Lecture 4: Video Applications

Topological Time Series Analysis - Theory And Practice

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7/21/2016

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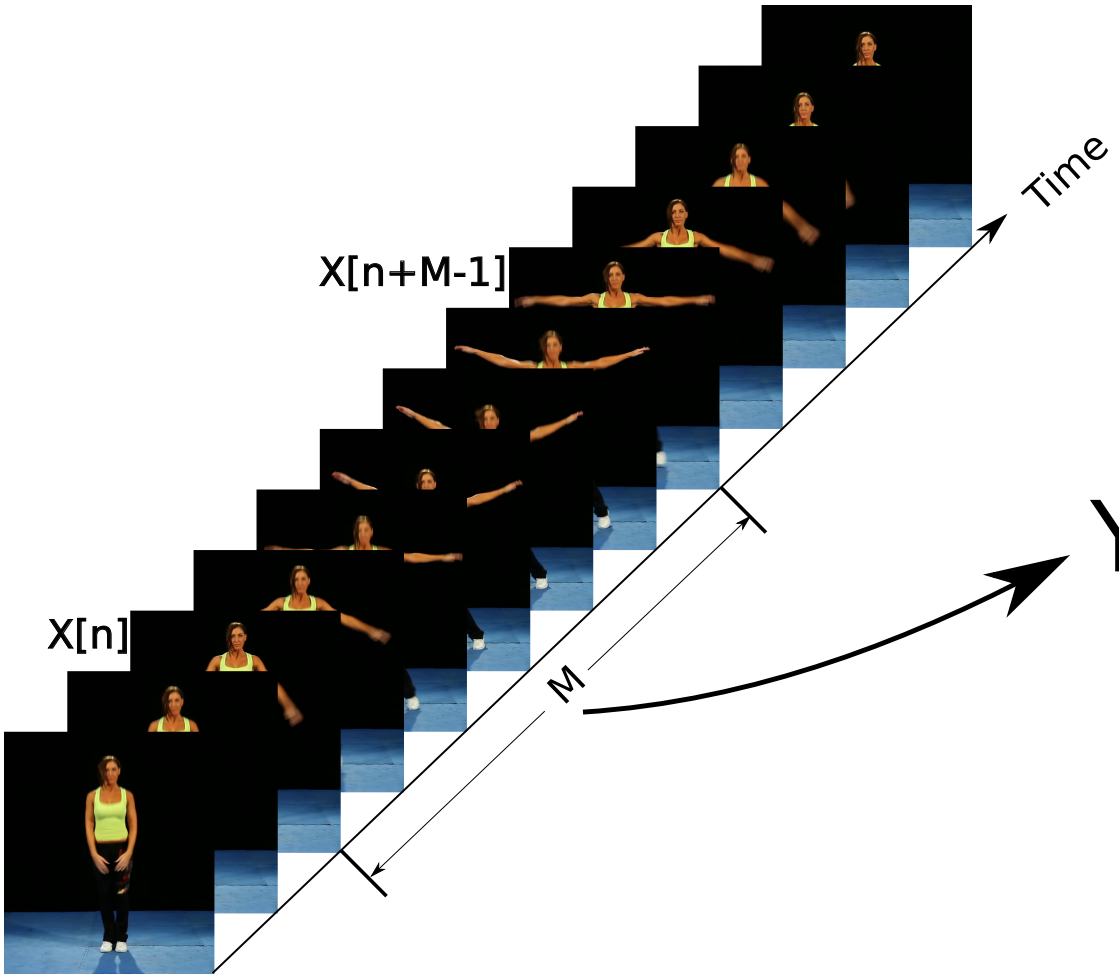
Sliding Window Videos



$$Y[n] = \begin{bmatrix} X[n] \\ X[n+1] \\ X[n+2] \\ \vdots \\ X[n+M-1] \end{bmatrix}$$

