SYDE 556/750

Simulating Neurobiological Systems
Lecture 7: Temporal Basis Functions

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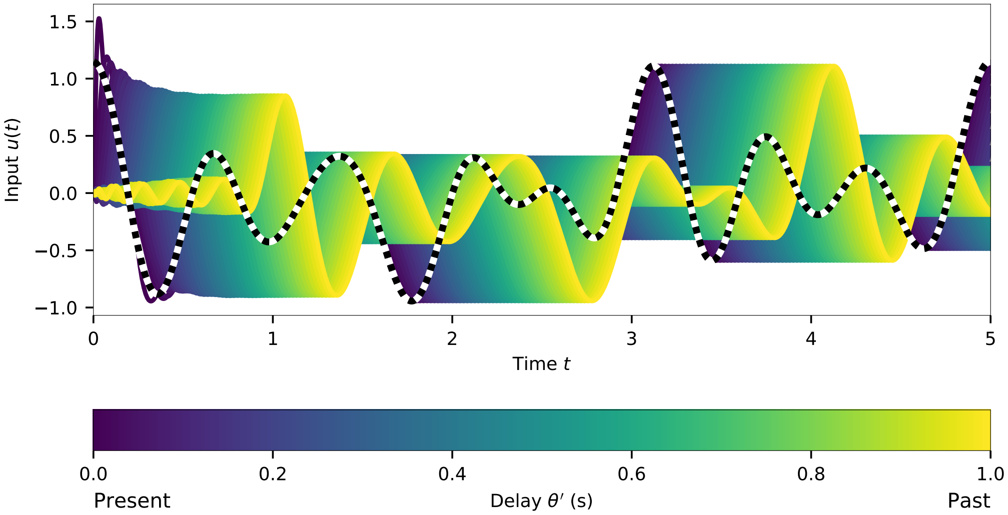
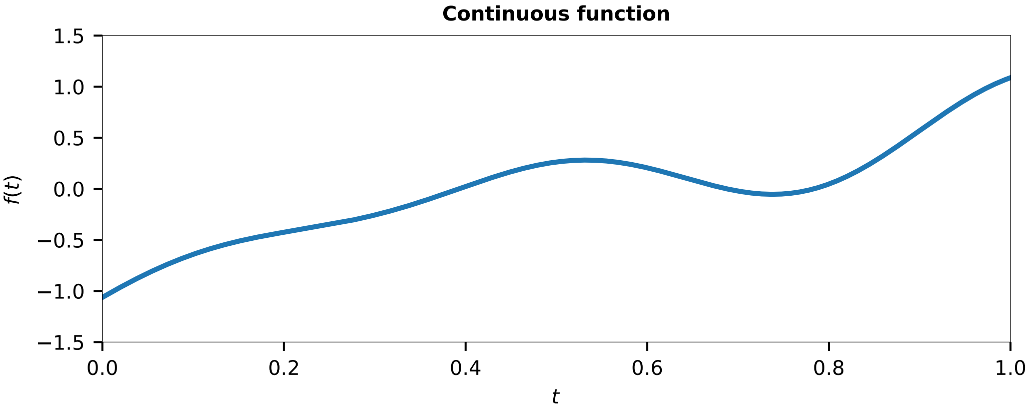
- Content: Terry Stewart, Andreas Stöckel, Chris Eliasmith

UNIVERSITY OF WATERLOO | FACULTY OF ENGINEERING

Representing Stimulus Histories



Representing Functions: Sampling



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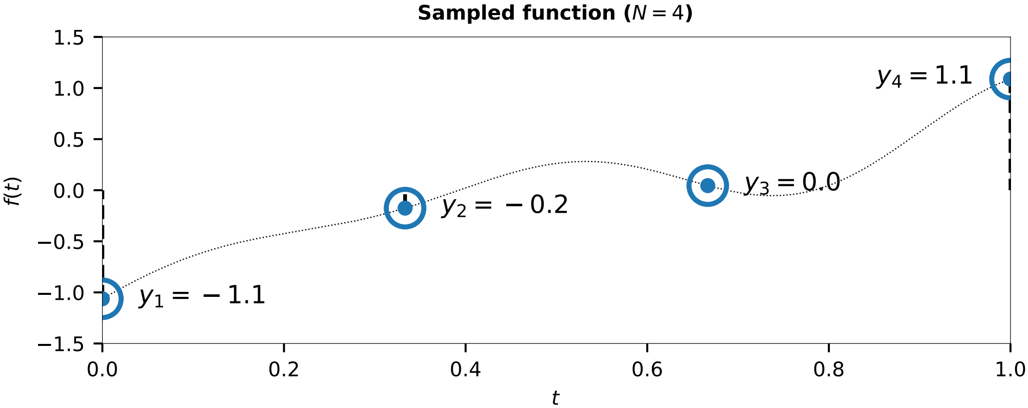

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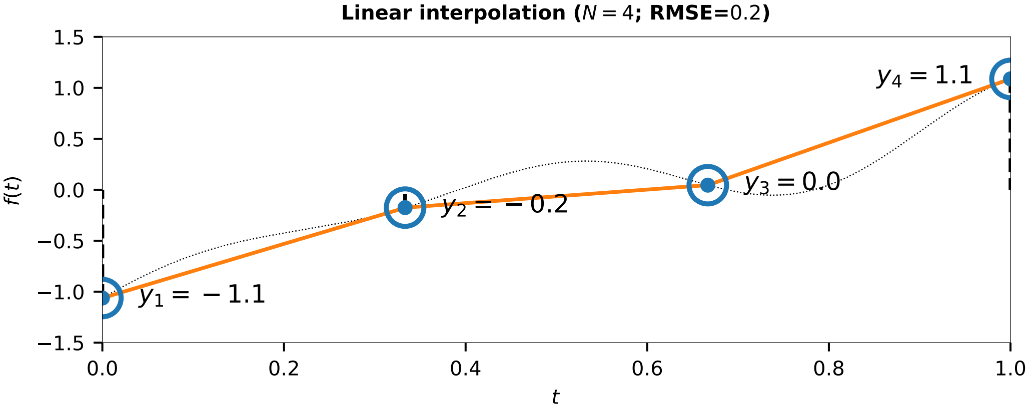

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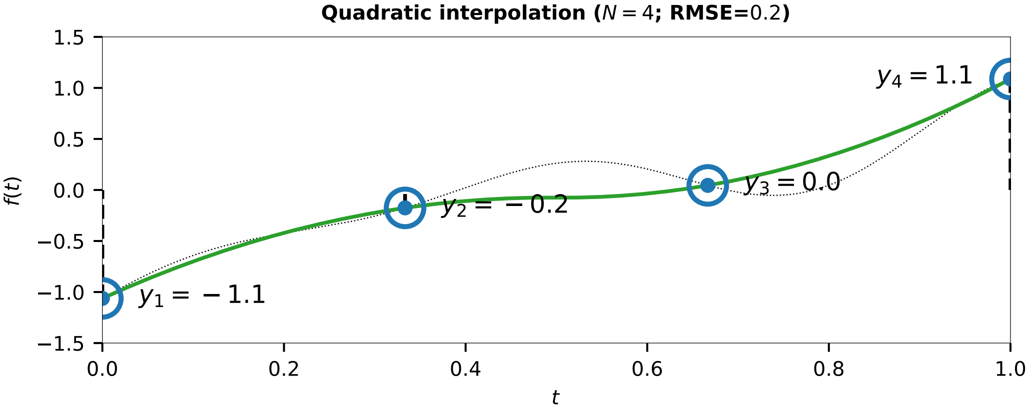

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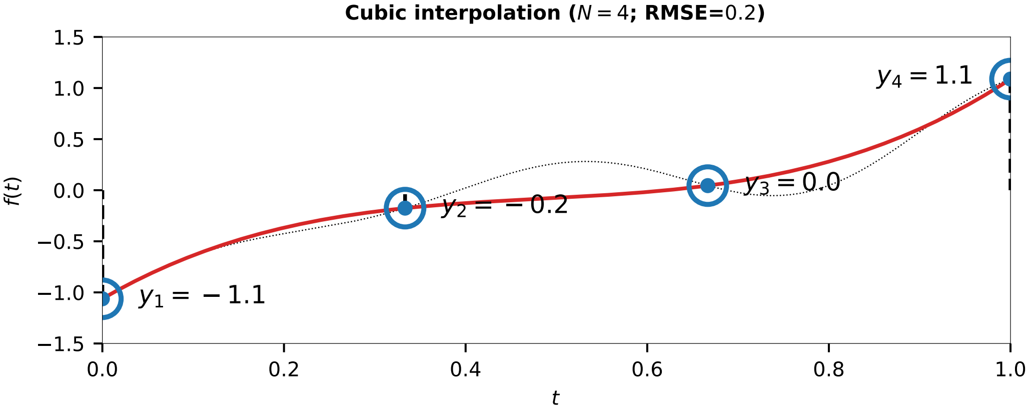

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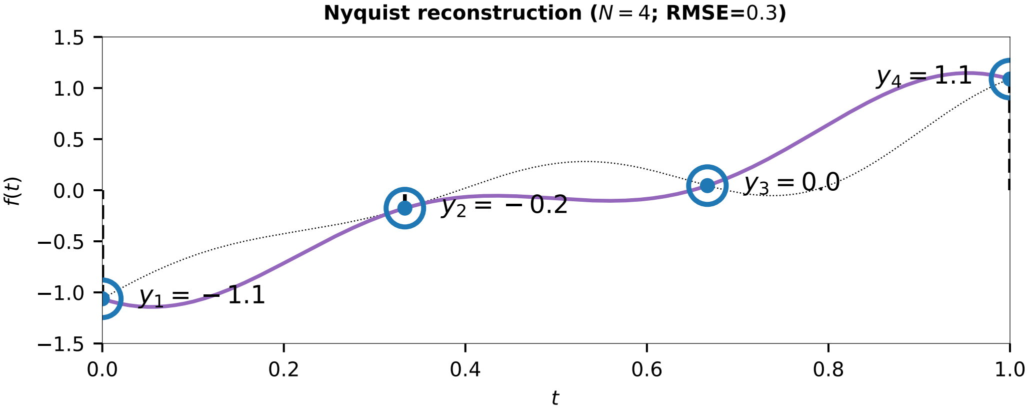

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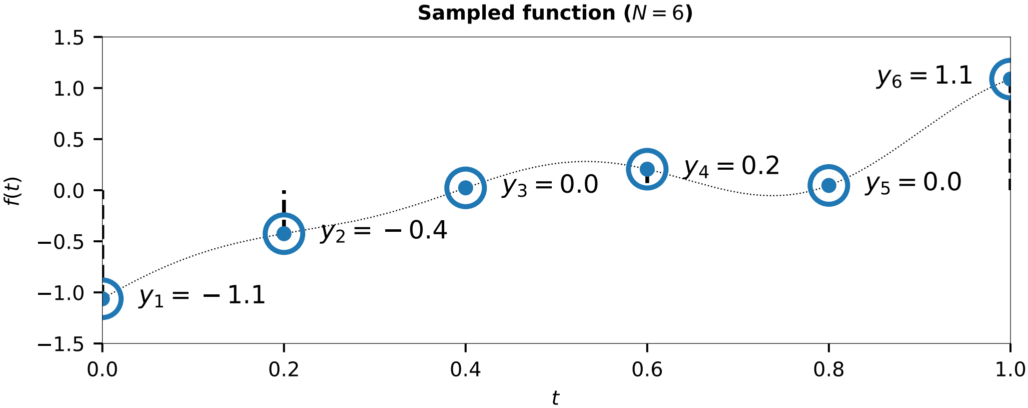

