# SYDE 556/750

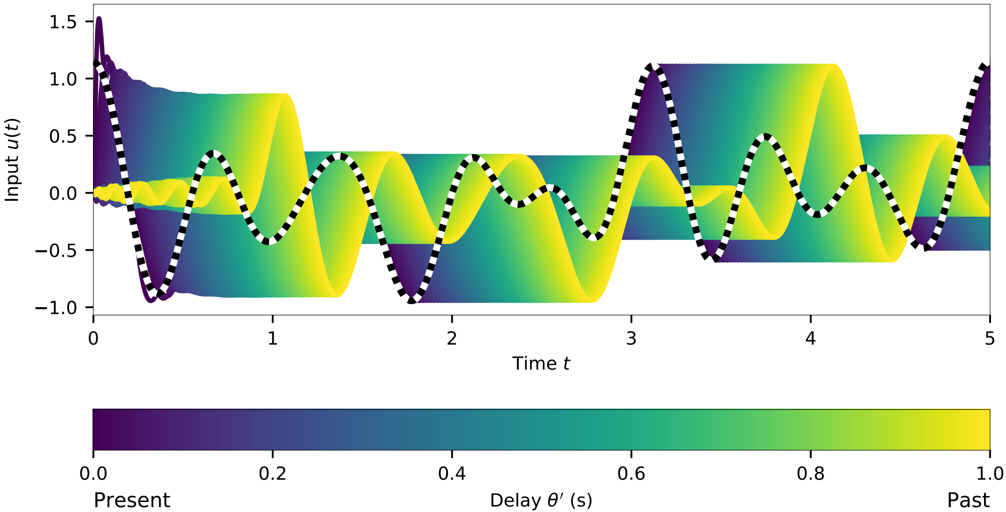
## Simulating Neurobiological Systems
## Lecture 7: Temporal Basis Functions

Andreas Stöckel

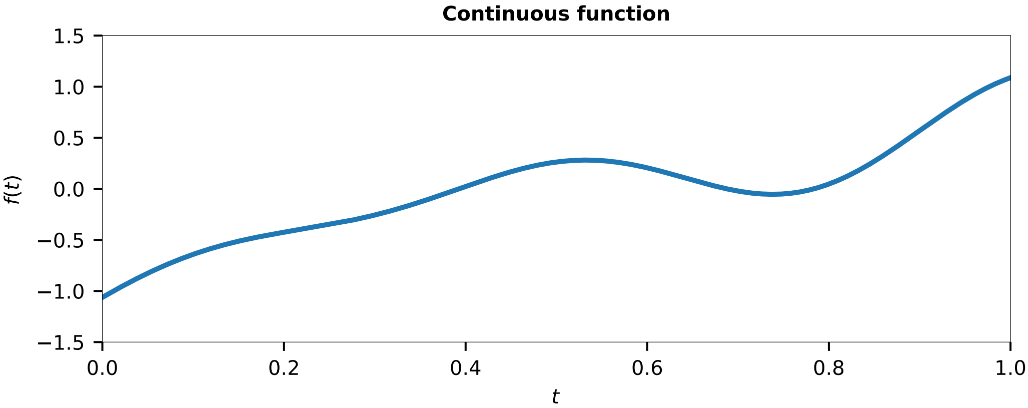
February 13, 2020

UNIVERSITY OF WATERLOO | FACULTY OF ENGINEERING

# Representing Stimulus Histories



# Representing Functions: Sampling



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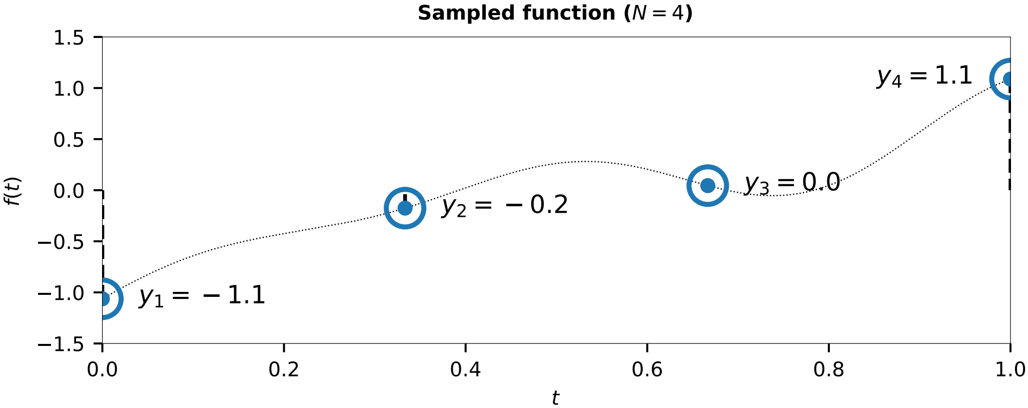

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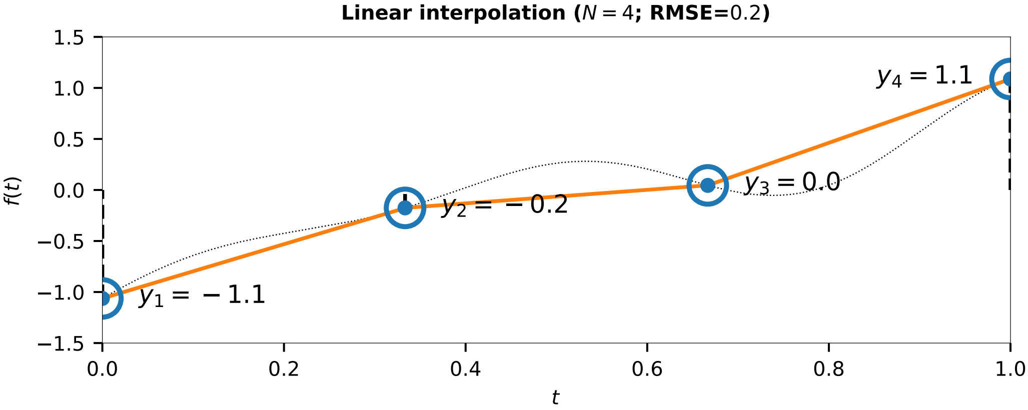

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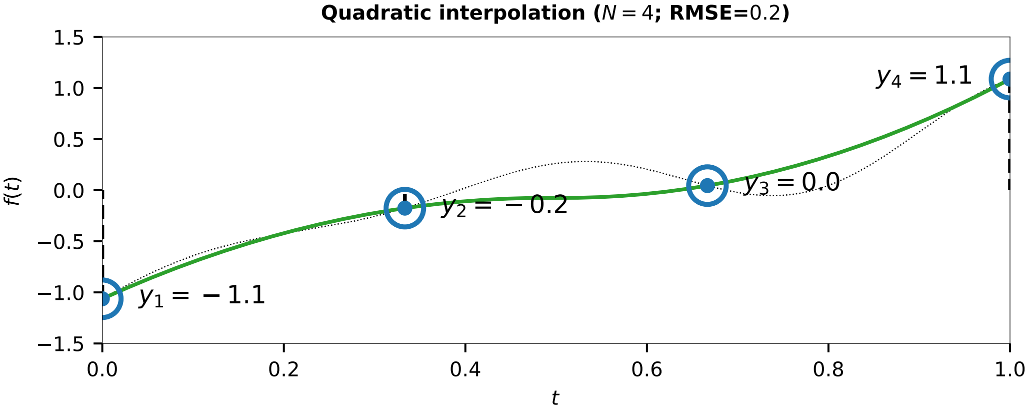