http://www.ctralie.com/Research/SlidingWindowVideo-SOCG2016/

Examples

Jumping jacks, heartbeat animation, my neck

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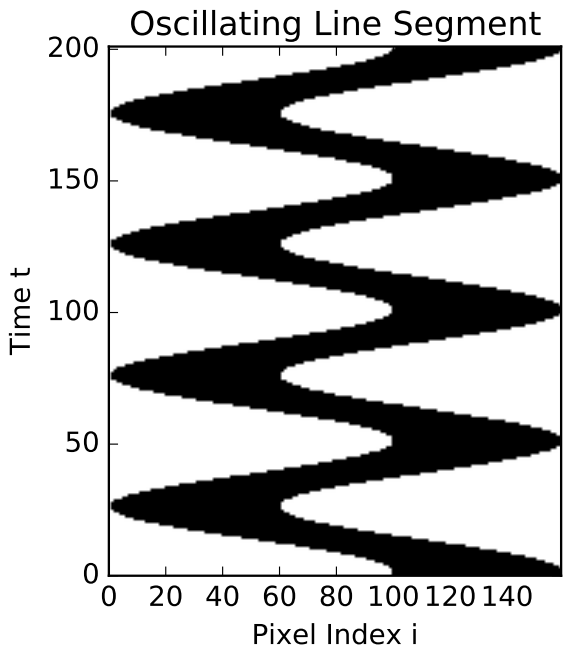
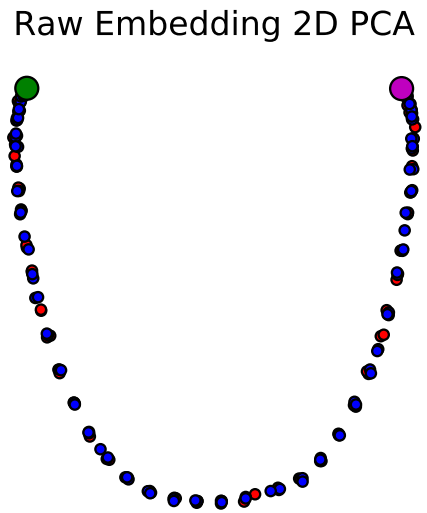
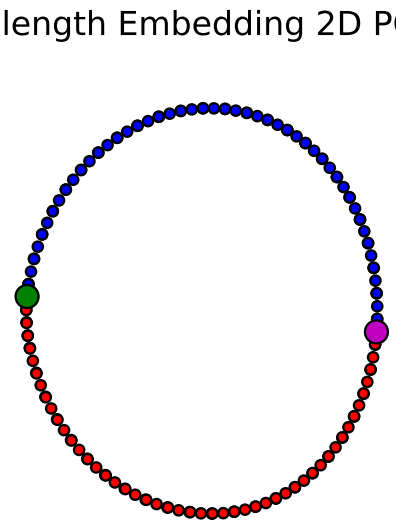
Pure Cosine Composition Model