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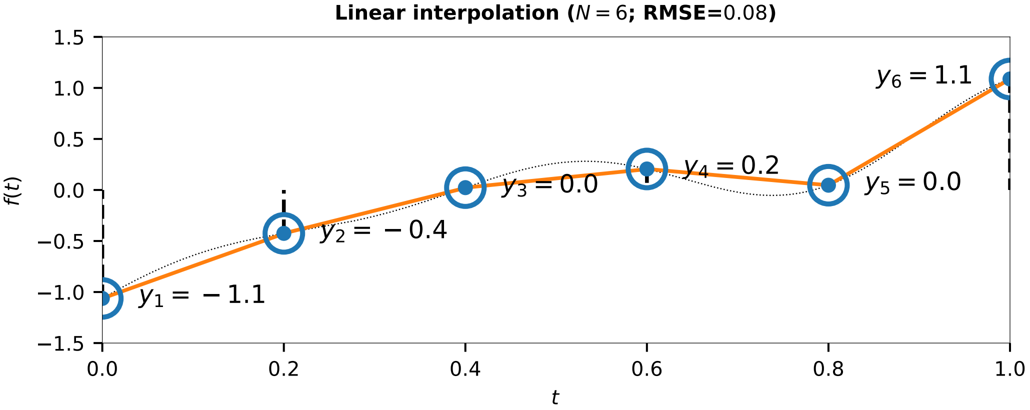

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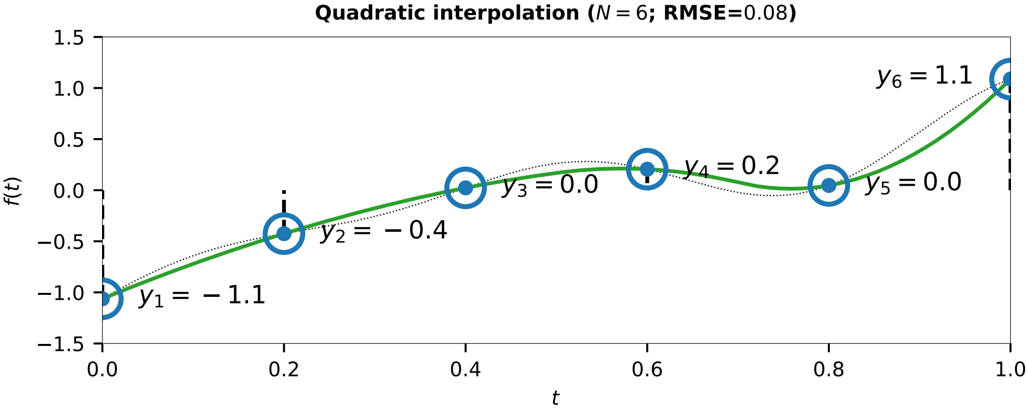

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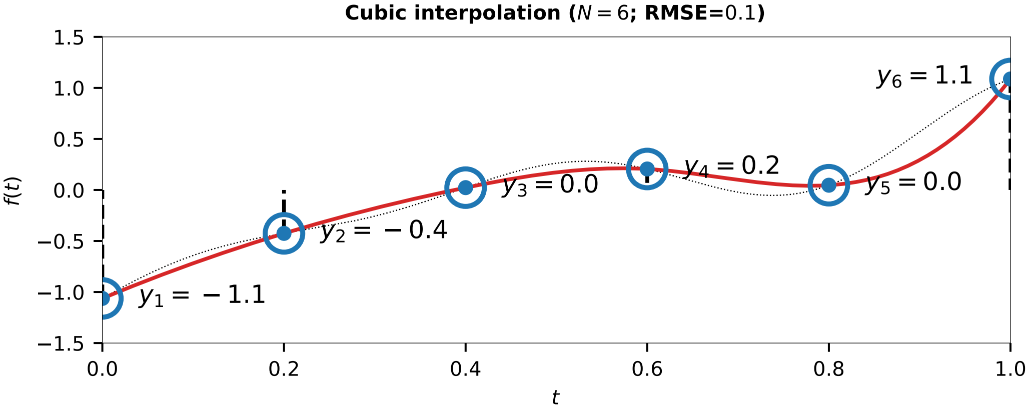

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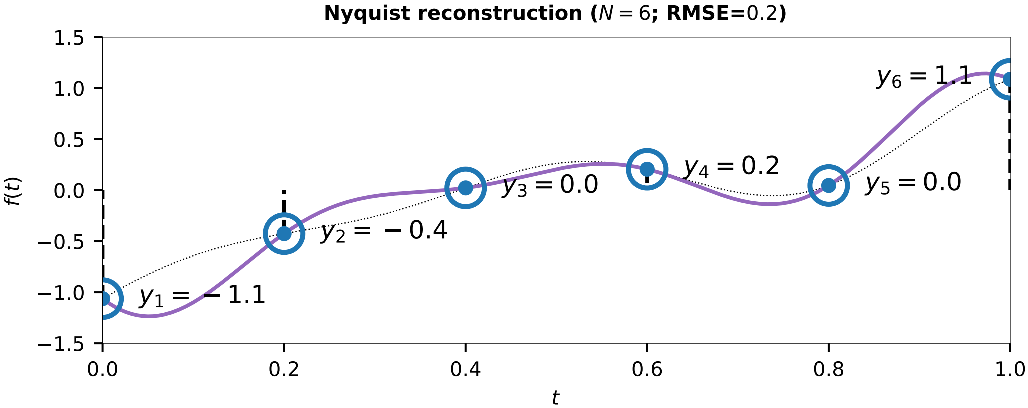
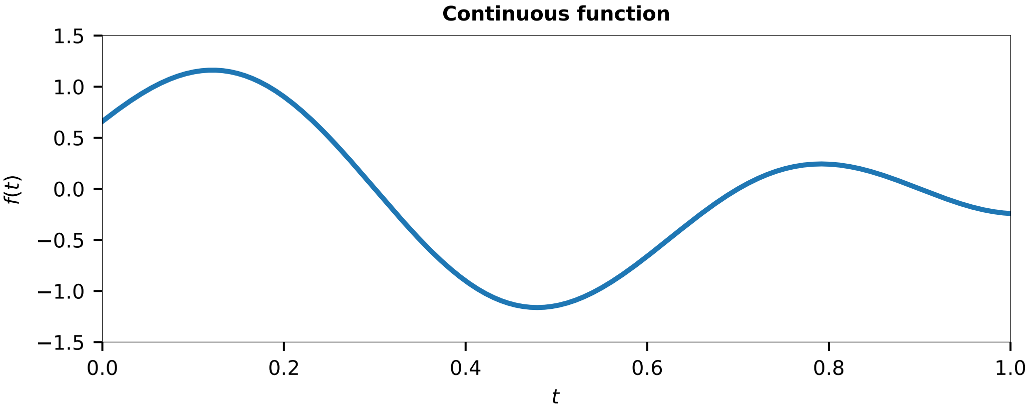


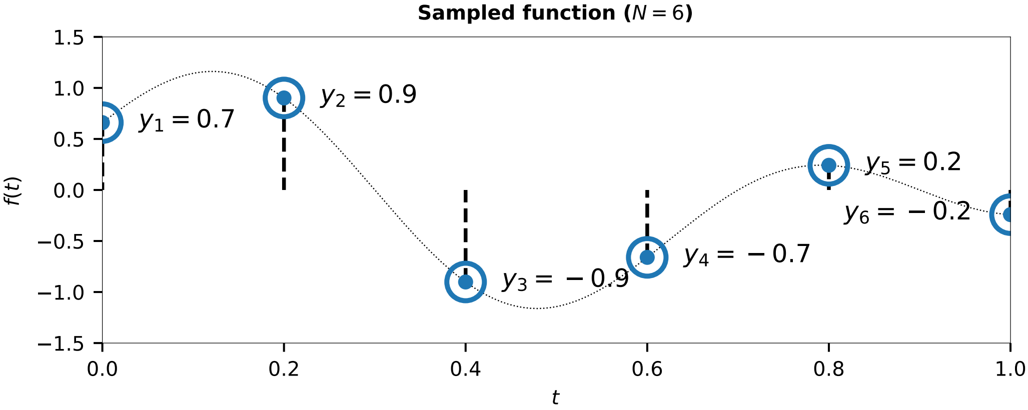
Nyquist Sampling

The Nyquist-Shannon Sampling Theorem
If $f(t)$ contains no frequencies greater than B then it is *completely* determined by samples spaced $\Delta t = \frac{1}{2B}$ apart ($N = 2BT$ equally spaced samples for a time-slice $[0, T)$). There is a *one-to-one mapping* between the samples $\mathbf{x}$ and the function $f(t)$.

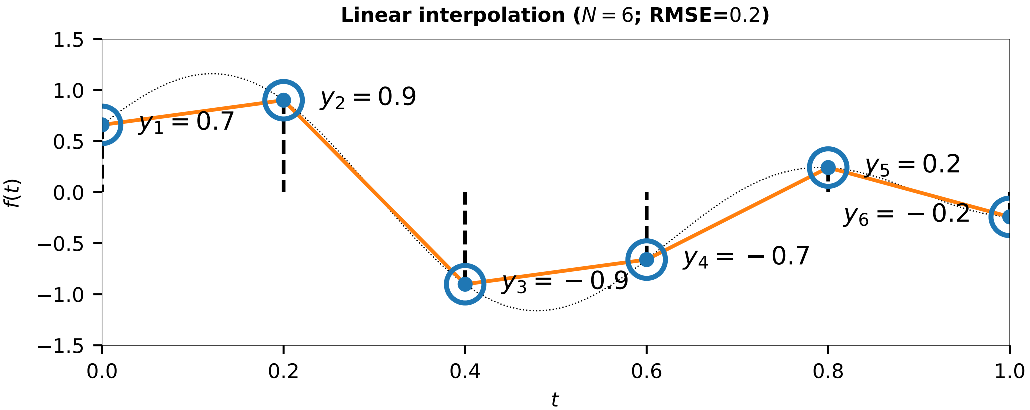
Representing Functions: Sampling <3Hz



Representing Functions: Sampling <3Hz



Representing Functions: Sampling $<$3Hz



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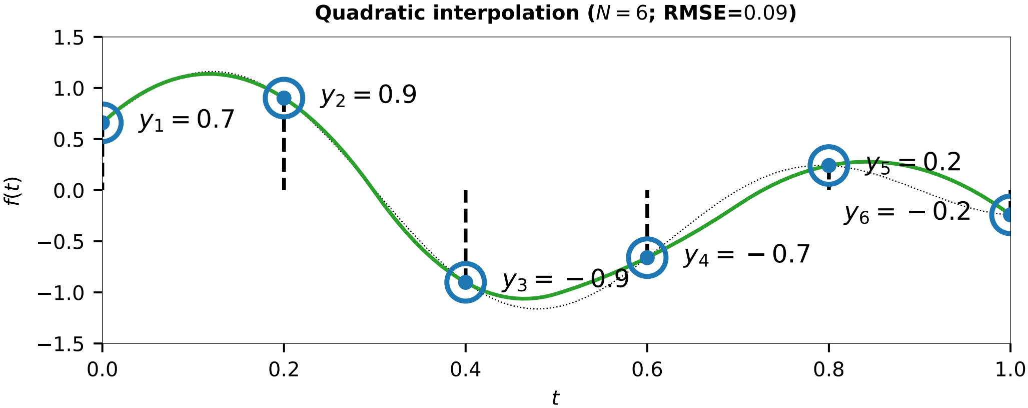

