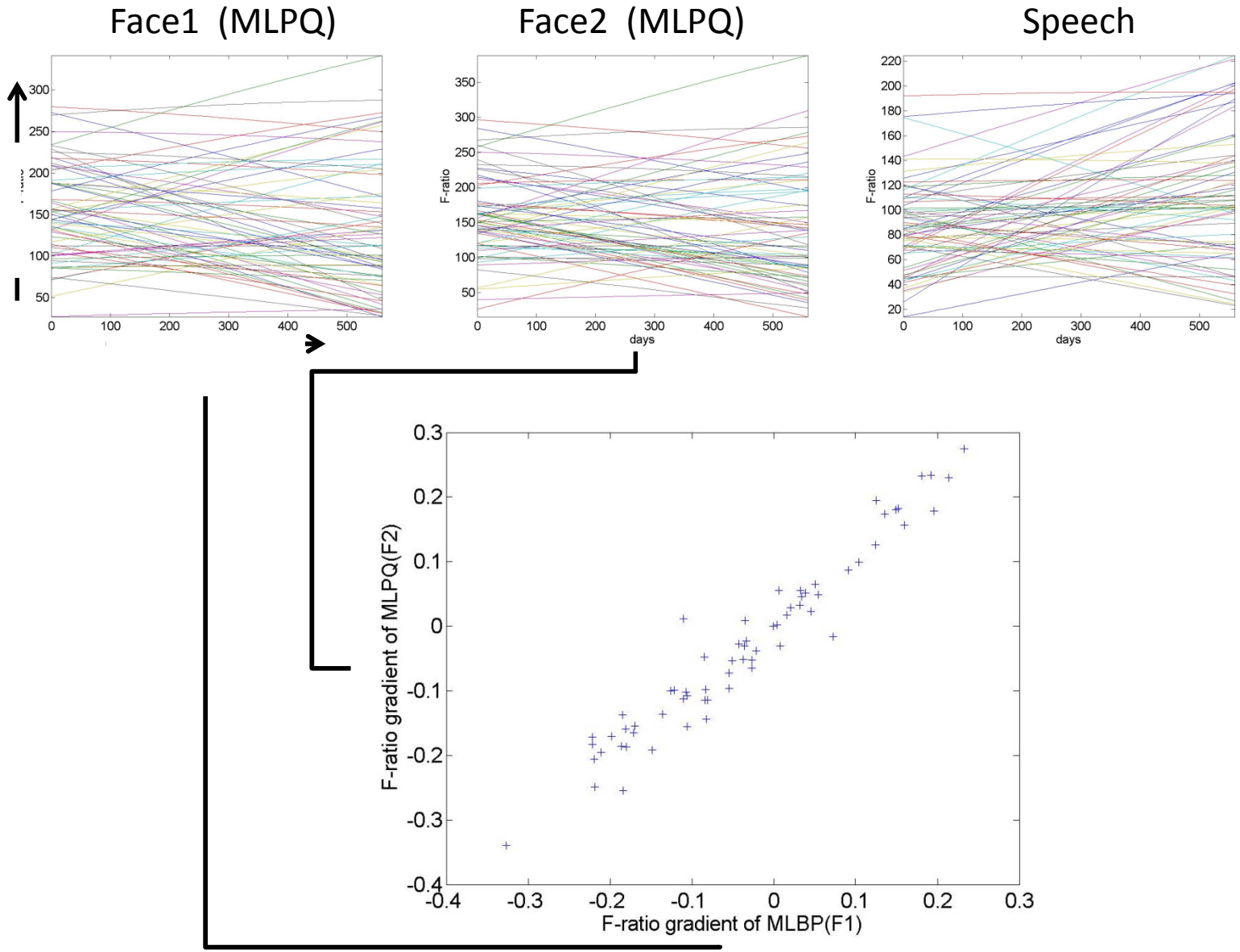


Partition 5 (getting better)