On the board

Oscillating Line Segment

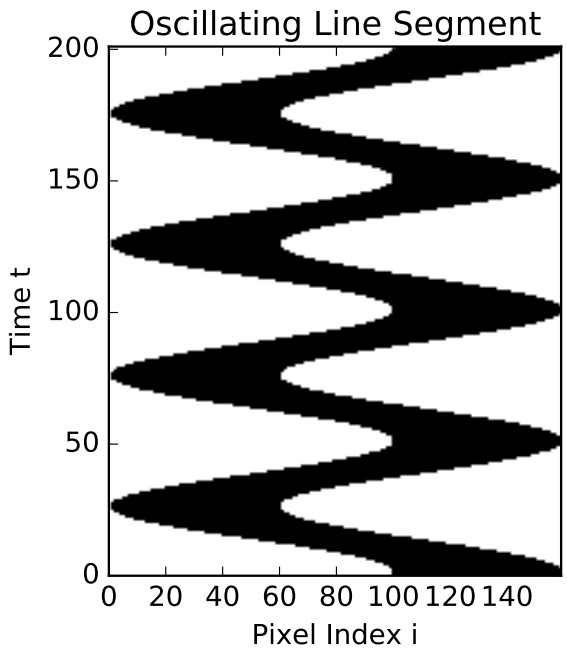


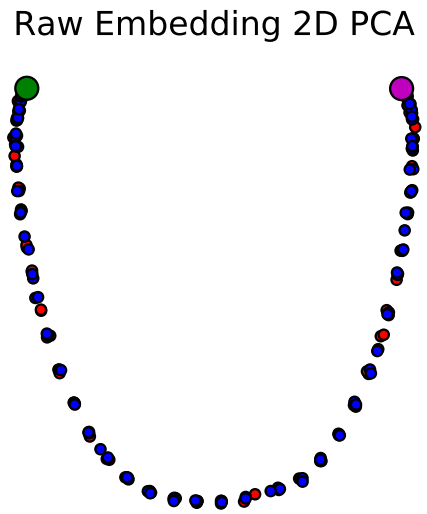


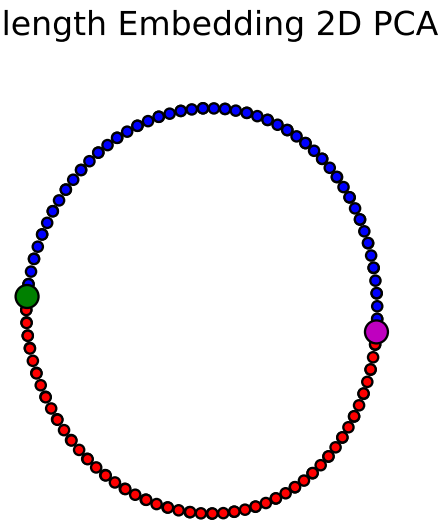


- Good Toy Example for Natural Video
- 2 questions

Oscillating Line Segment

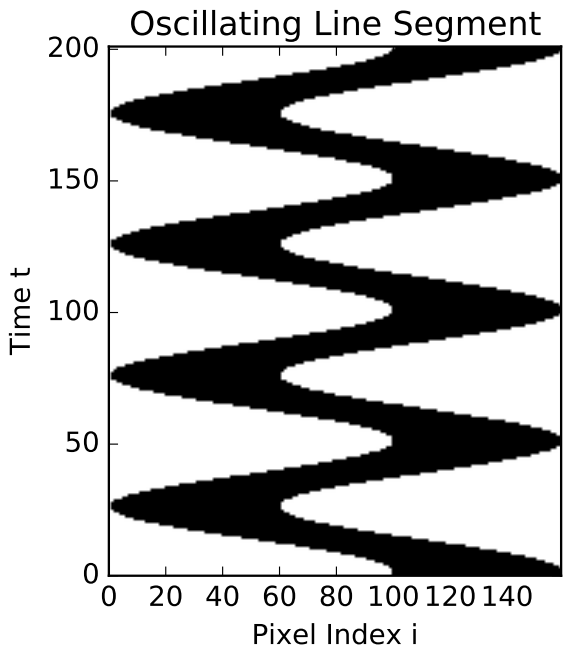


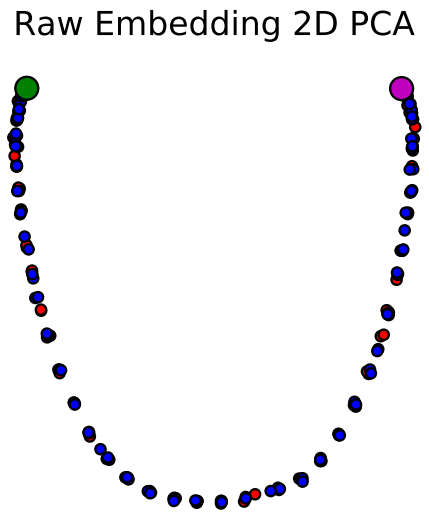


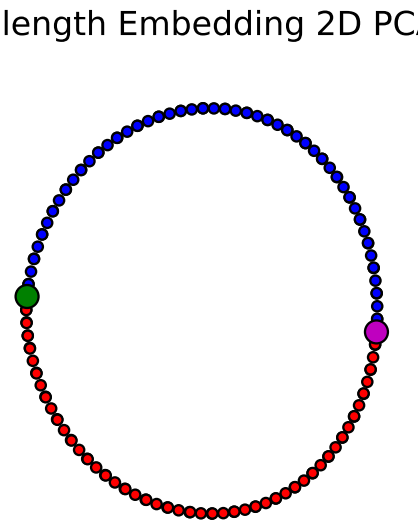


- Good Toy Example for Natural Video
- 2 questions
    1. Why is it path-like without embedding?