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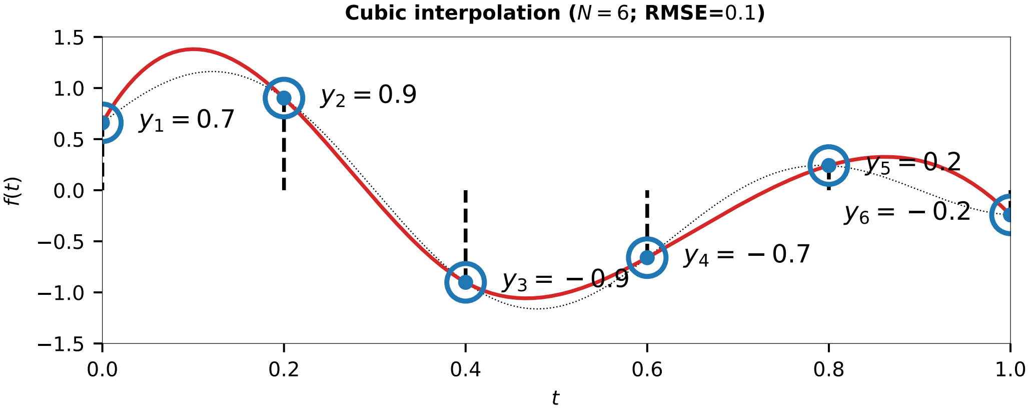

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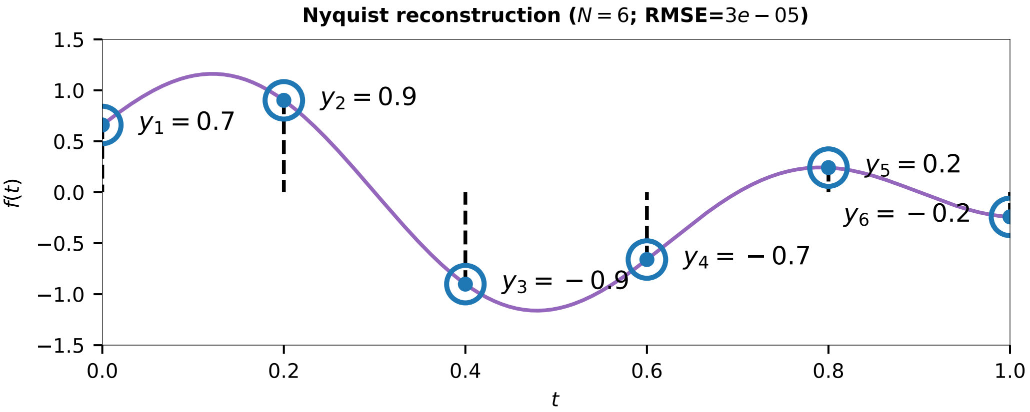

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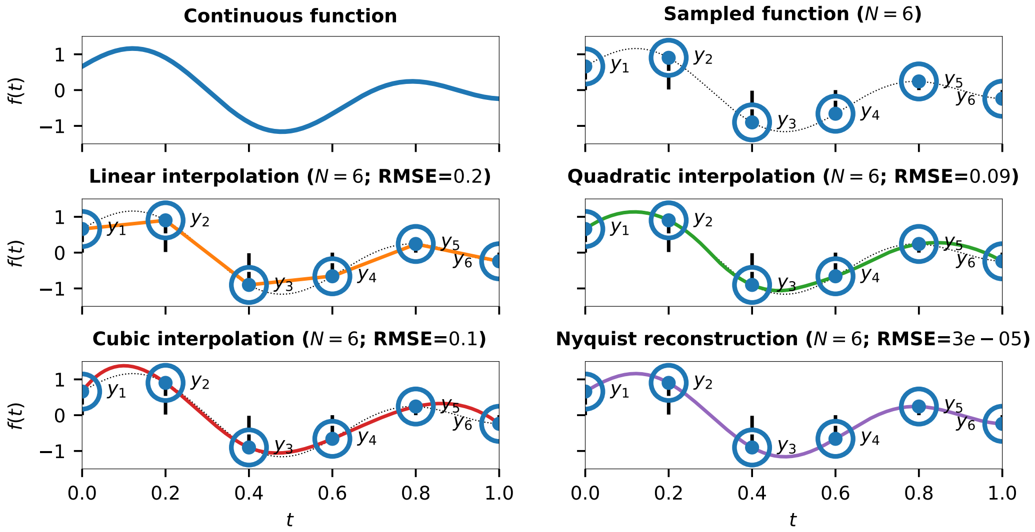
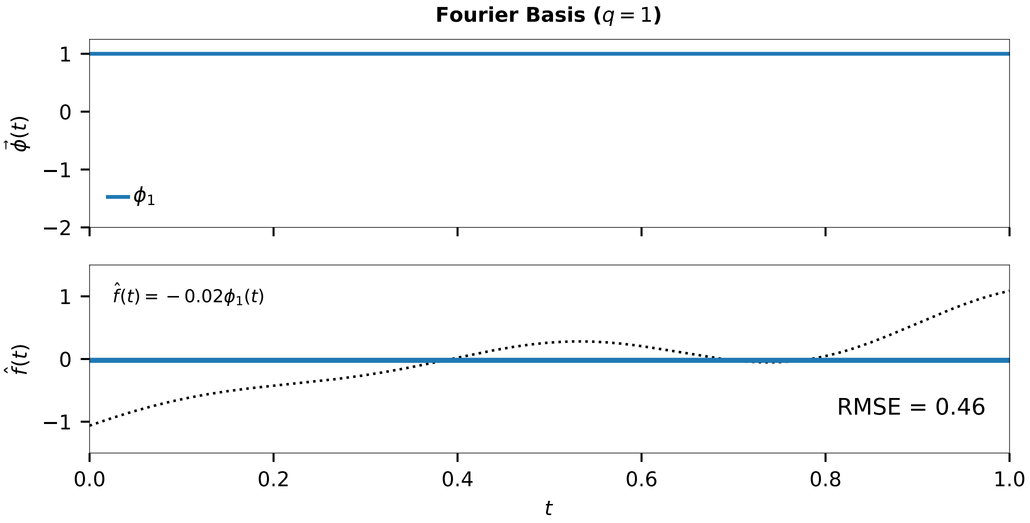


Representing Functions: Fourier Basis



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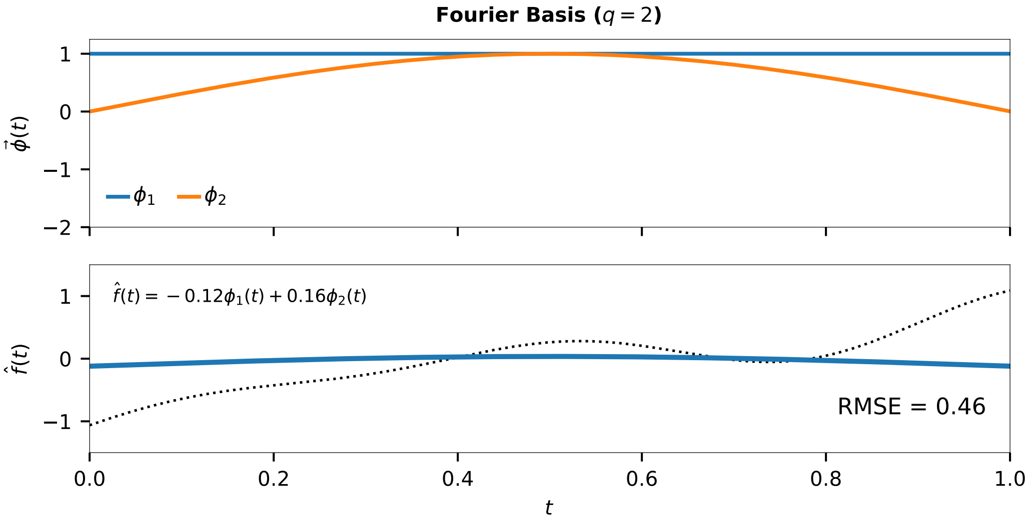
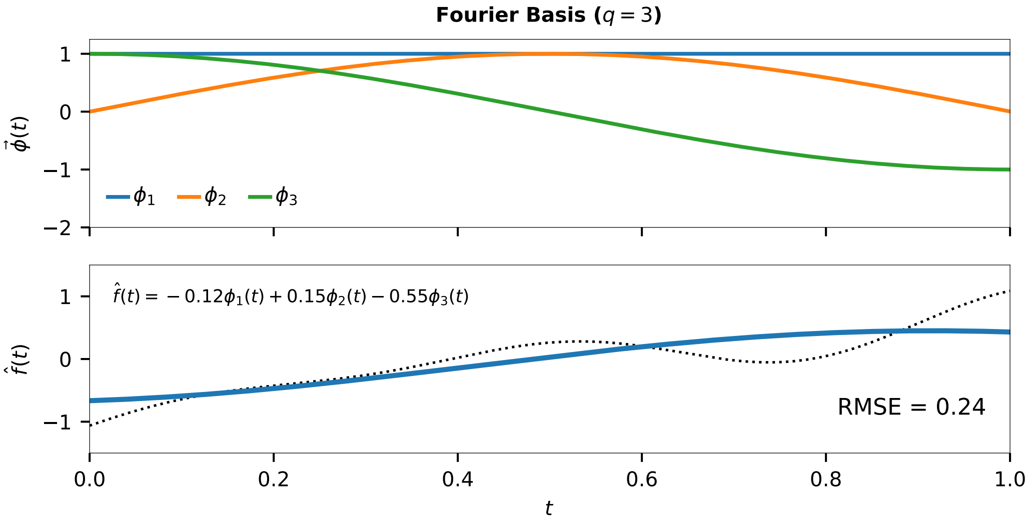