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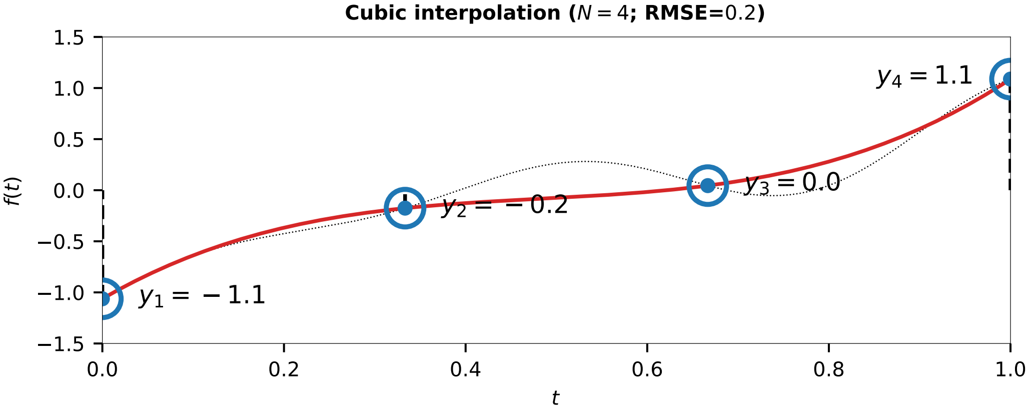

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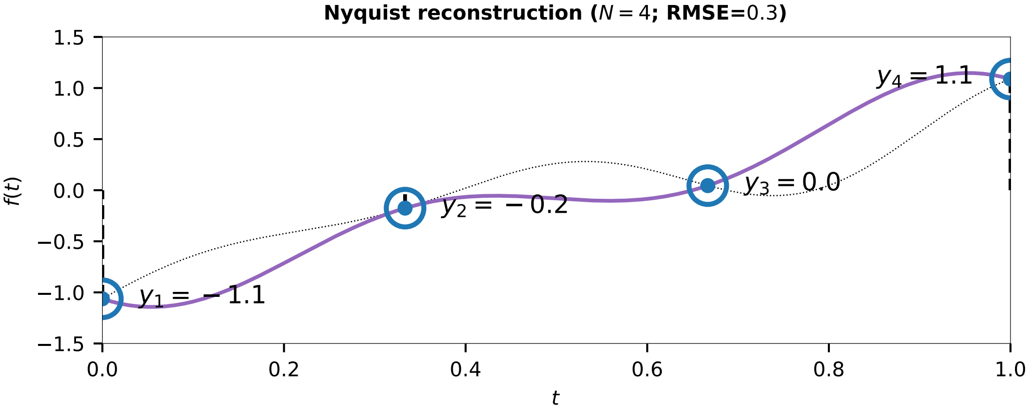

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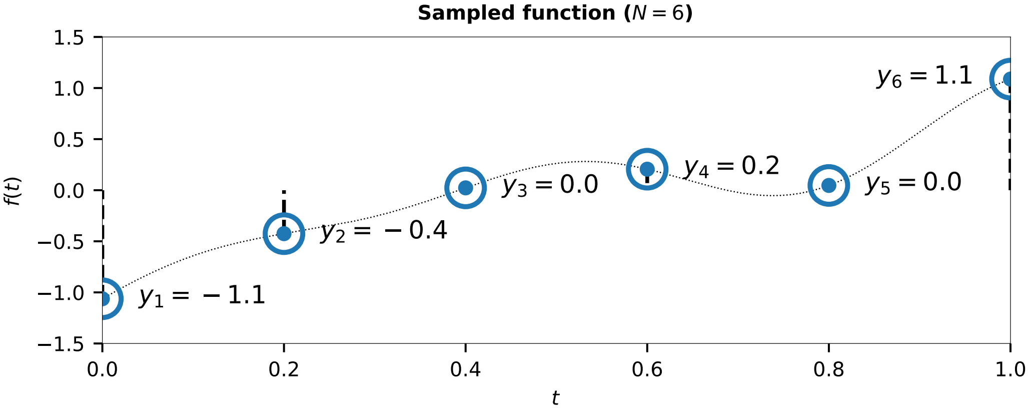

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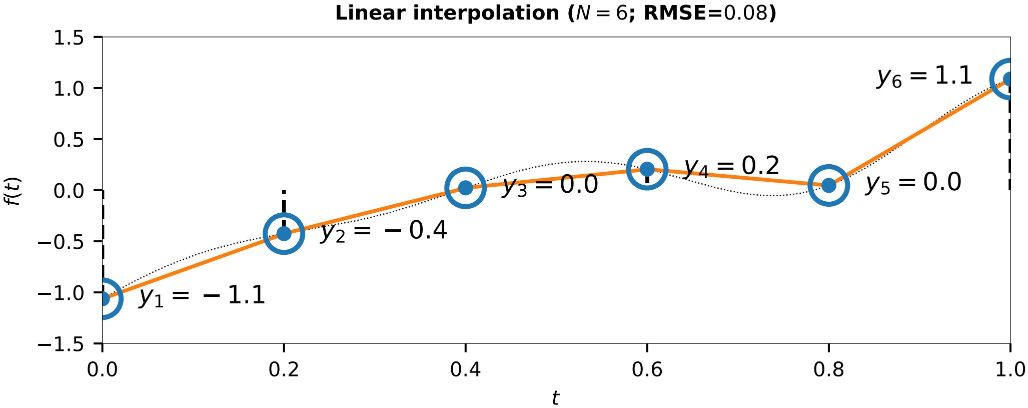

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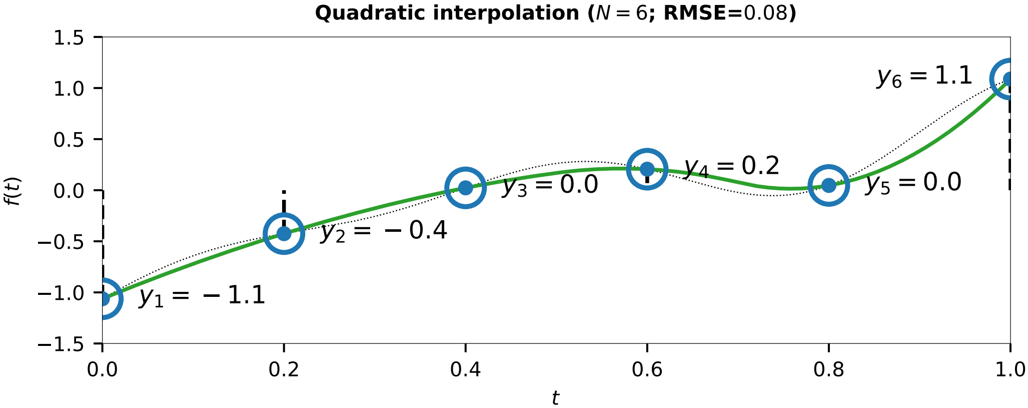