Oscillating Line Segment







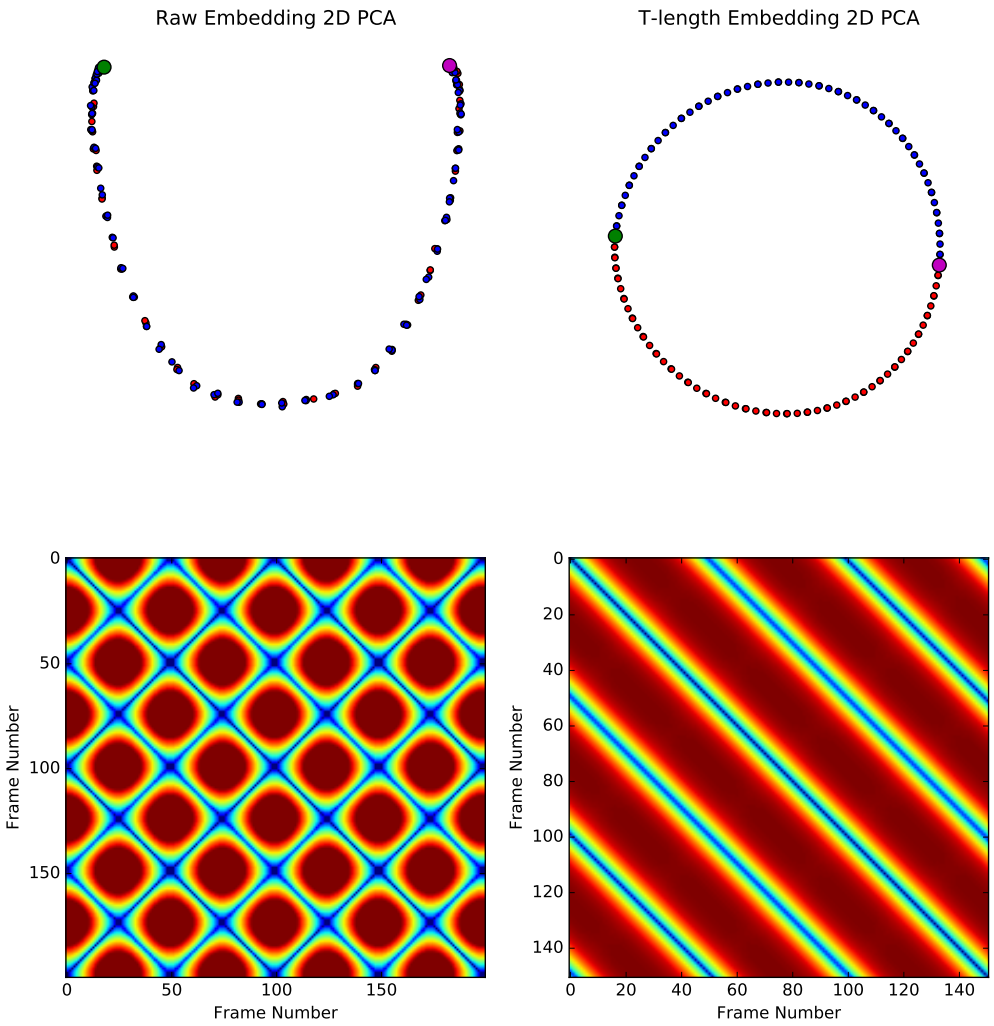
- Good Toy Example for Natural Video
- 2 questions
    1. Why is it path-like without embedding?
    2. Why is it curved?

Jumping Jacks Example

Show PCA Videos

Distance Matrix Interpretation

Oscillating Bar

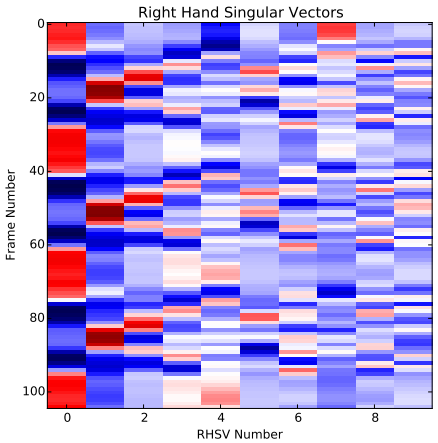


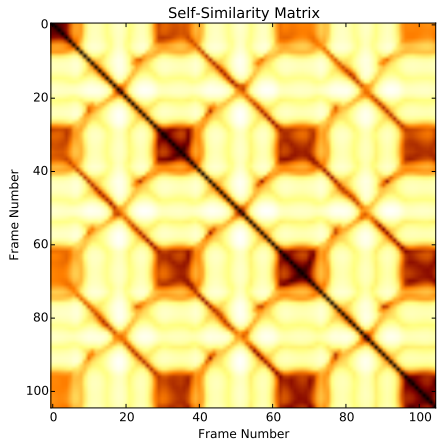
Distance Matrix Interpretation

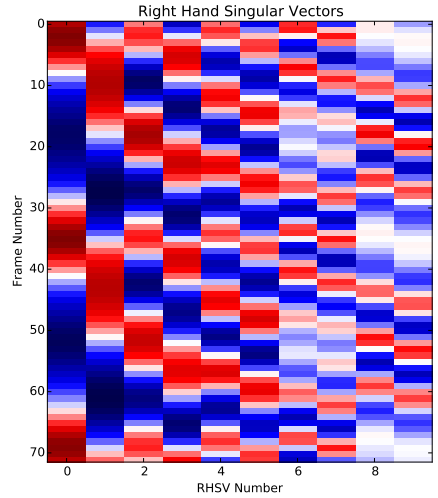
Convolving along diagonals (show video)