Representing Functions: Fourier Basis



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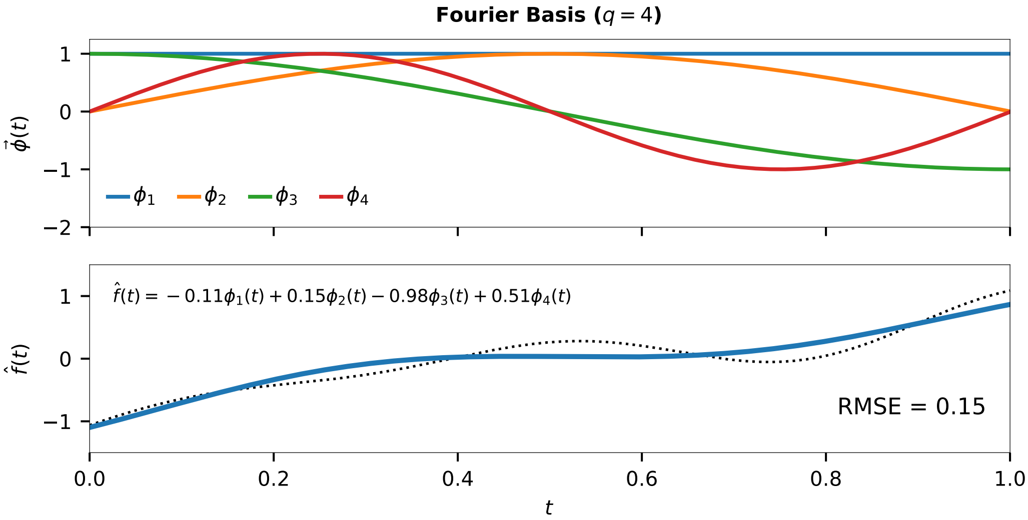

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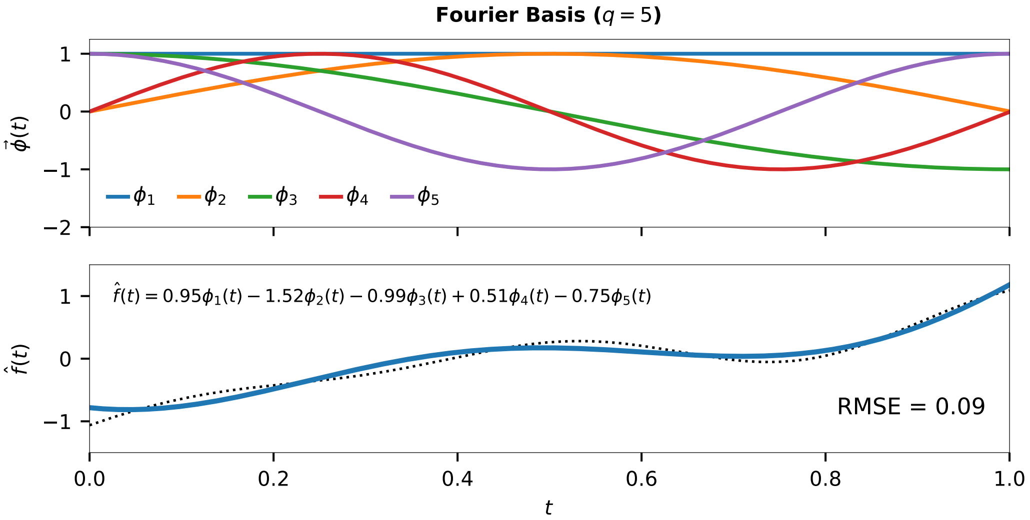

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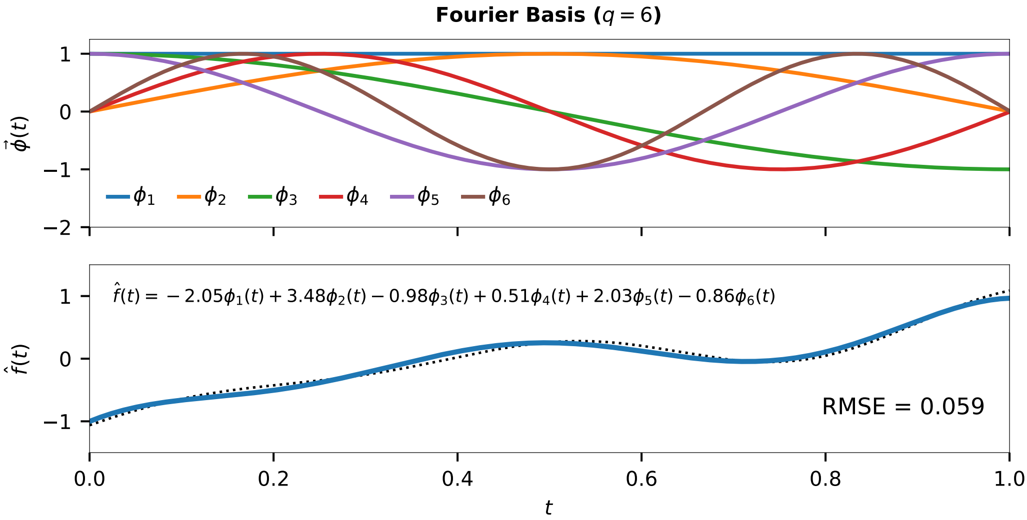
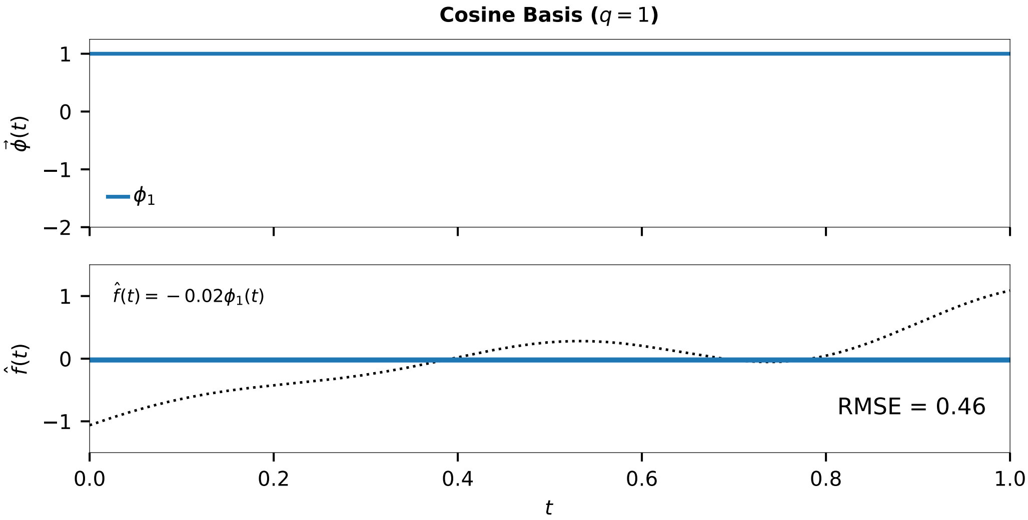
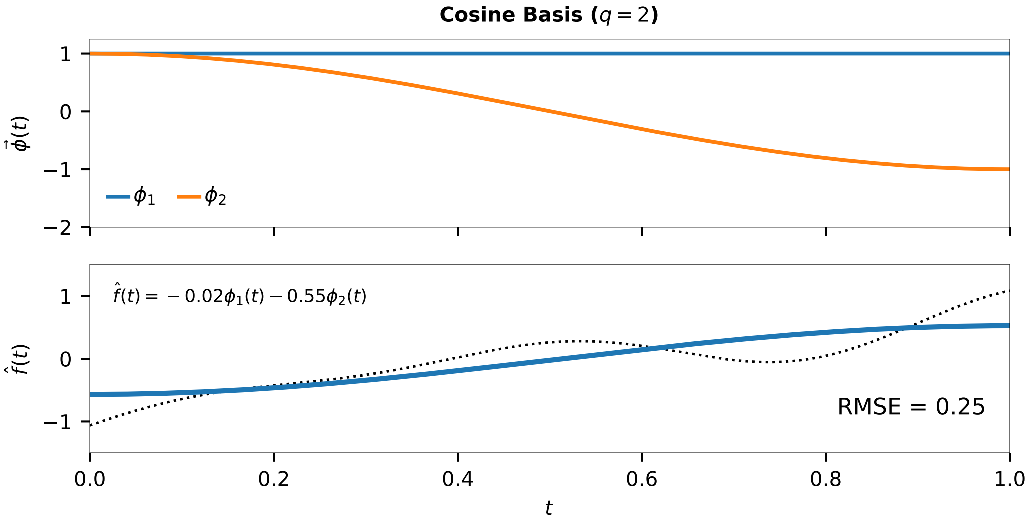


Representing Functions: Cosine Basis



Representing Functions: Cosine Basis



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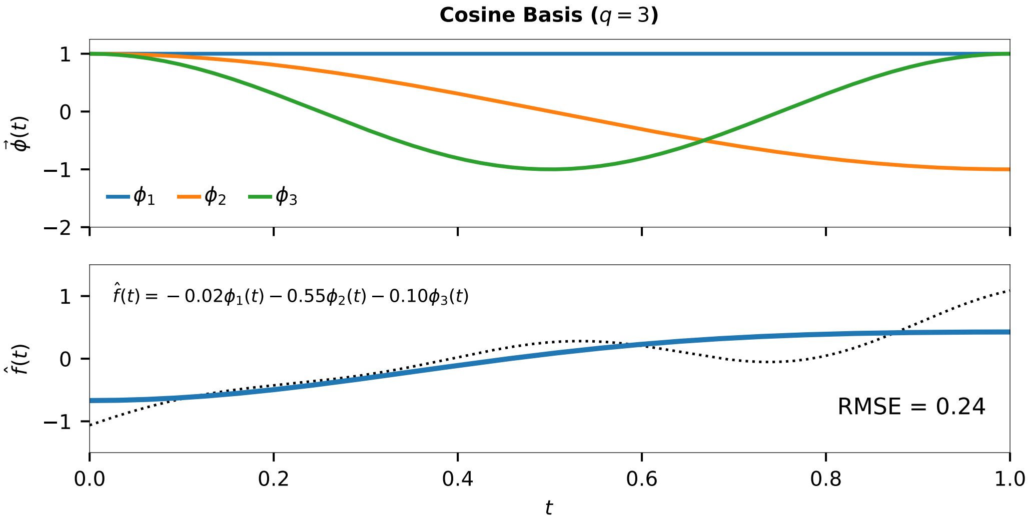