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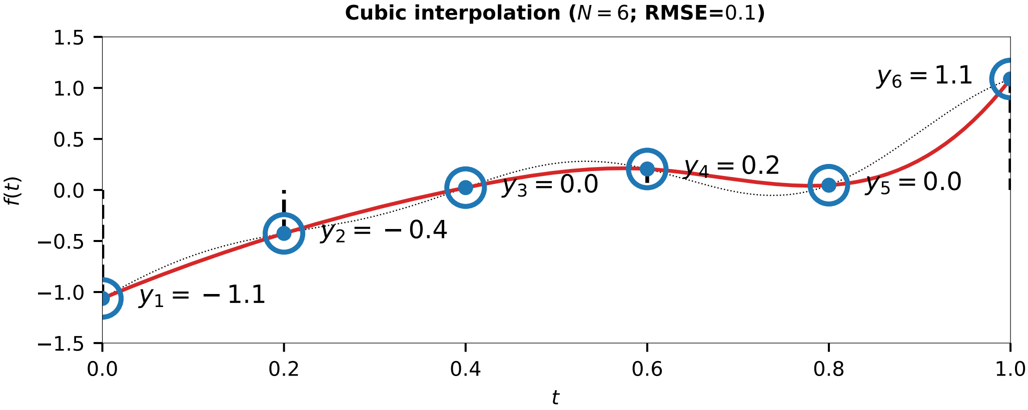

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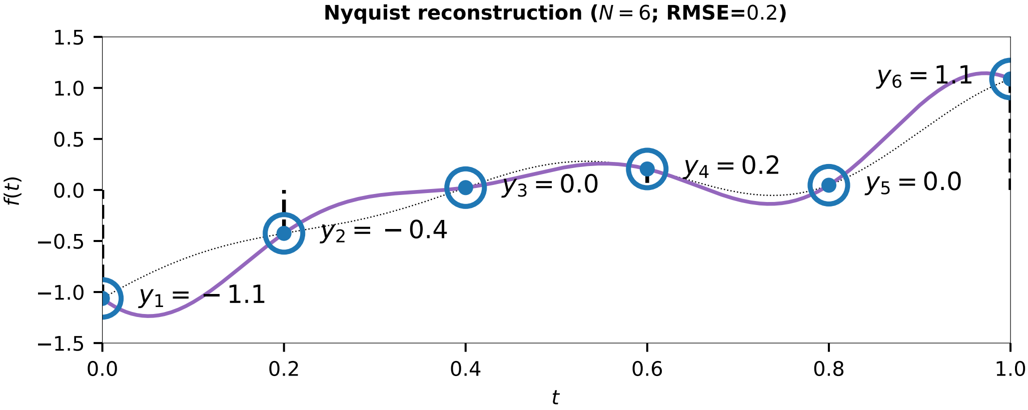

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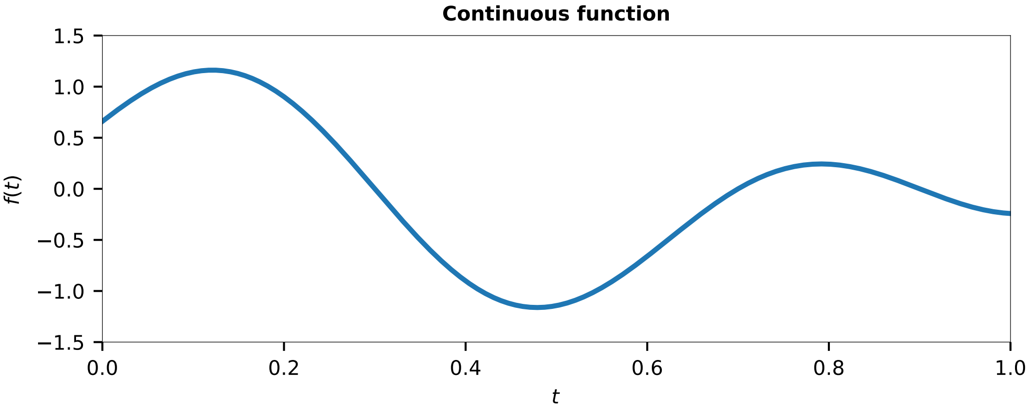

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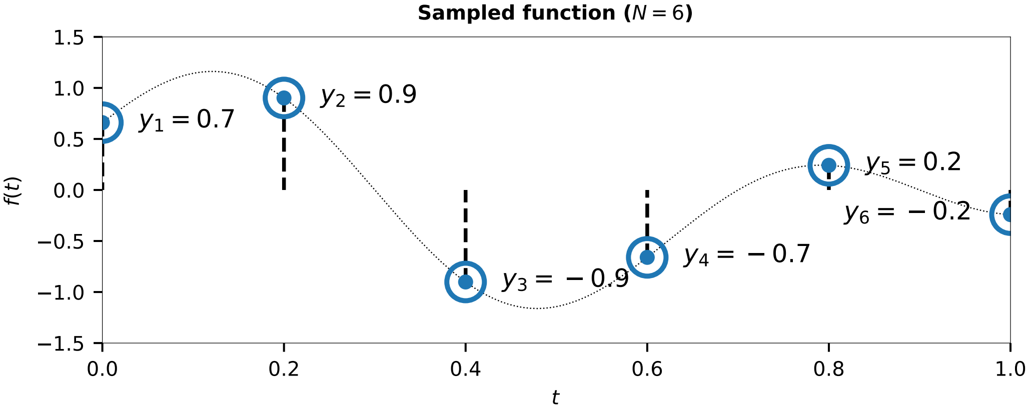

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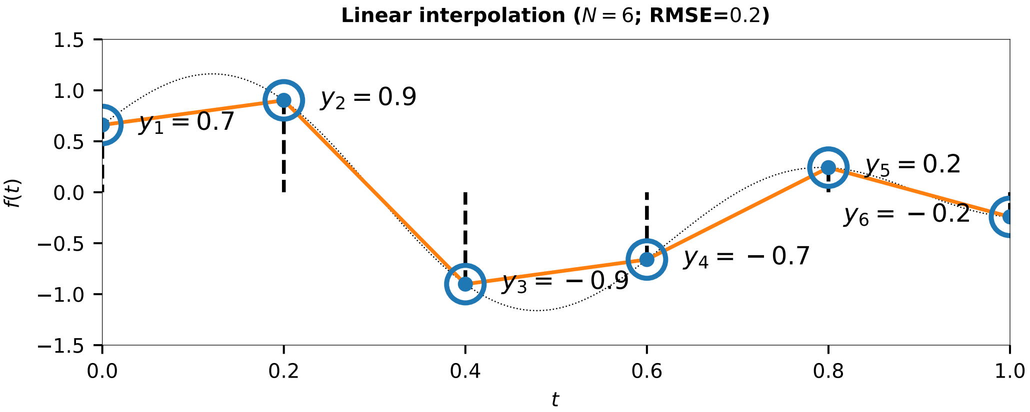

