Measuring Dependencies between Biological Signals with Self-supervision, and its Limitations

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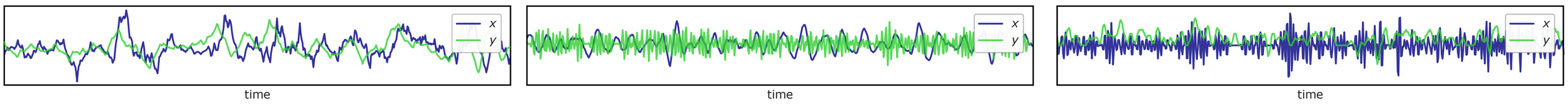
QUIZ for you: Which time series pairs below are statistically **dependent**?



*for the Answer, Link the capital Letters in this sentence

Failure to detect **dependence** ⟹ ***Missed*** **Scientific Discovery.**

- **Statistical dependence** is for scientific discoveries—it uncovers the complex between various types of processes
- Existing methods **cannot** detect arbitrary (unknown) **non-linear dependencies**, which are typical in biological sciences.

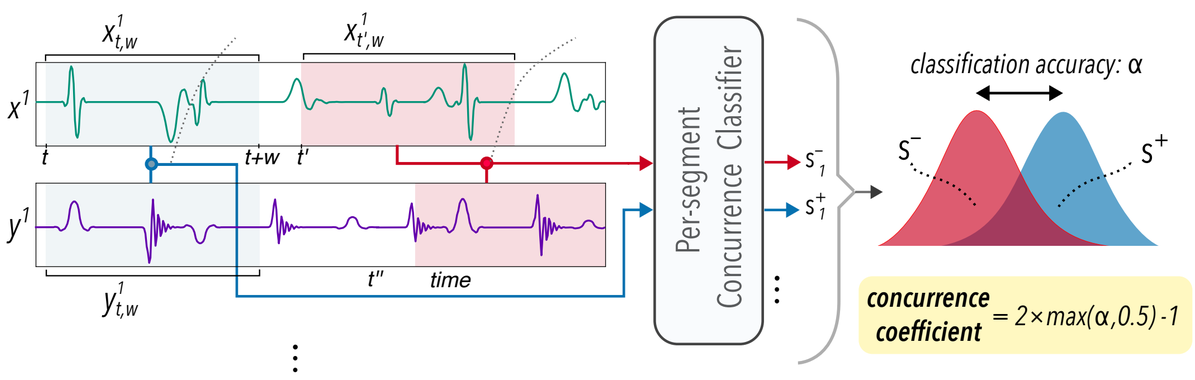
Concurrence: The most generic dependence metric to our knowledge.

- Bounded between 0 and 1 — Easy interpretation
- Theoretically linked with dependence
- Detects wide range of dependencies with ***no ad-hoc modification***

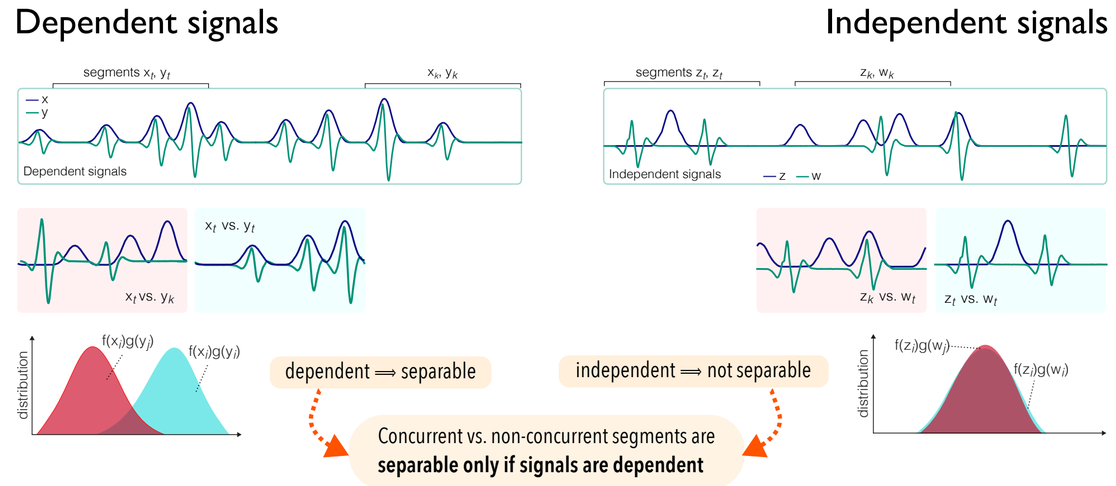
- **Its code works out-of-the-box** with single- or multi-dimensional signals:
  - Brain (fMRI)
  - Physiological
  - Behavioral