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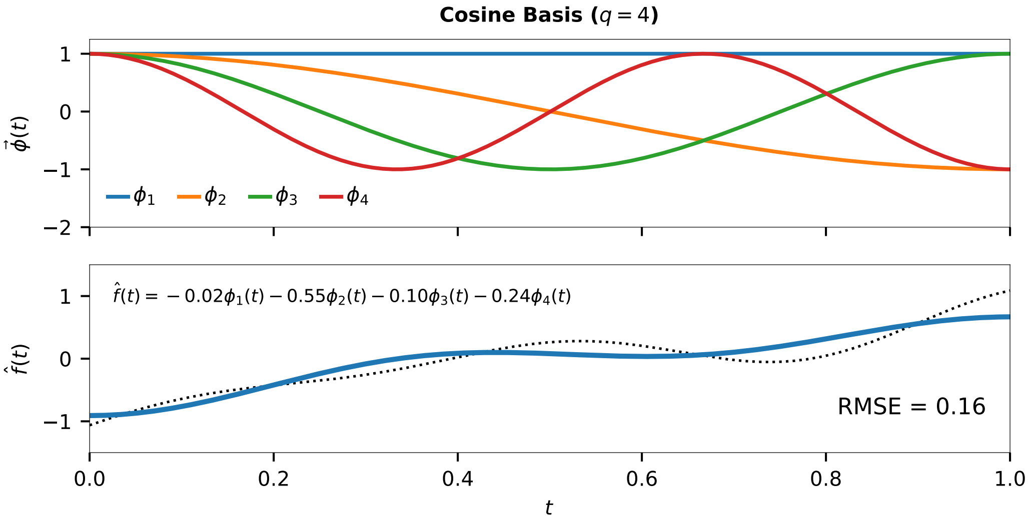

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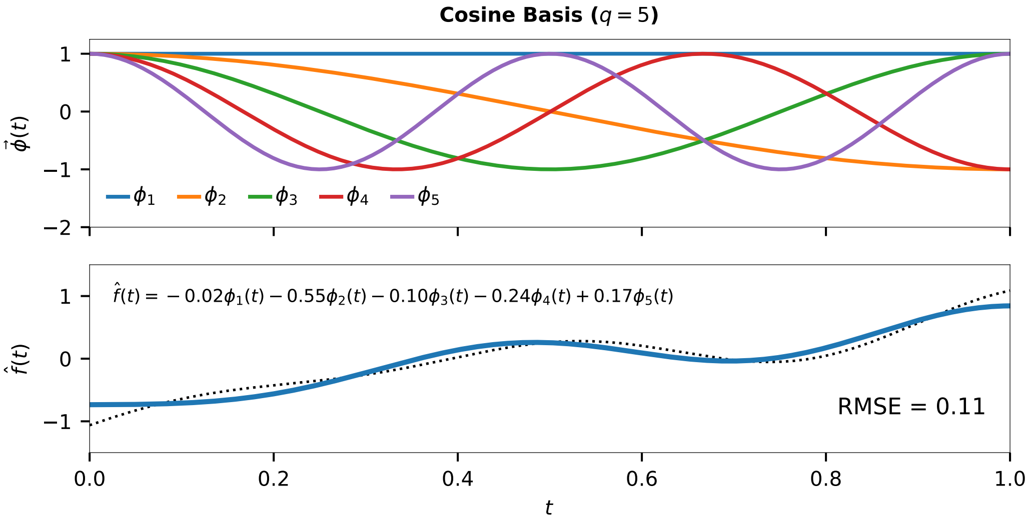

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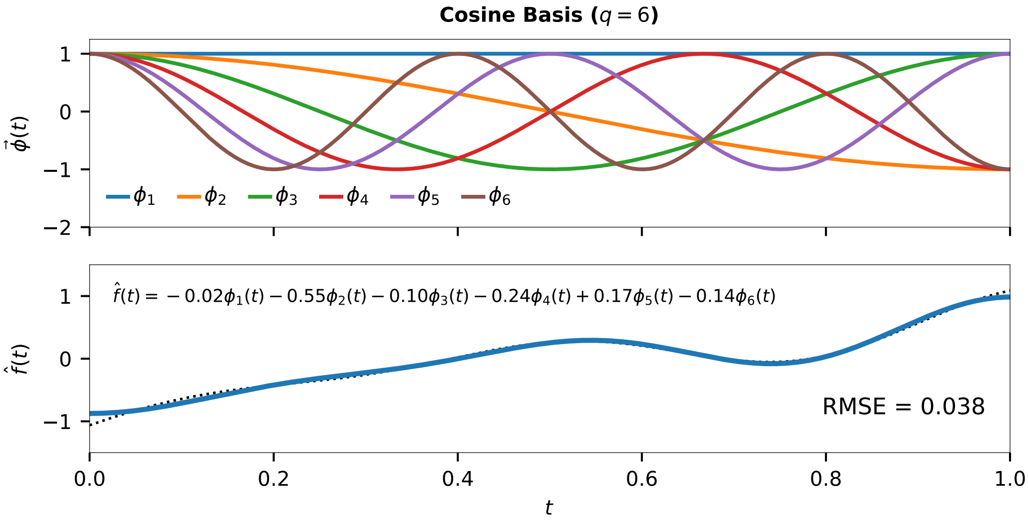
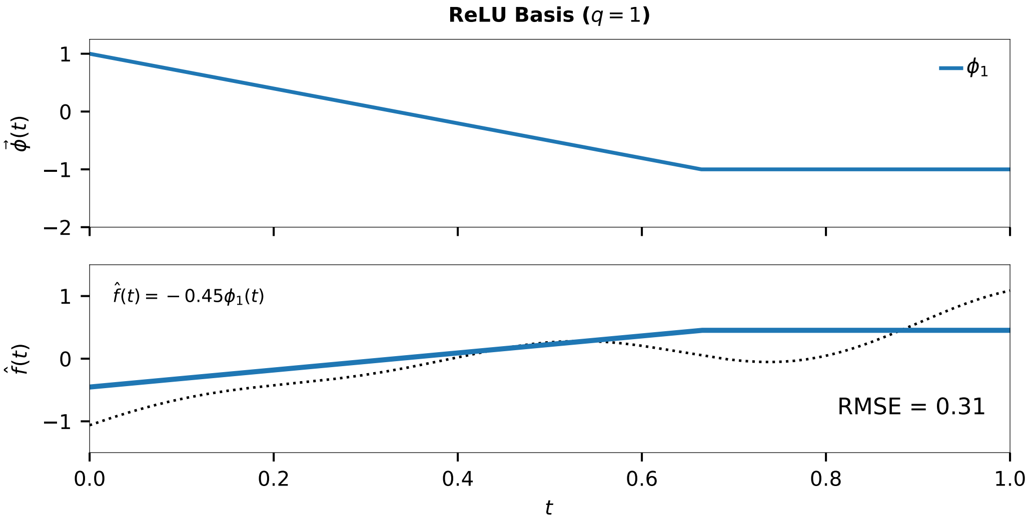
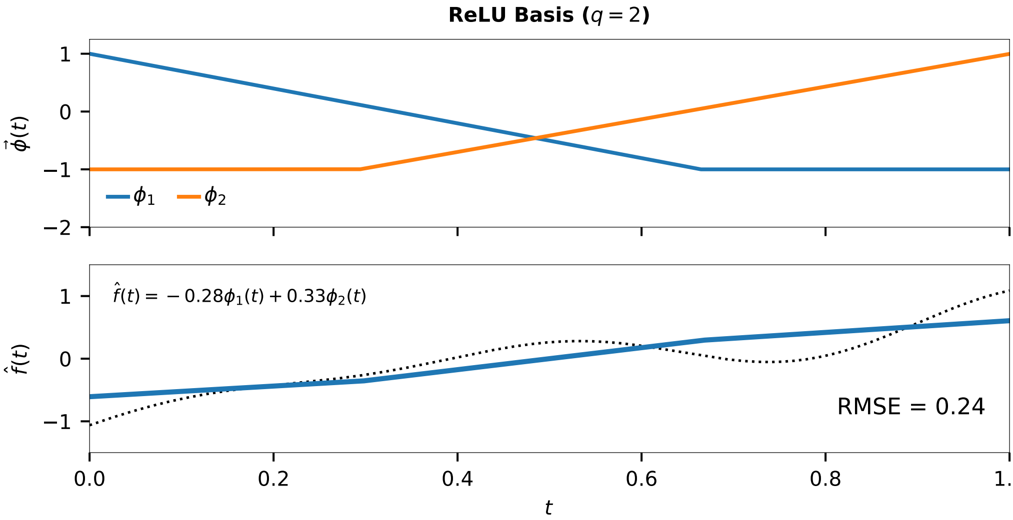


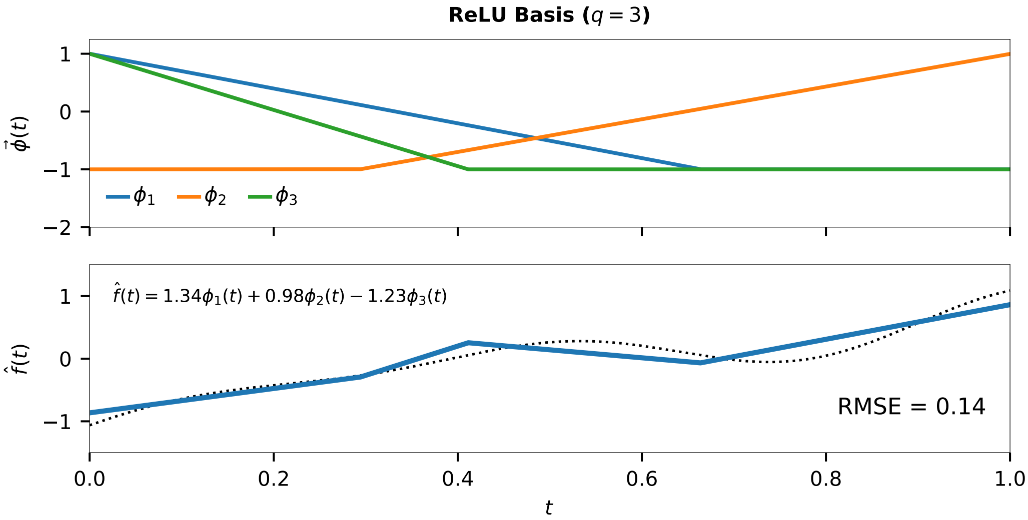
Representing Functions: ReLU Basis



Representing Functions: ReLU Basis



Representing Functions: ReLU Basis



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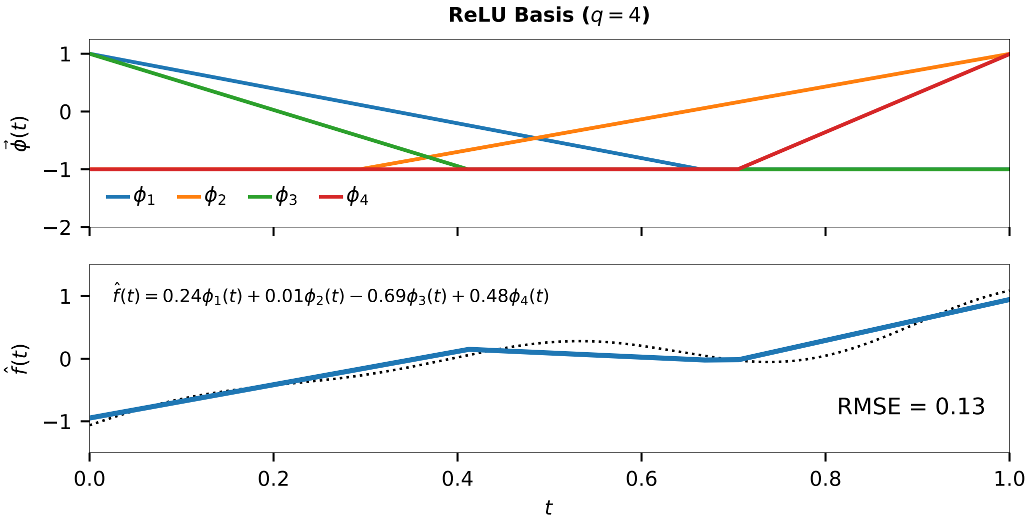