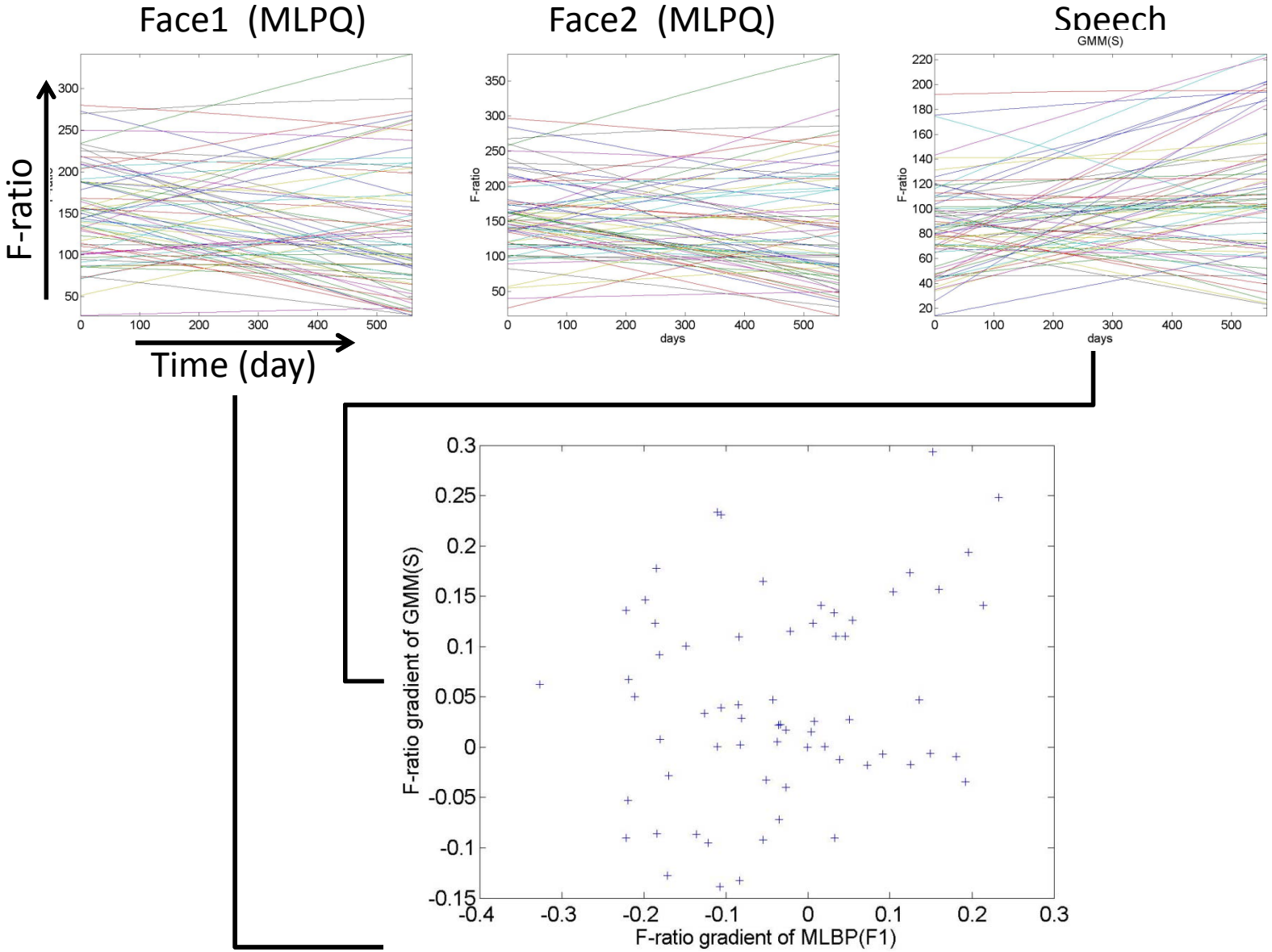




Modality correlation in ageing?