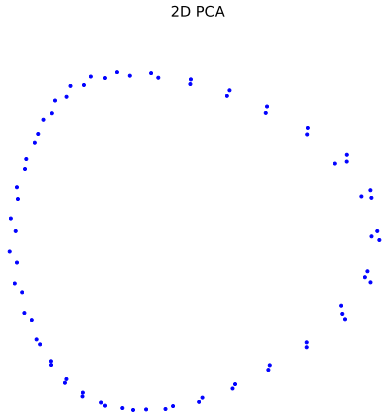
Distance Matrix Interpretation

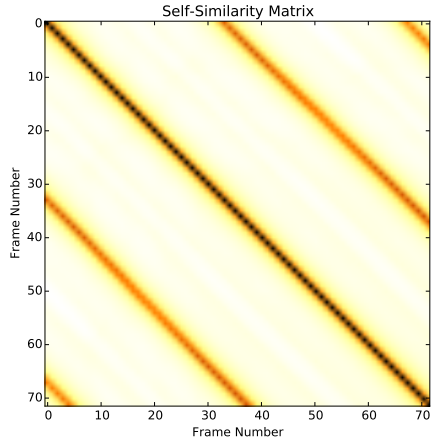
Jumping Jacks







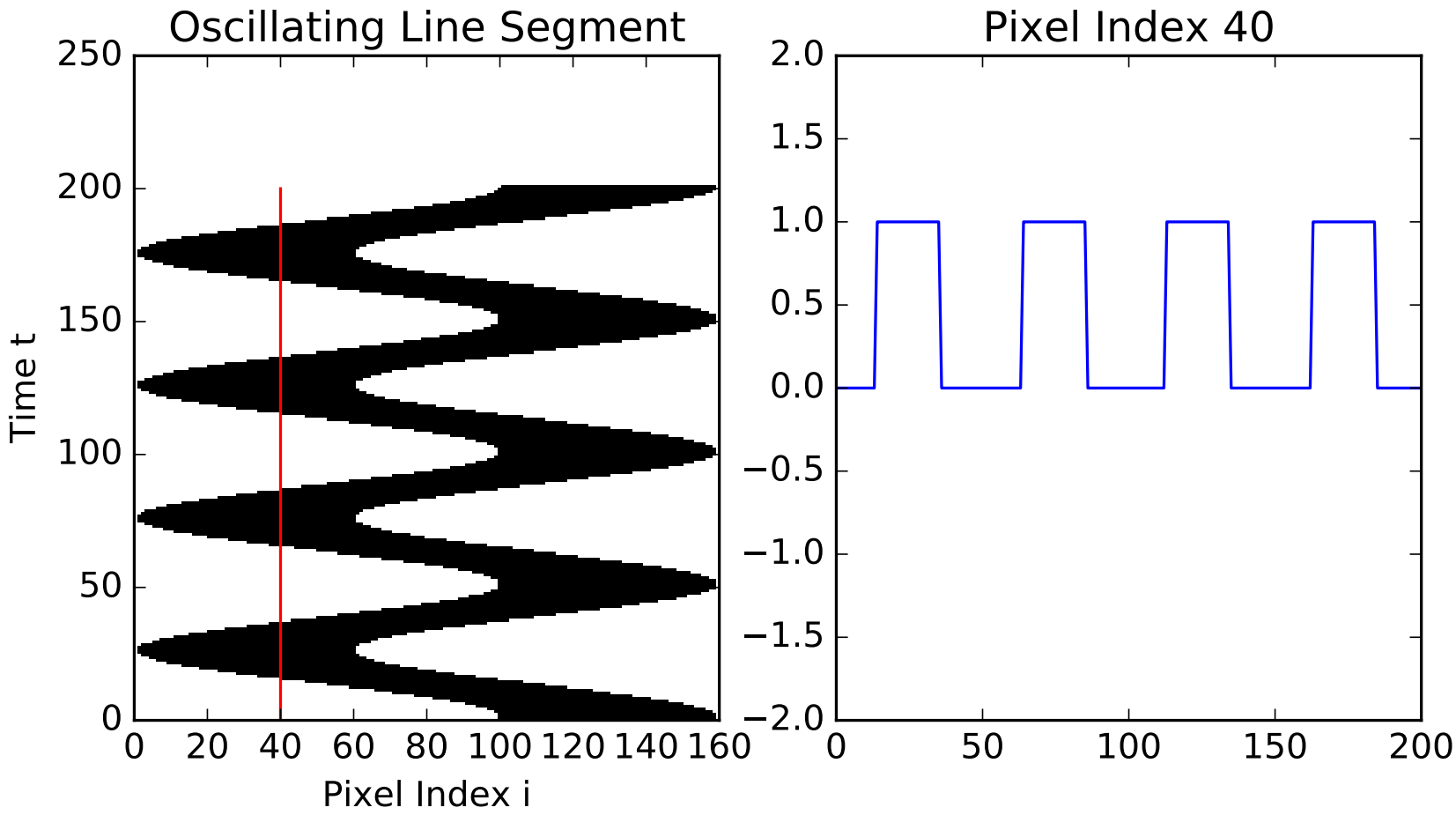




Oscillating Line Segment

Why is it curved?

- Eulerian pixel view



Jumping Jacks Video Eulerian View

Show video

Principal Component Videos

Show videos for heartbeat and jumping jacks

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Naive Embedding

Naive video stacking blows up in memory!