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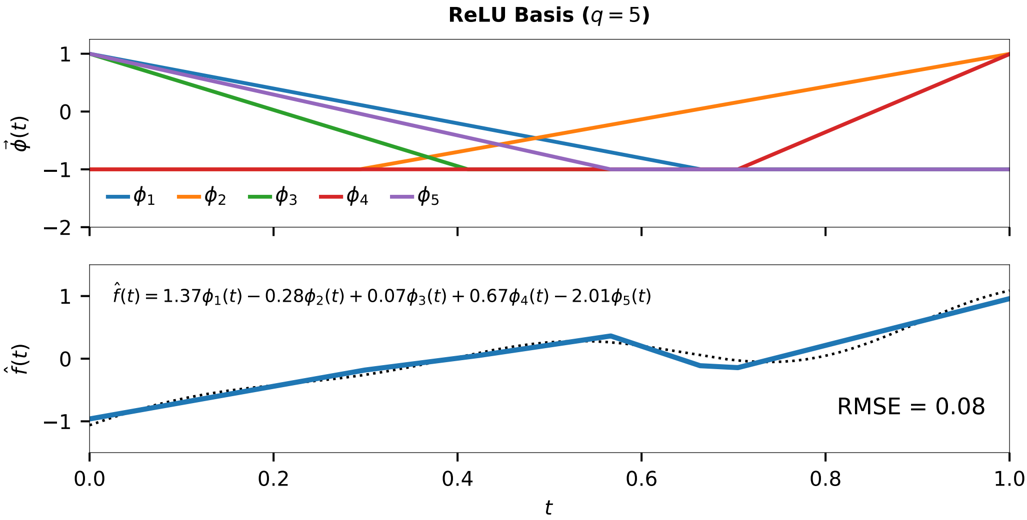

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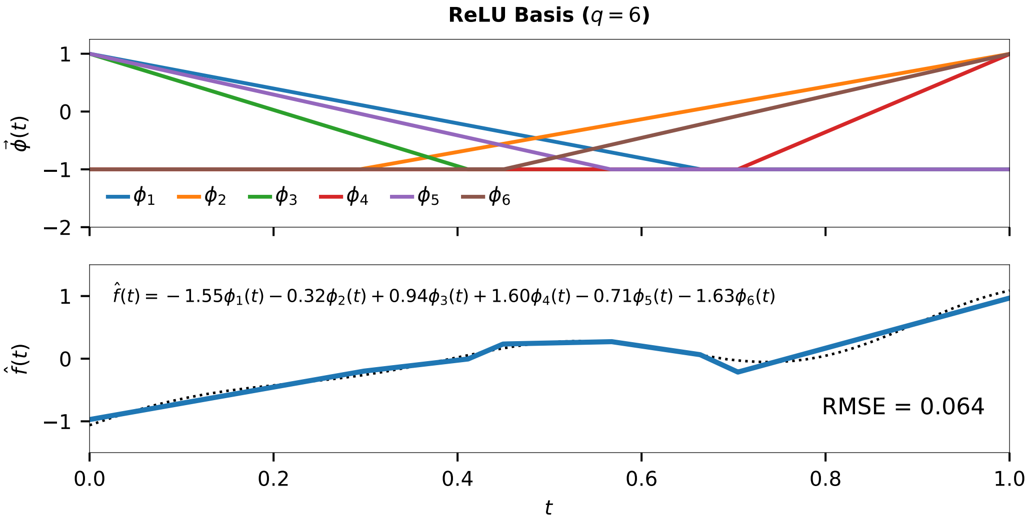
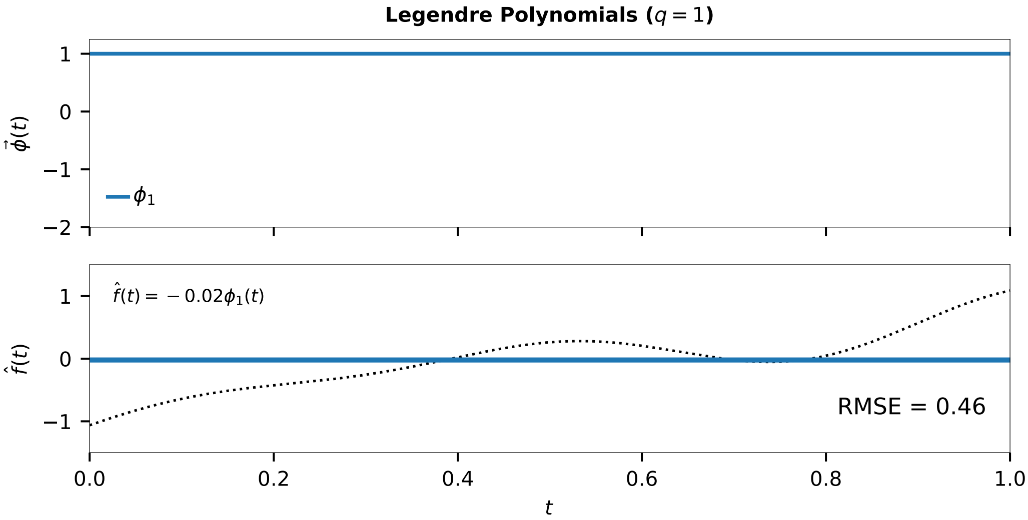
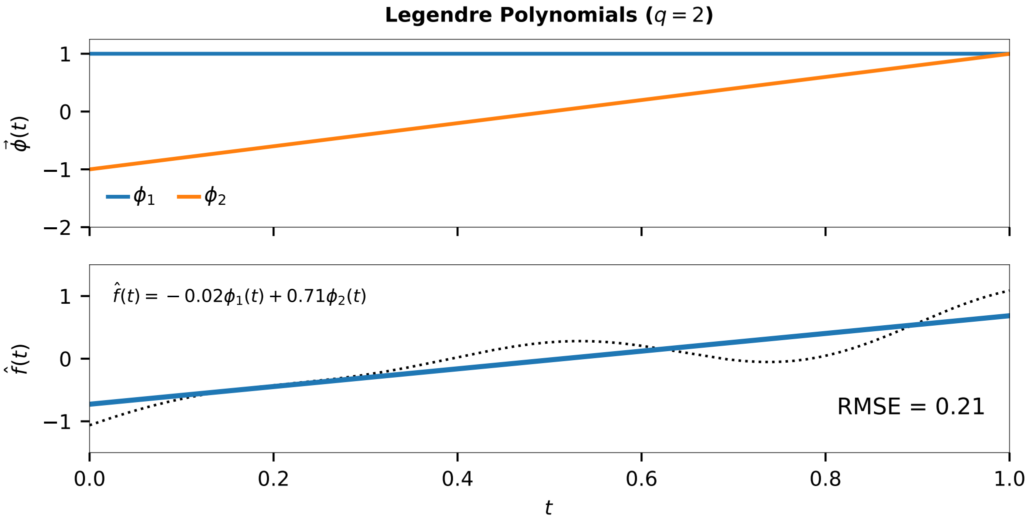


Representing Functions: Legendre Basis



Representing Functions: Legendre Basis



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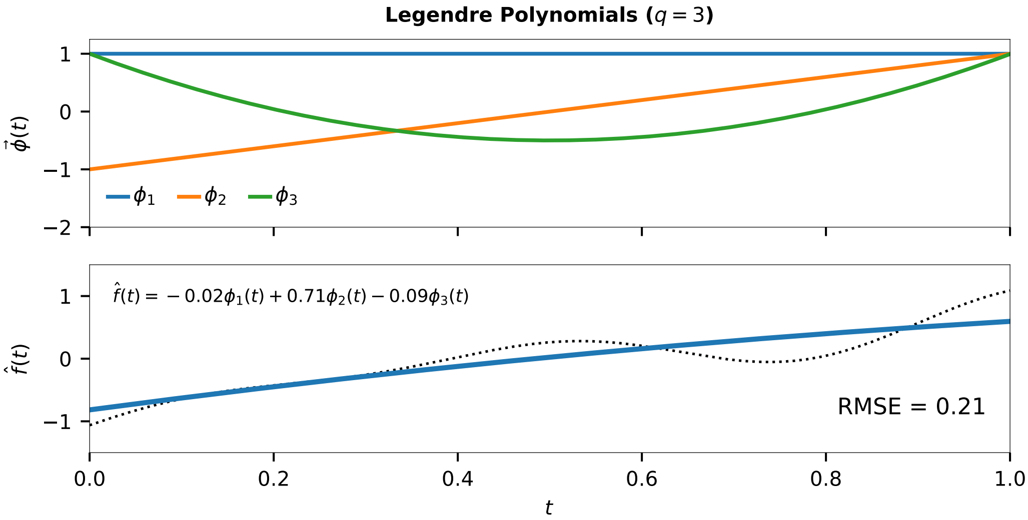

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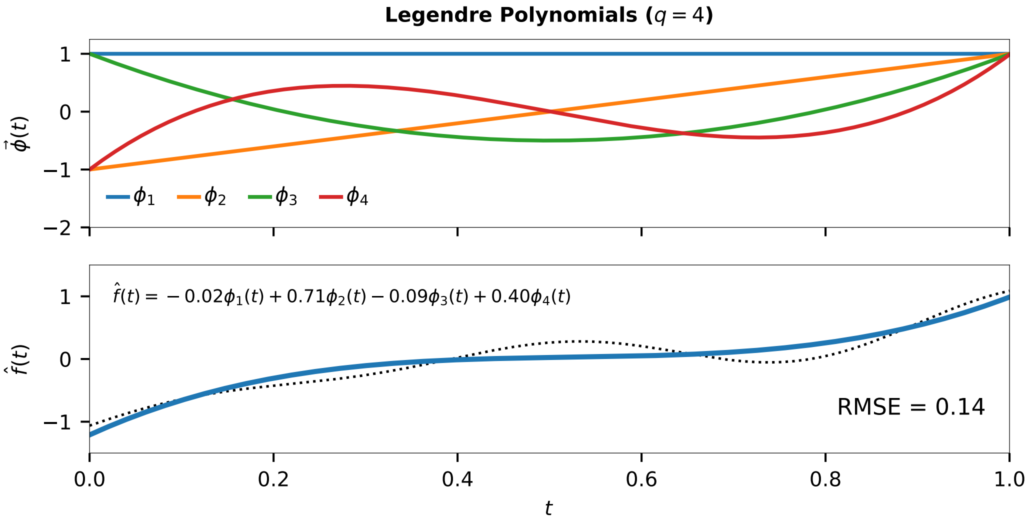