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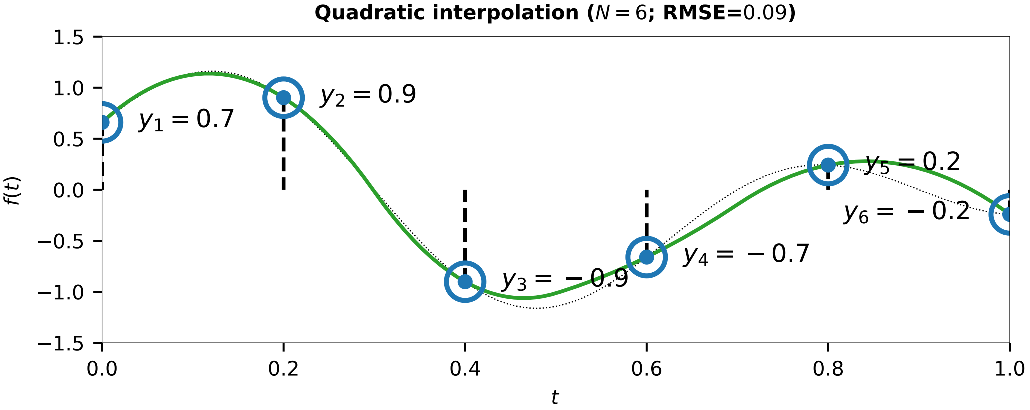

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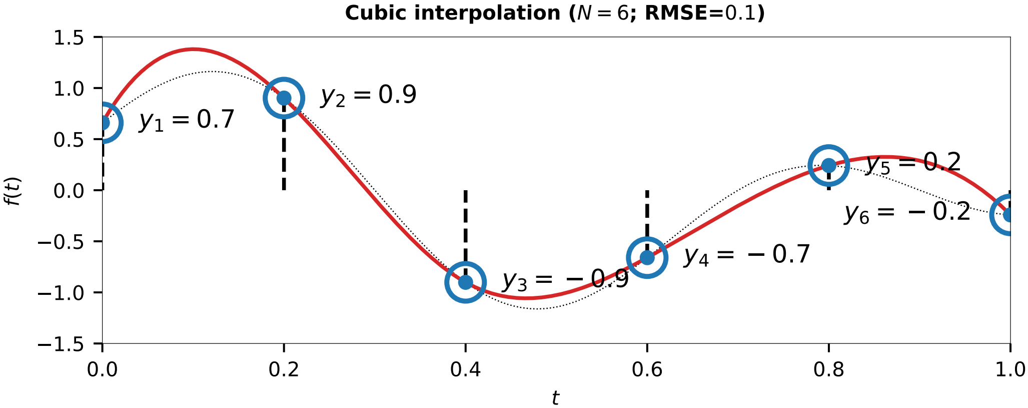

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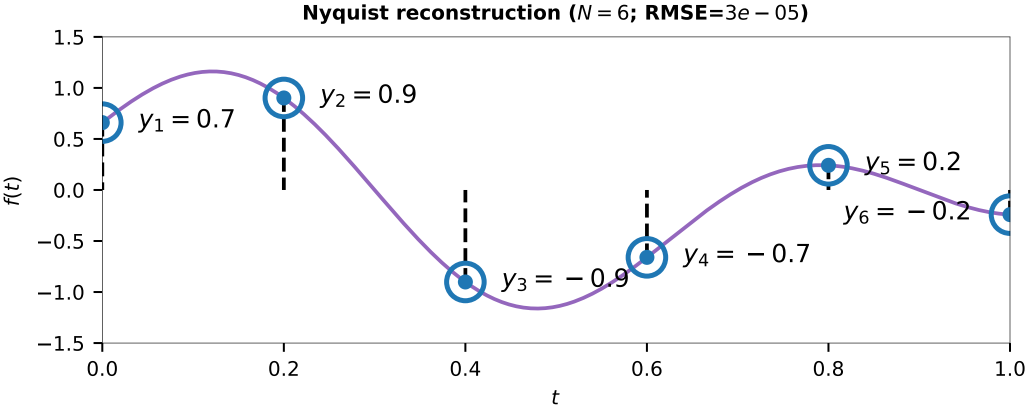

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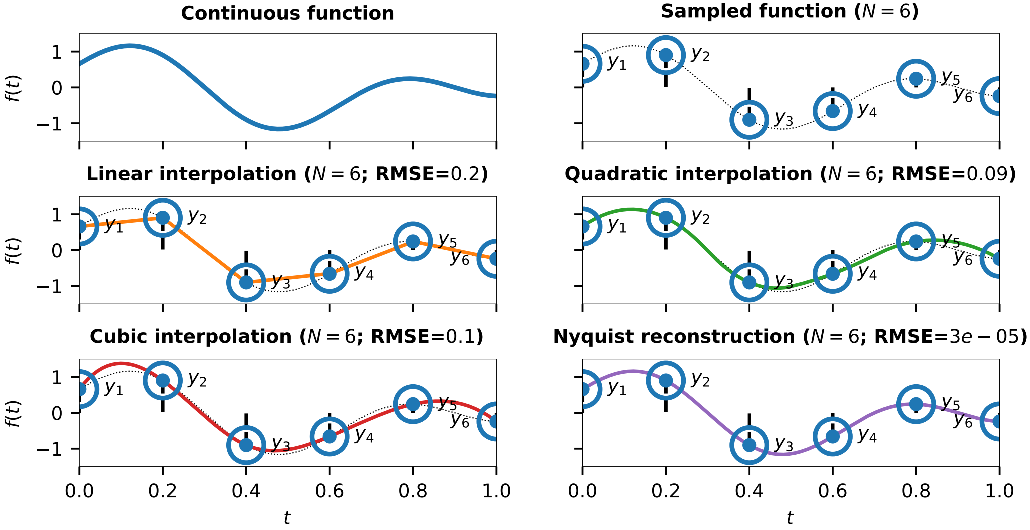
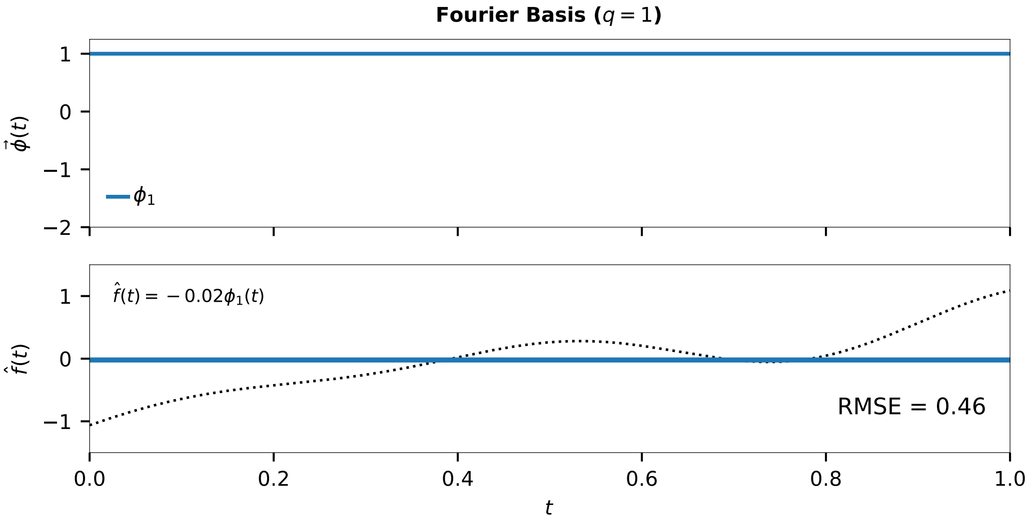