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- E.g. 400x400 video of length 300 frames, delay of 30 frames

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Solution?

Naive Embedding

Naive video stacking blows up in memory!

- E.g. 400x400 video of length 300 frames, delay of 30 frames

Solution?

- Do SVD

What About Drift?

e.g. $X(t) = (cos(t), sin(t), t)$
Show video

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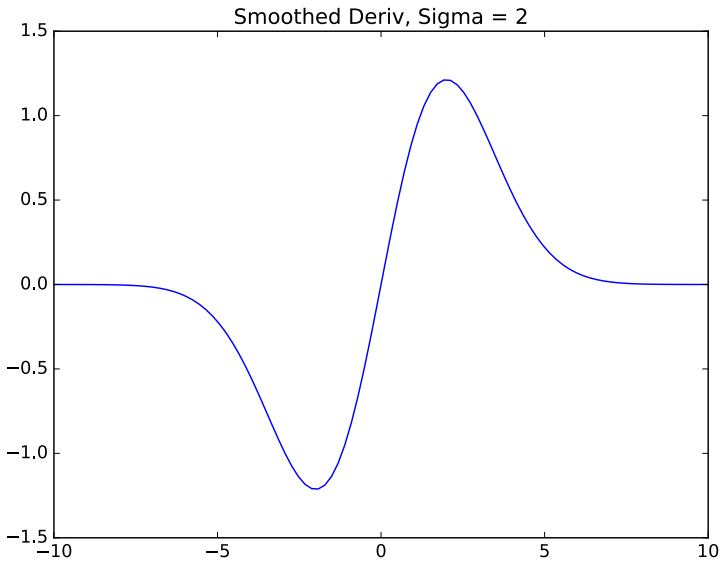
Show video