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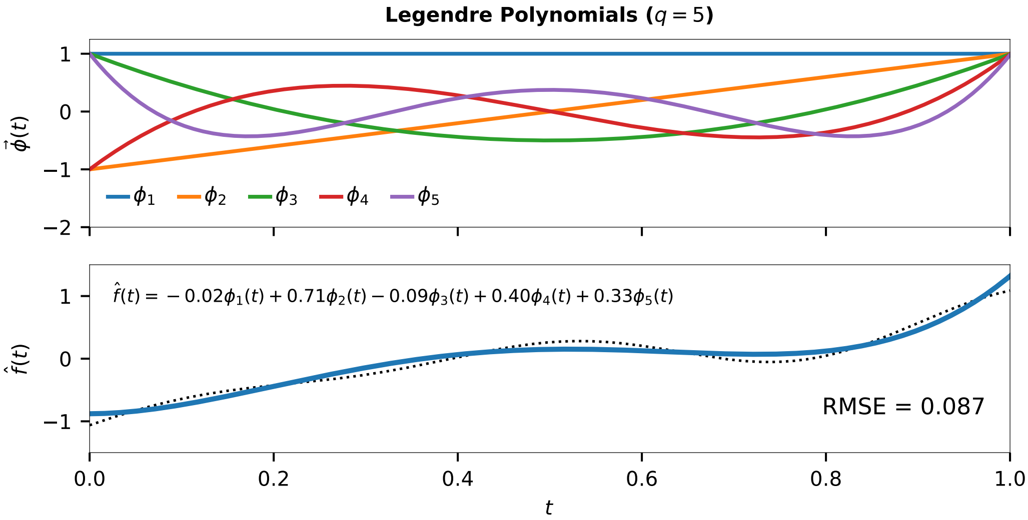

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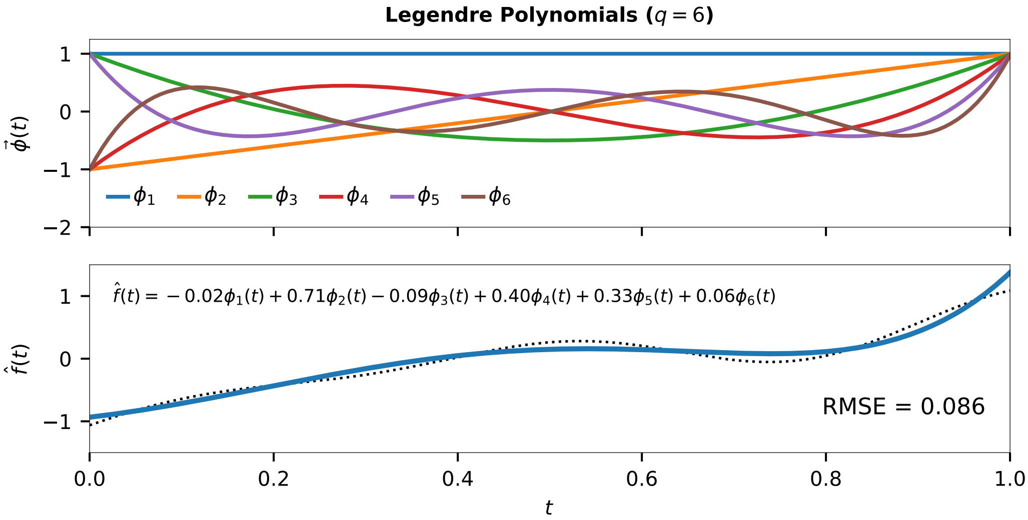
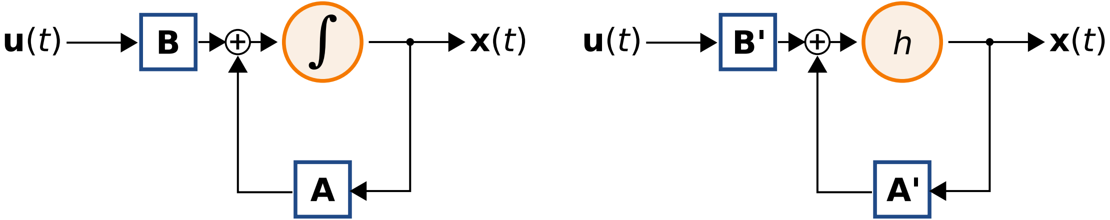


Implementing the Delay Network

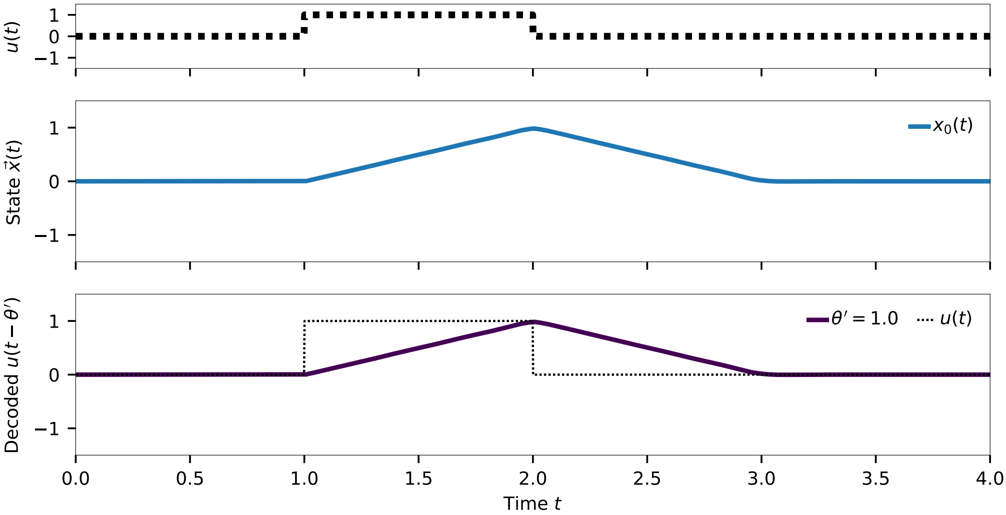


$$\theta \mathbf{A} = a_{ij} \in \mathbb{R}^{q \times q}\,, \qquad a_{ij} = \begin{cases} (2i+1)(-1) & i < j\,, \\ (2i+1)(-1)^{i-j+1} & i \geq j \end{cases}$$

$$\theta \mathbf{B} = b_i \in \mathbb{R}^{q}\,, \qquad b_i = (2i+1)(-1)^i$$

$$\mathbf{A}' = \tau \mathbf{A} + \mathbf{I} \qquad \mathbf{B}' = \tau \mathbf{B}$$

Delay Network: Step Function



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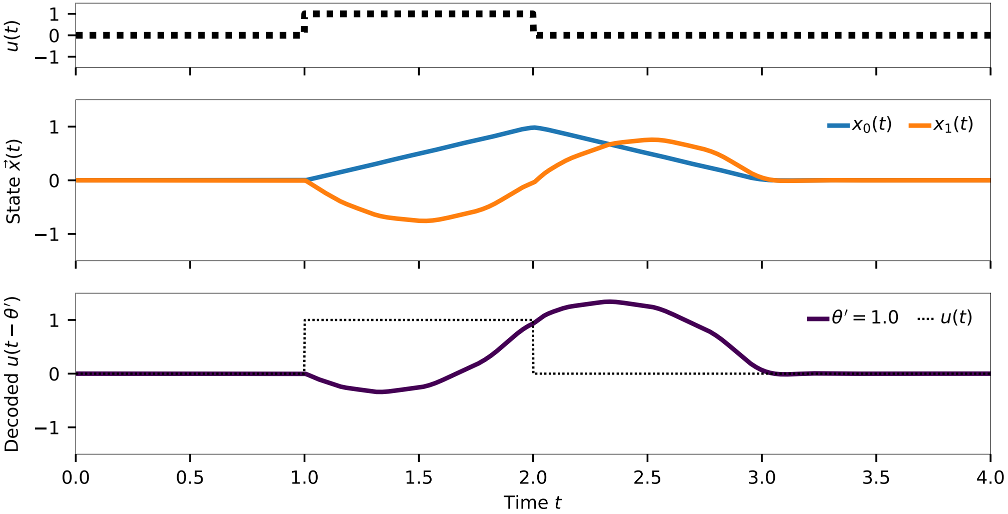

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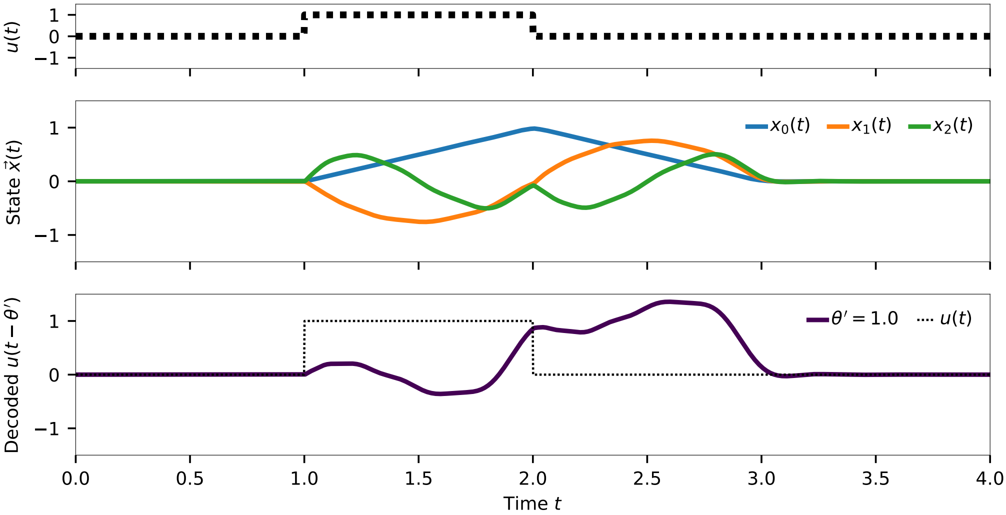

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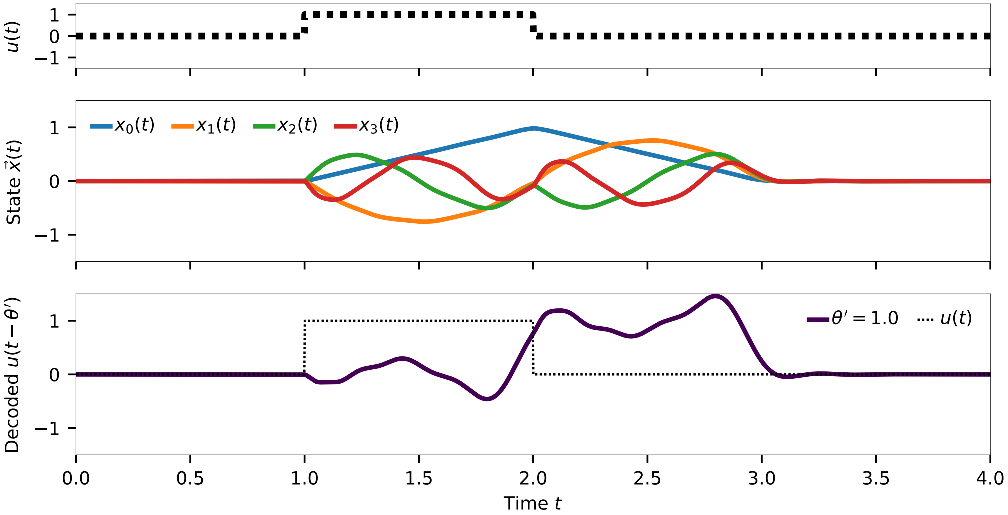