Concurrence—What does it measure?

Concurrence is the degree to which a classifier can separate concurrent segments vs. misaligned segments

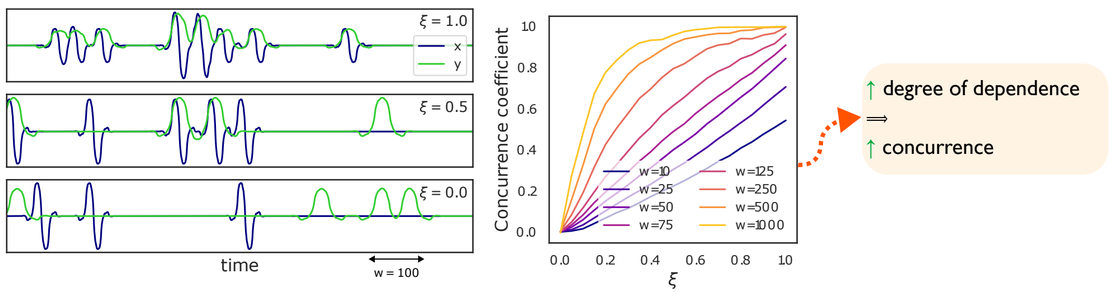


Why does it work?



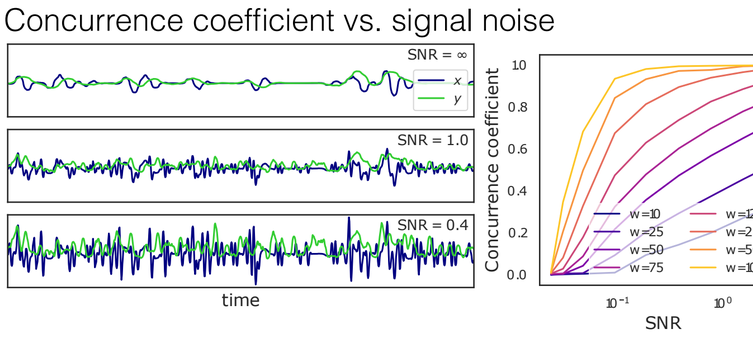
Experiments—Synthetic data

Concurrence coefficient ∝ degree of dependence



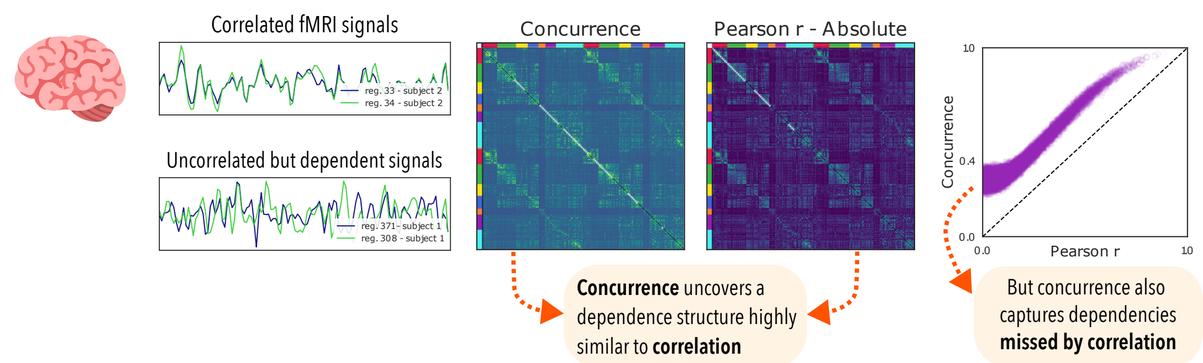
↑ degree of dependence
⟹
↑ concurrence

Concurrence coefficient vs. signal noise



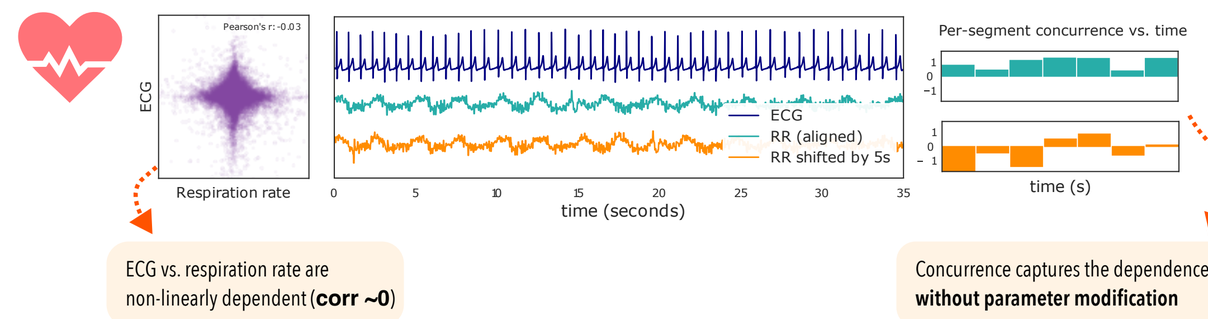
Concurrence works even with a SNR of 0.1

Experiments—Real signals



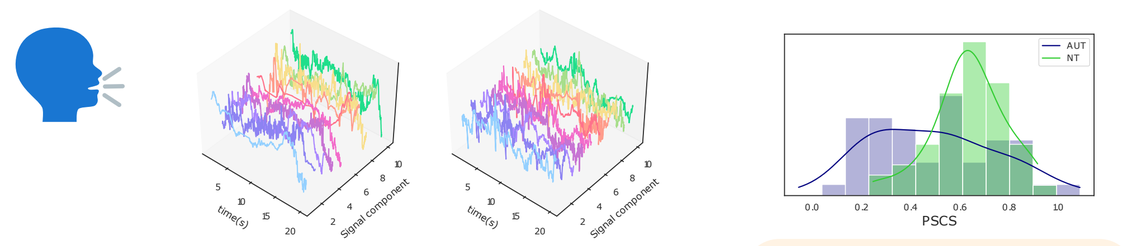
Concurrence uncovers a dependence structure highly similar to **correlation**

But concurrence also captures dependencies **missed by correlation**



ECG vs. respiration rate are non-linearly dependent (**corr ~0**)

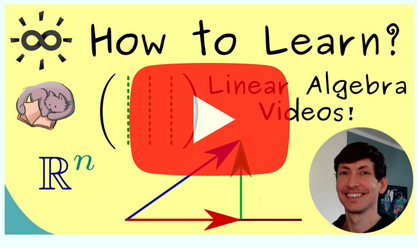
Concurrence captures the dependence **without parameter modification**



The same concurrence model works with **multi-dimensional** behavior signals

Captures **clinically meaningful differences**: NT participants have > behavioral coordination than participants with autism

Scan QR for video explanation



code → github.com/sariyanidi/concurrence