- Take smoothed time derivative of each pixel

$$g(t) = te^{-t^2/(2\sigma^2)}$$



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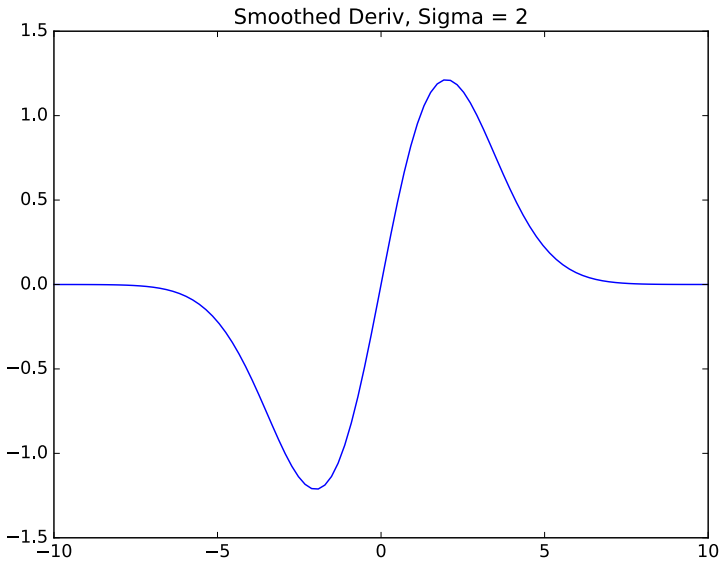
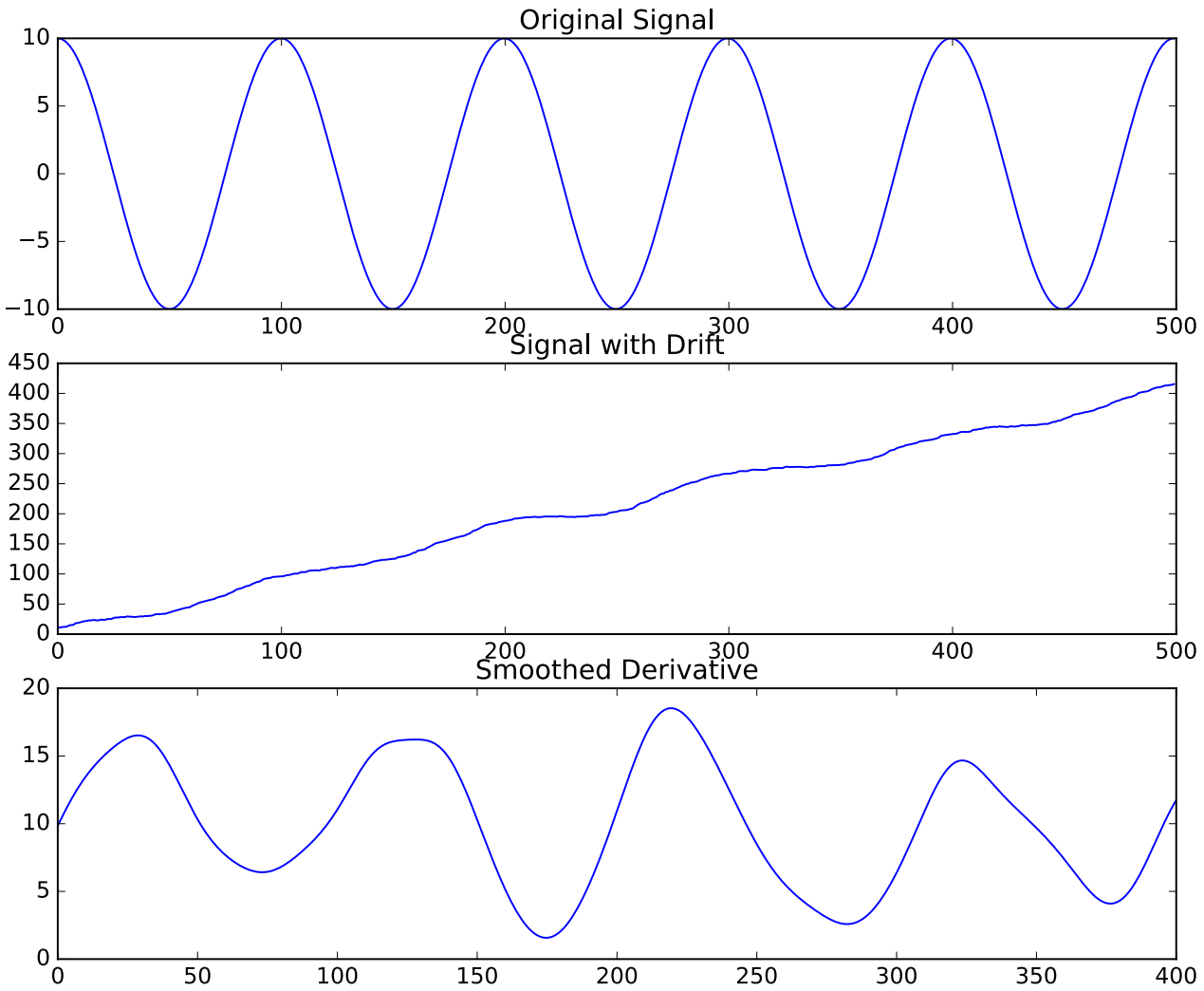