Modality correlation in ageing?



Conclusions

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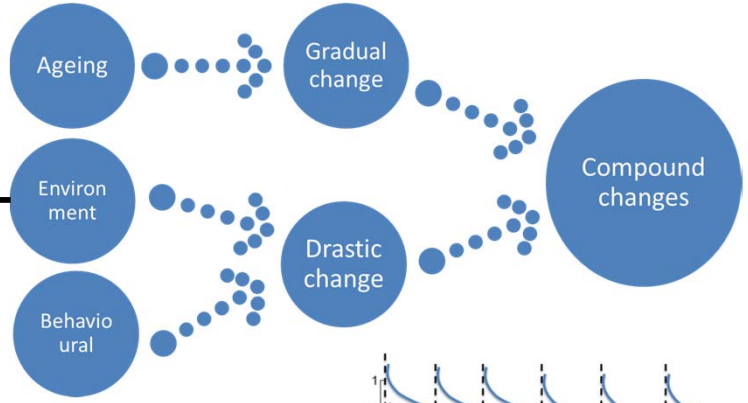
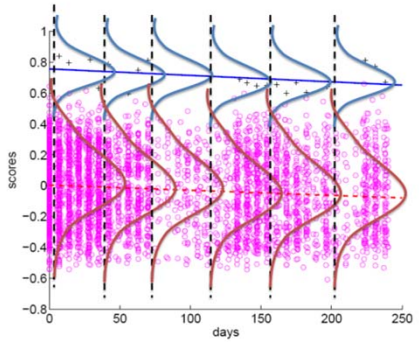
Ageing

- Complex issue



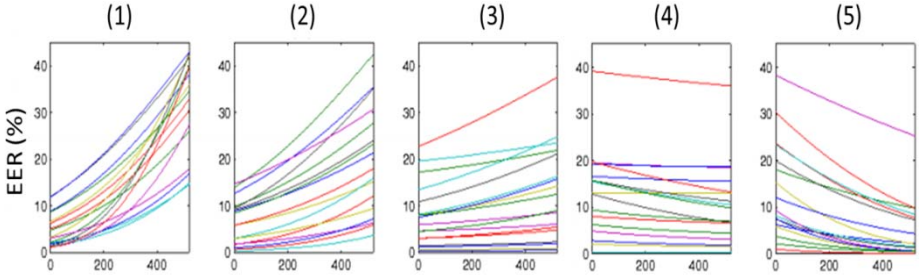
Contribution

- A framework to detect ageing



Findings

- Ageing and habituation
- Subject-dependency



Questions?

Email to n.poh@surrey.ac.uk

Thanks to the MOBIO project and partners
Chan Chi Ho, Medha Pandit, Josef Kittler
IBPC conference and special session

Ageing

- Complex issue

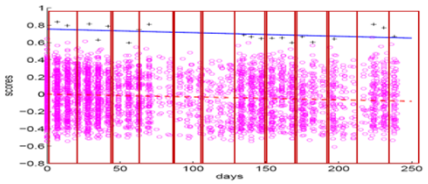
Contribution

- A tool to detect ageing

Findings

- Ageing and habituation
- Subject-dependency

windowing



Cannot model subject-specific performance

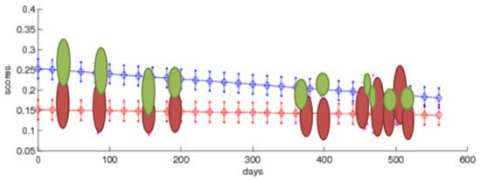
Vulnerable to sparse observations & discontinuities