# Representing Functions: Fourier Basis



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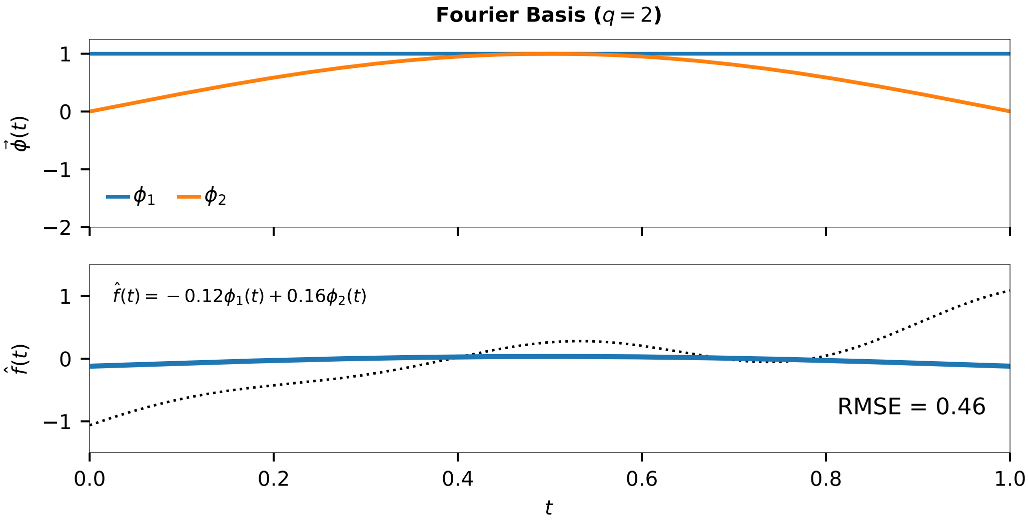

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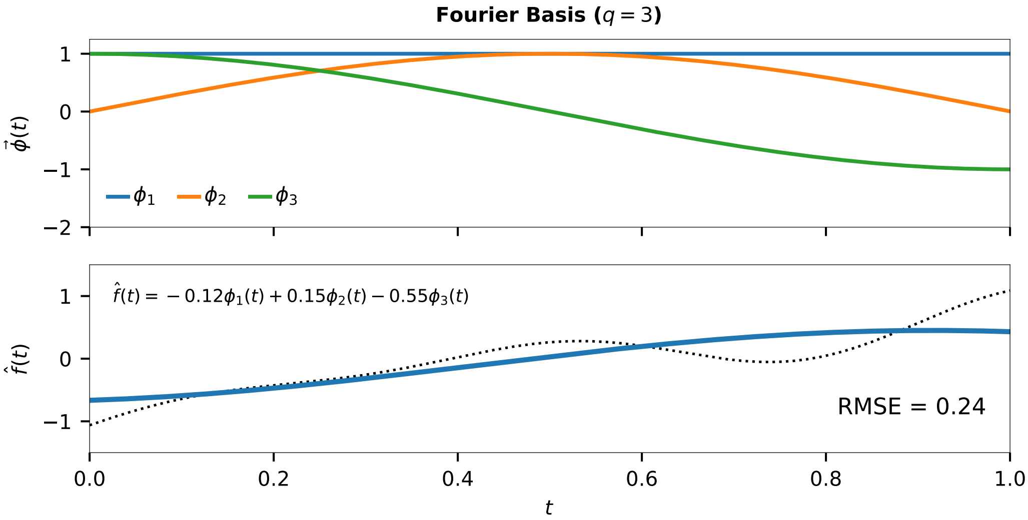

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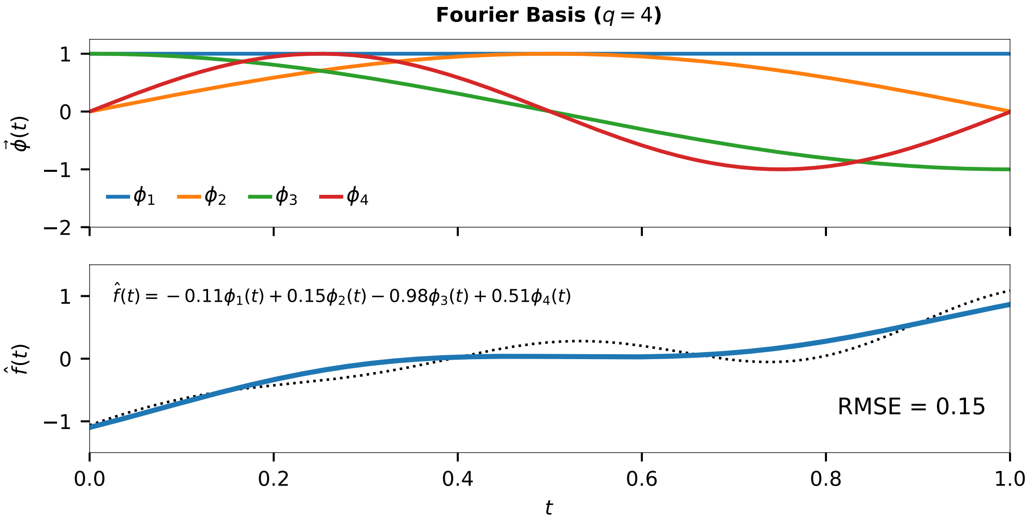