- Can be interpreted as a bandpass filter

1D Drift Example



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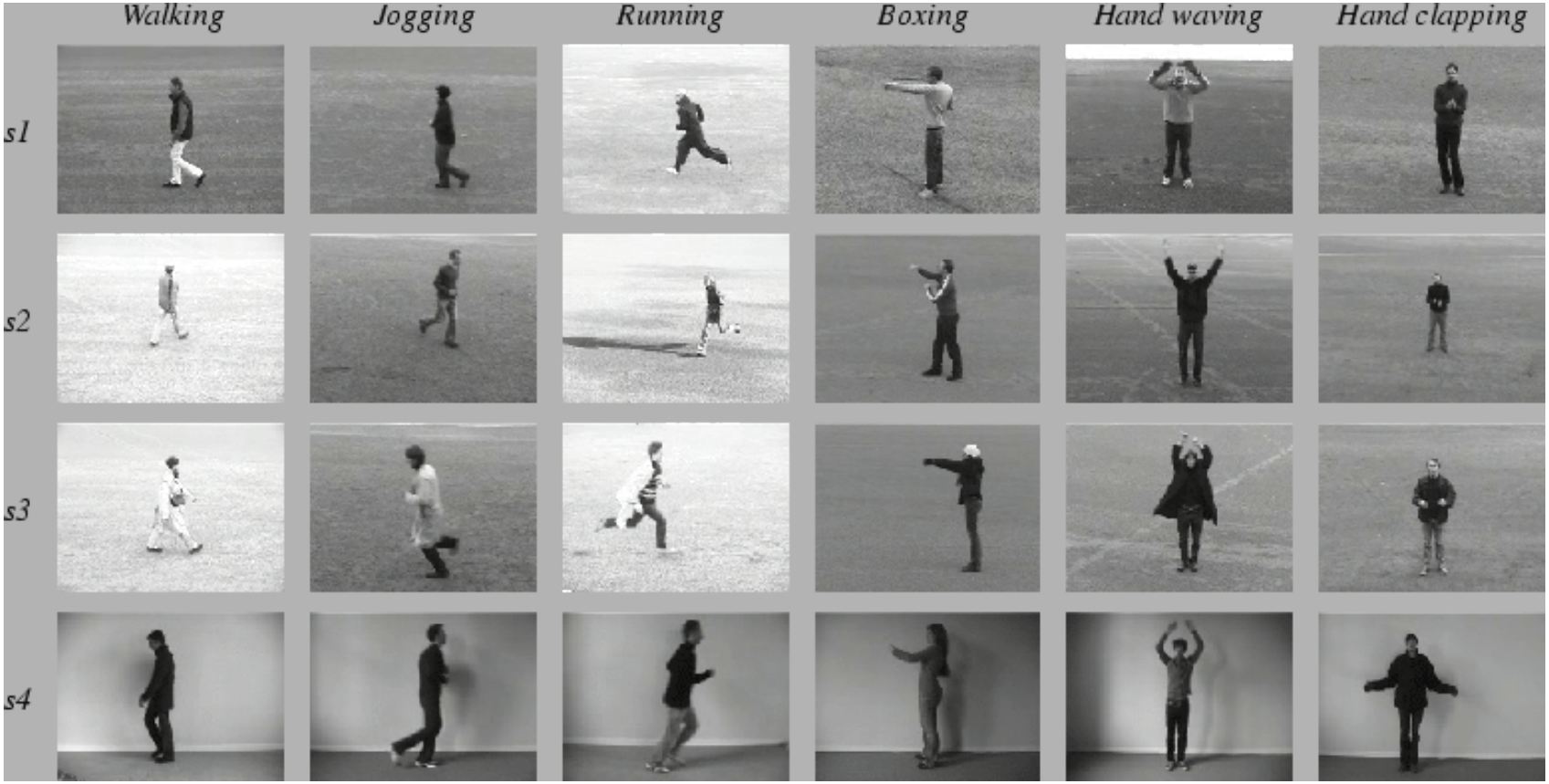
KTH Dataset



http://www.nada.kth.se/cvap/actions/

KTH Dataset

- We are *not* doing activity recognition!!
  Castrodad, Alexey, and Guillermo Sapiro. “Sparse modeling of human actions from motion imagery.” International journal of computer vision 100.1 (2012): 1-15.
- Instead, we will be ranking periodicity

KTH Dataset: Experiment 1

Window length vs persistence

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Window length vs persistence

- ▷ Keep dimension fixed. For window length W, $\tau = d/W$

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- ▷ Keep number of points fixed. $dT = (N - d\tau)/N$

KTH Dataset: Experiment 1

Window length vs persistence

- ▷ Keep dimension fixed. For window length W, $\tau = d/W$
- ▷ Keep number of points fixed. $dT = (N - d\tau)/N$
- ▷ Take blocks of 160 frames

KTH Dataset: Experiment 2 (Interactive)

Rank 4 videos as a class

KTH Dataset: Experiment 3 (Interactive)

Rank all videos for a particular person