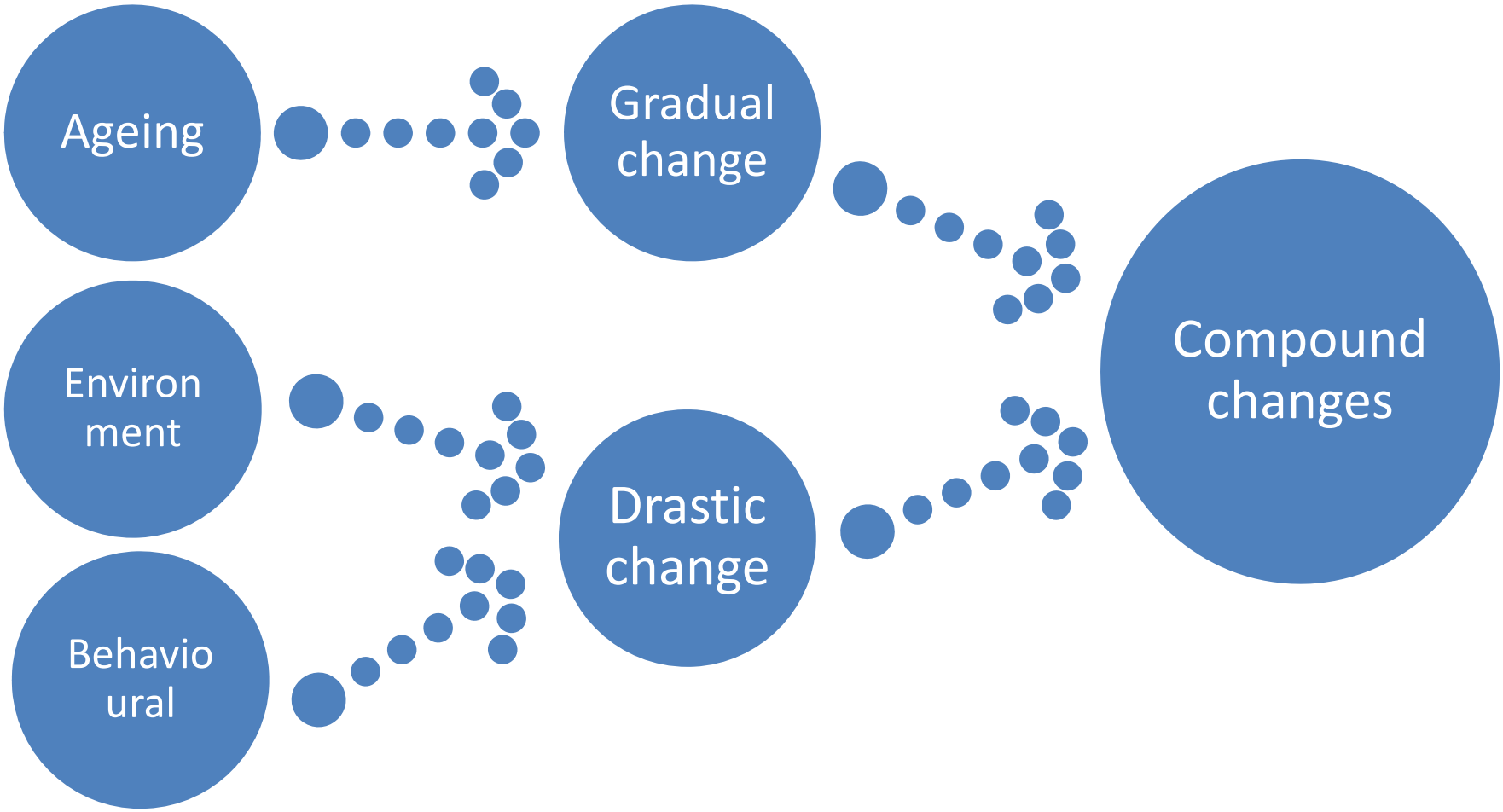
Rely on smoothness assumptions

Subject-specific performance

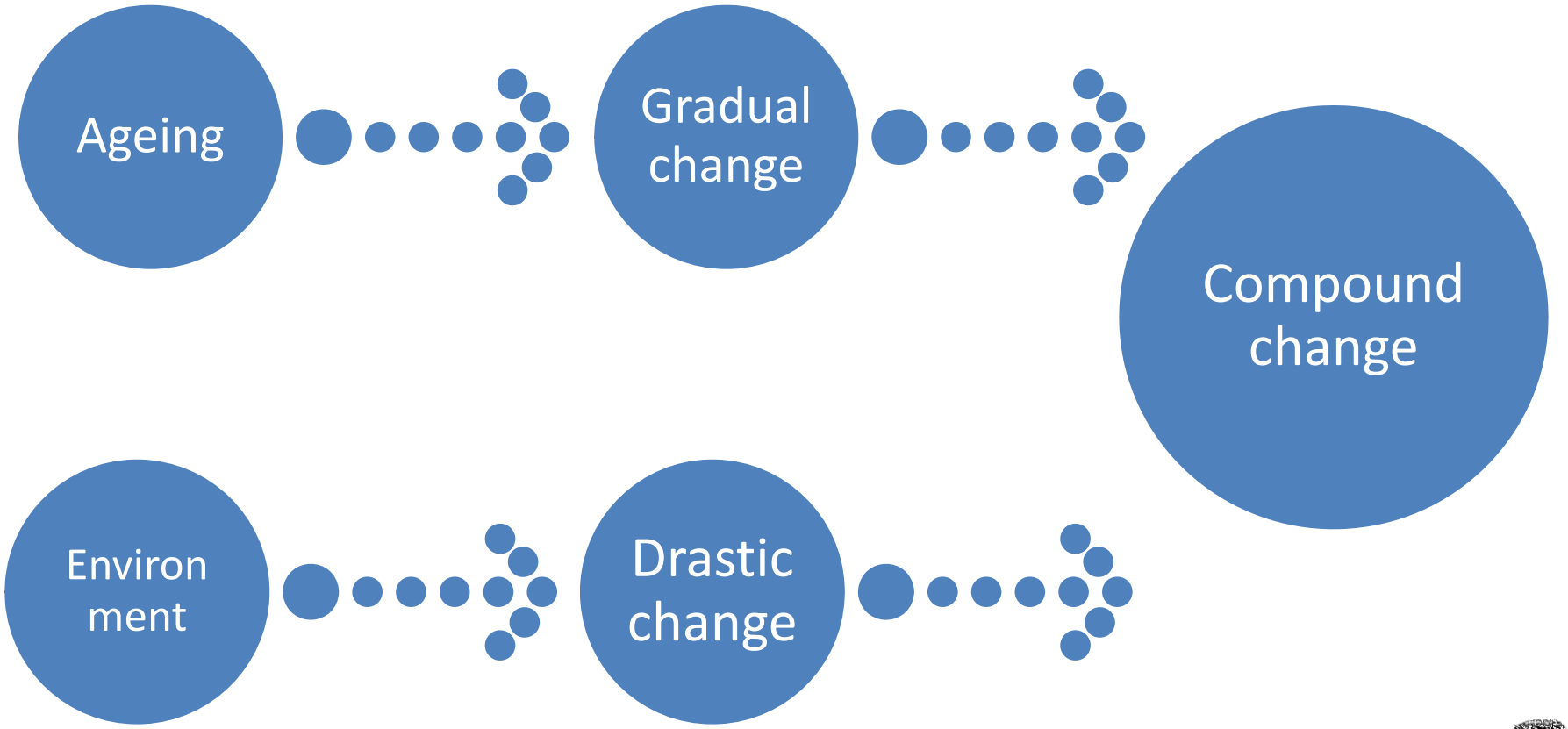
Parametric error model (sensitive to *minute* changes)

regression




Ageing
Environ ment
Behavio ural
Gradual change
Drastic change
Compound changes

Ageing


Ageing
Gradual change
Compound change
Environ ment
Drastic change