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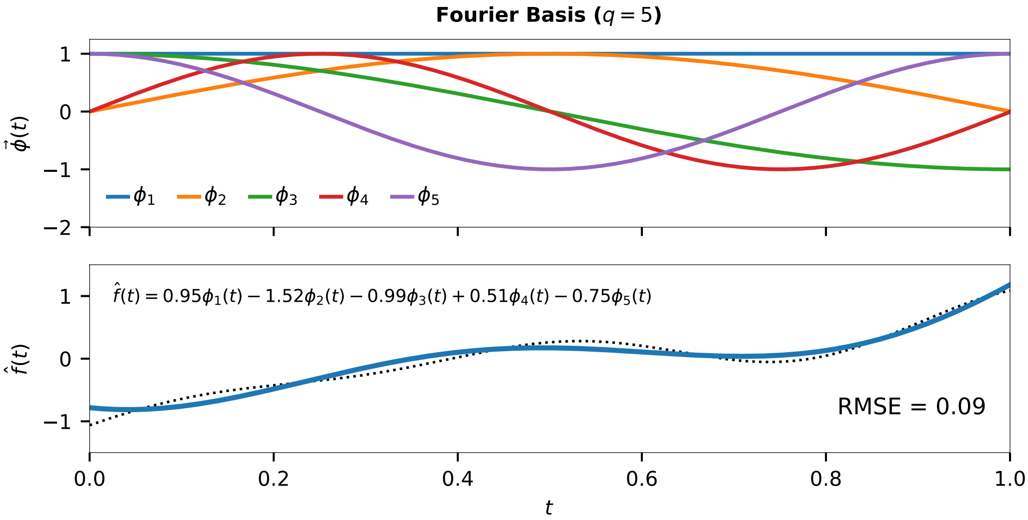

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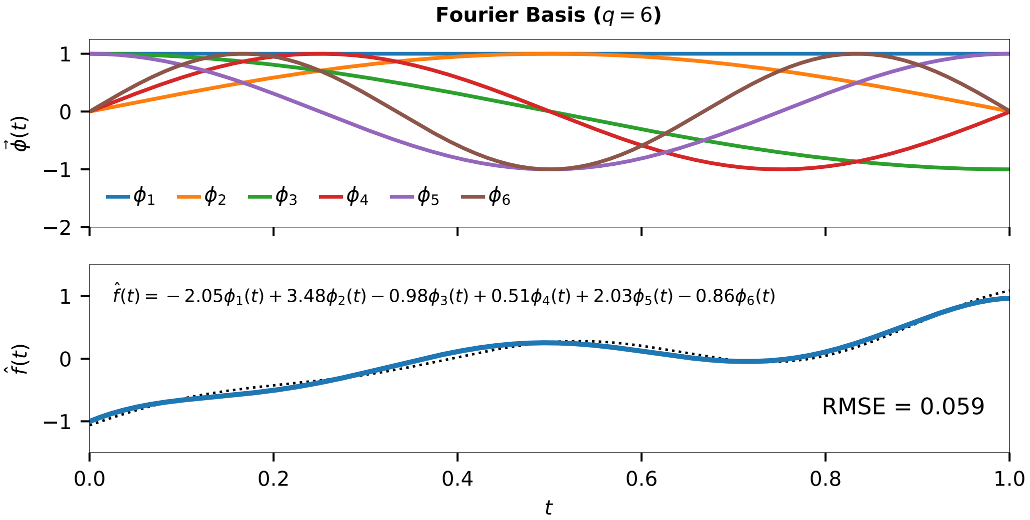
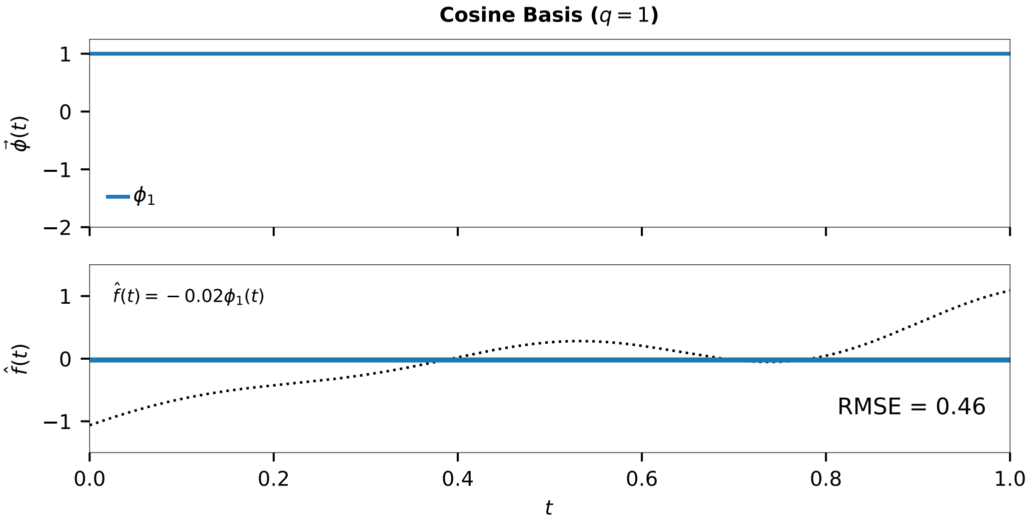


# Representing Functions: Cosine Basis



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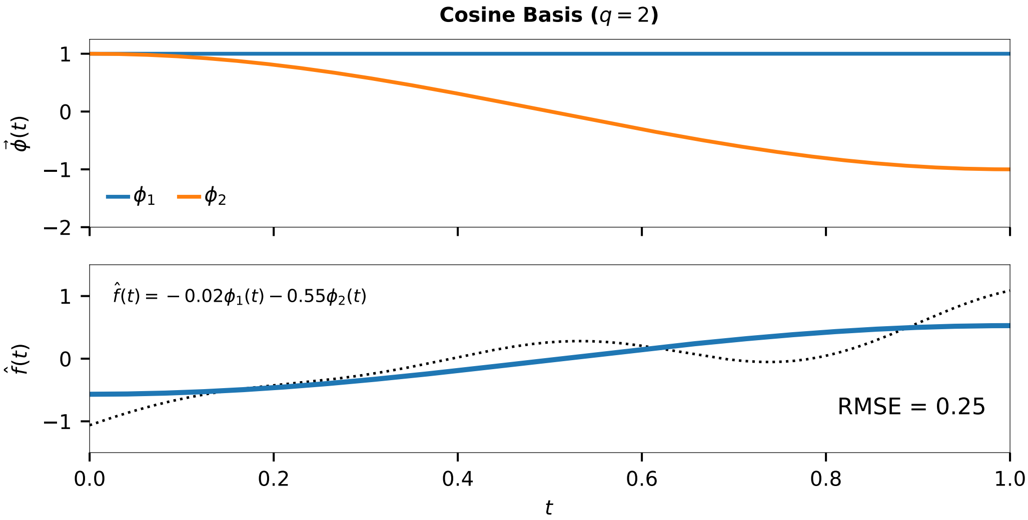