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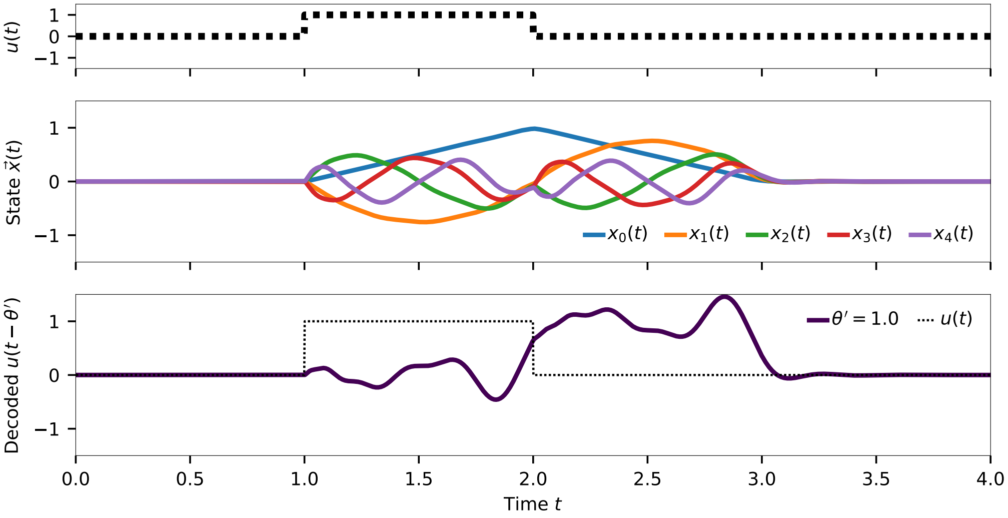

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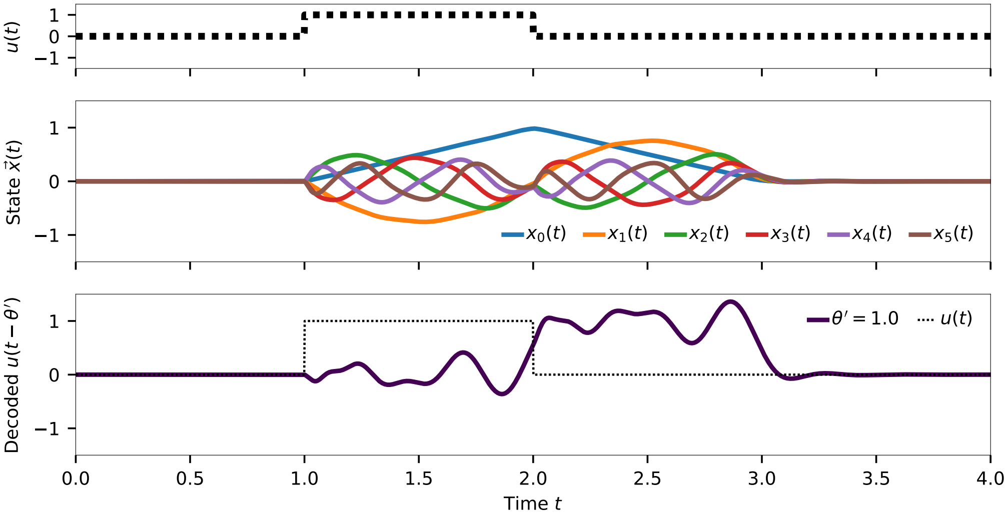
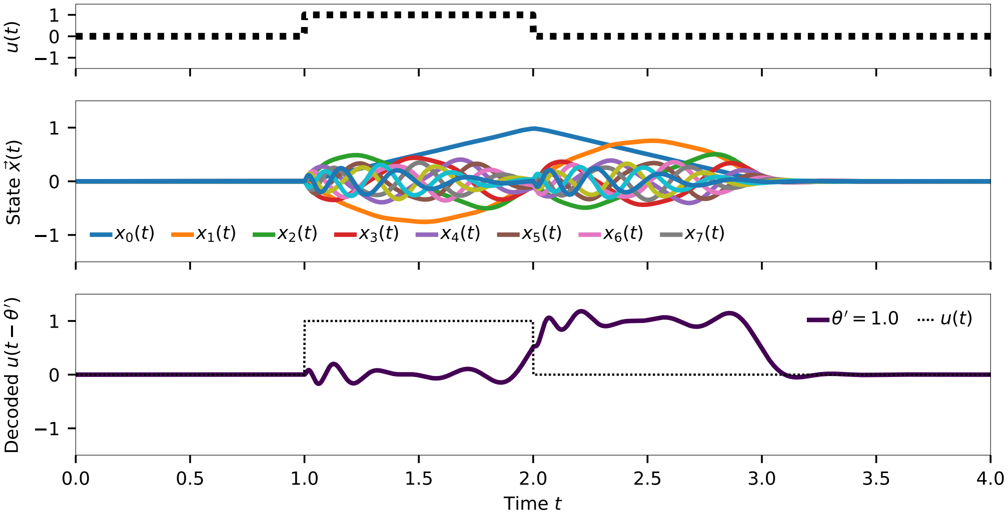
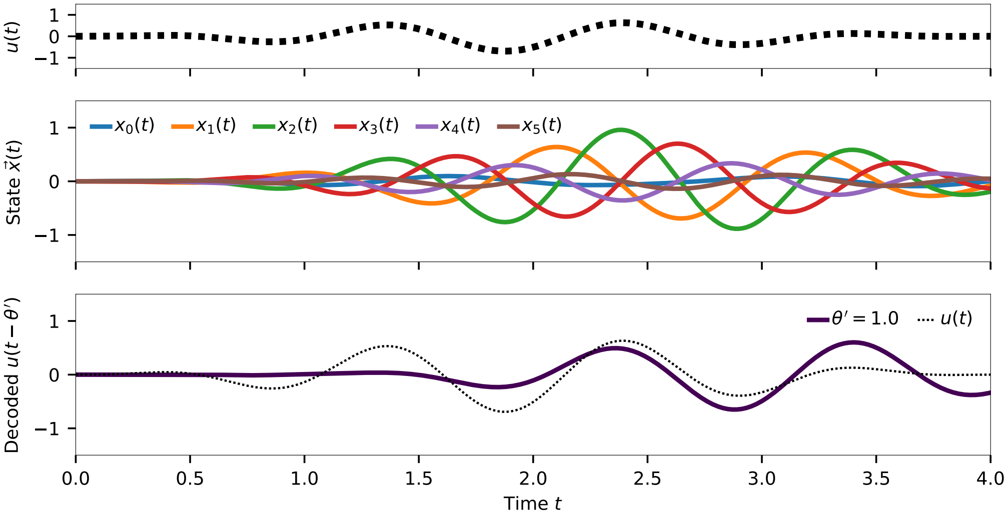


Delay Network: Step Function



Delay Network: Windowed Sine Function



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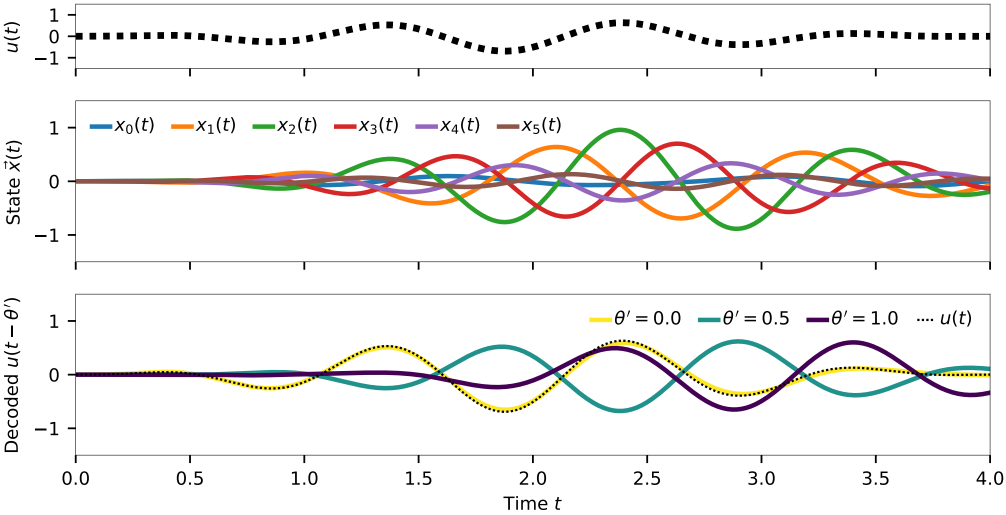

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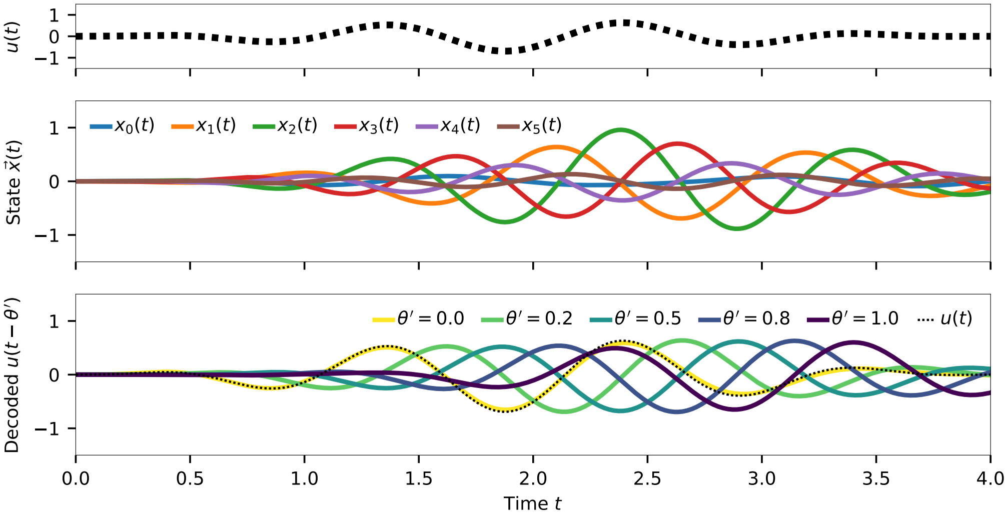

Image sources

Title slide
Infrared Photograph of a Sundial Near the Einstein Tower in Potsdam, Germany
Author: DrNRNowaczyk, 2007.
From Wikimedia.