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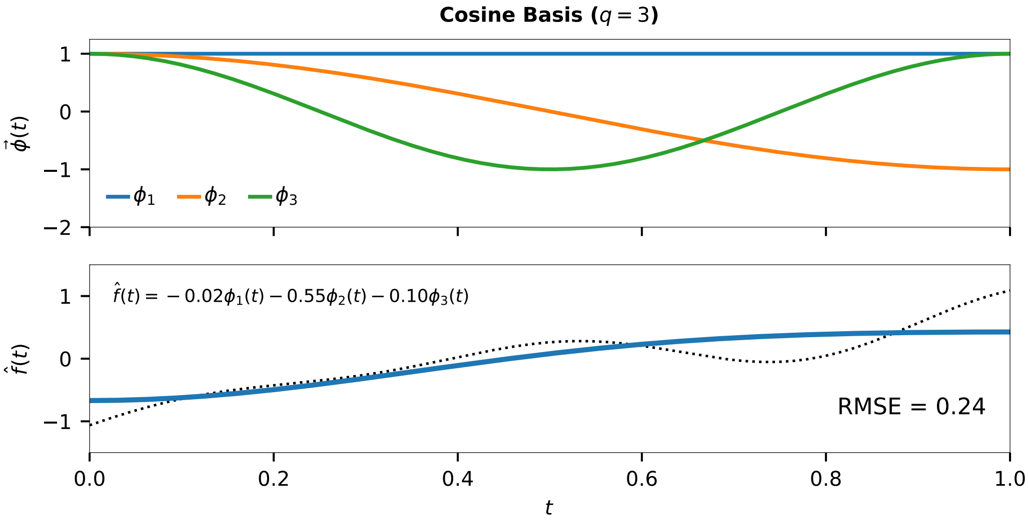

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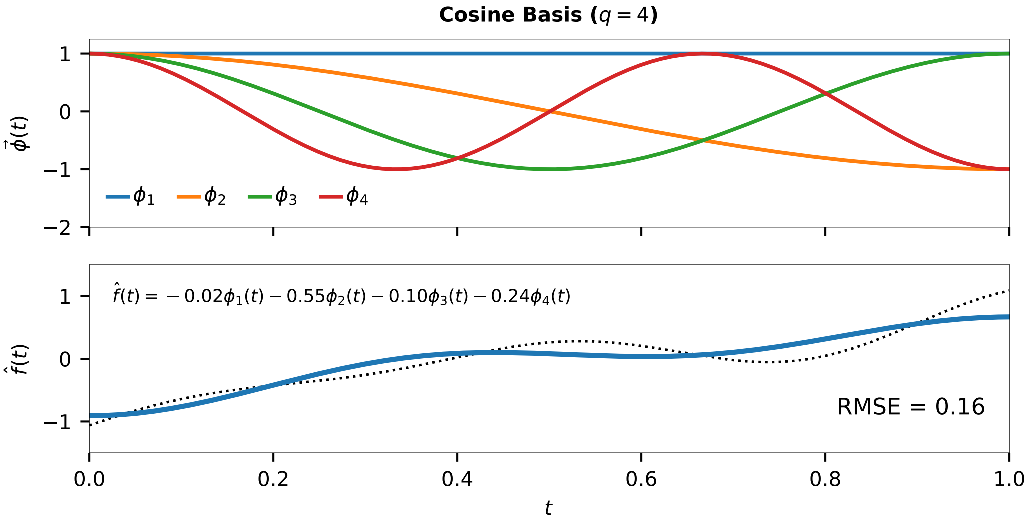

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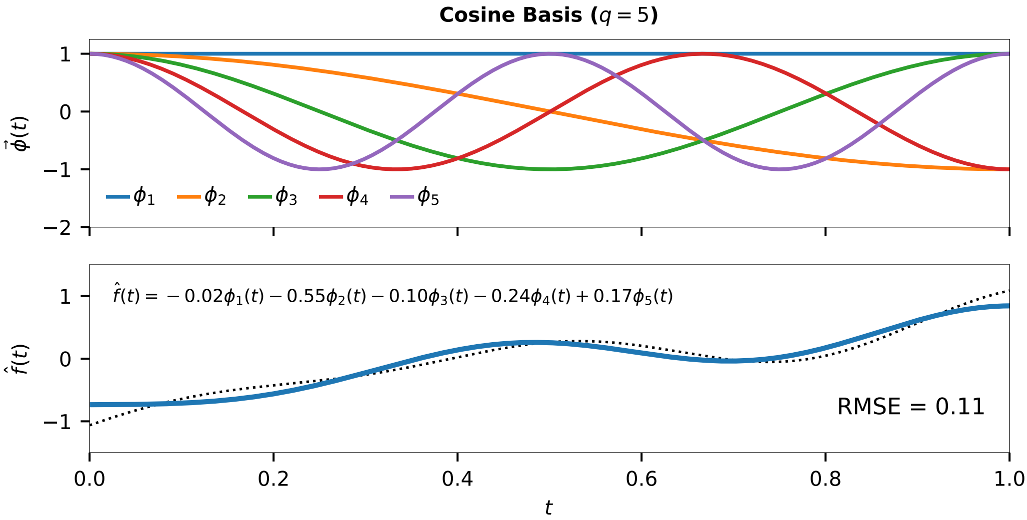

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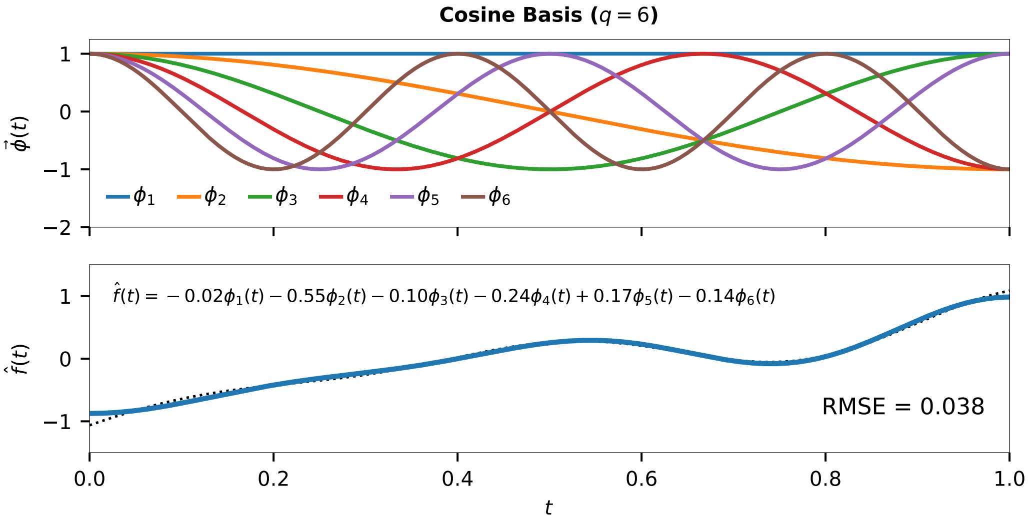
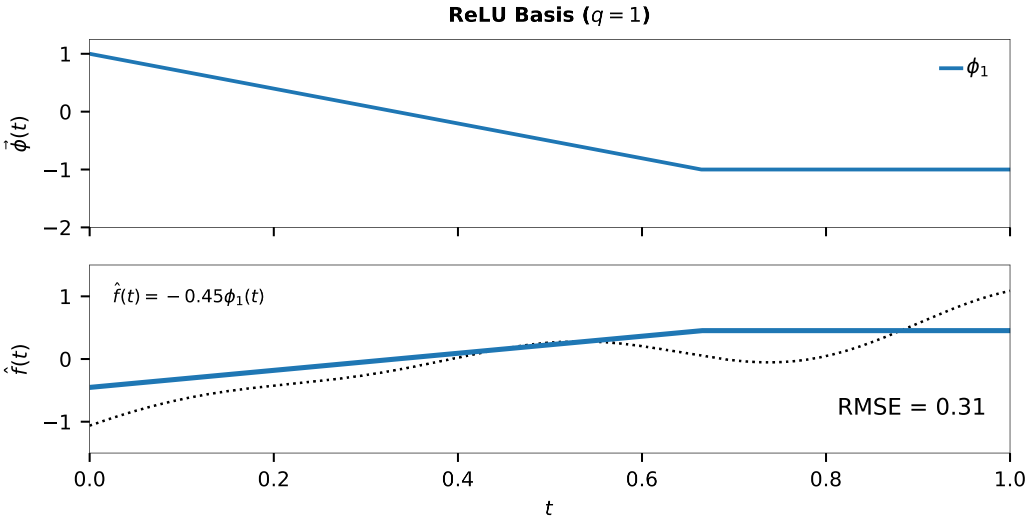


# Representing Functions: ReLU Basis



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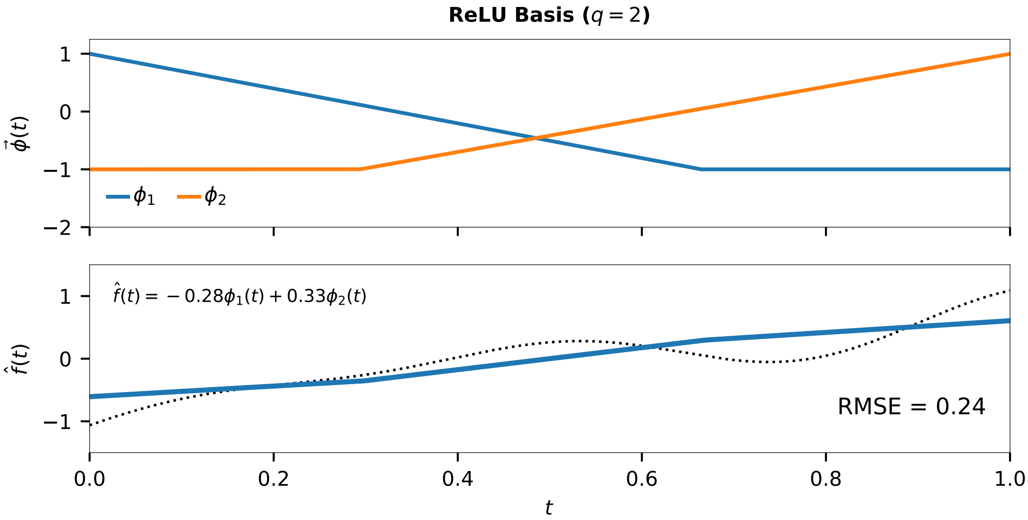

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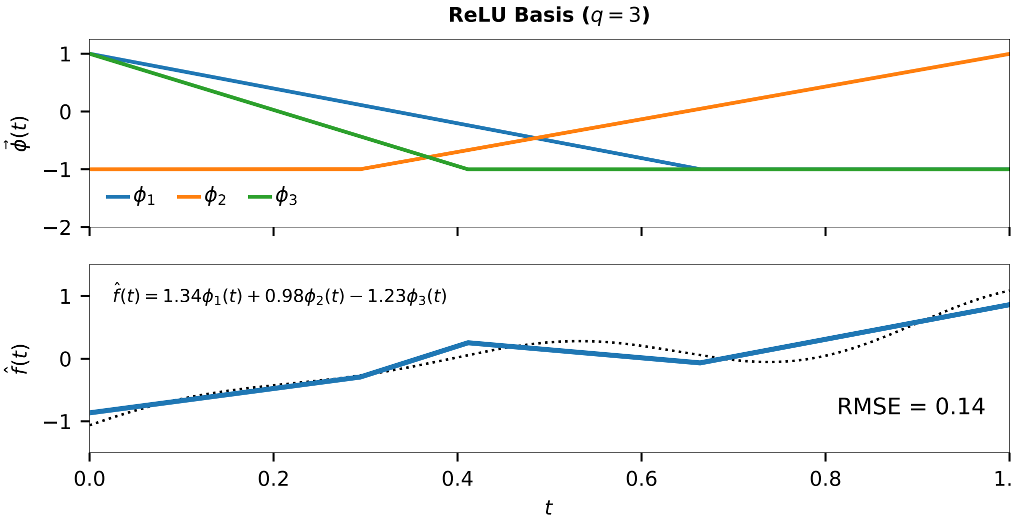

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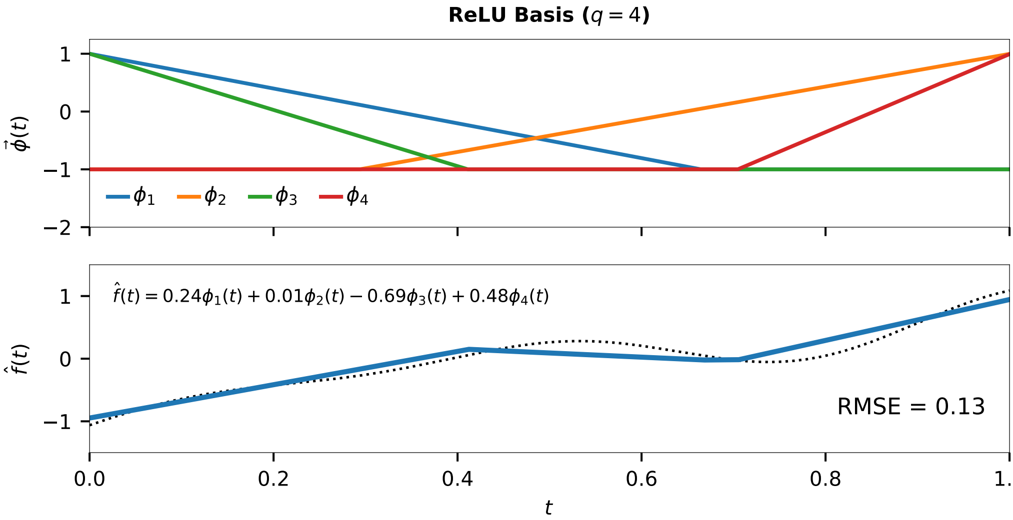

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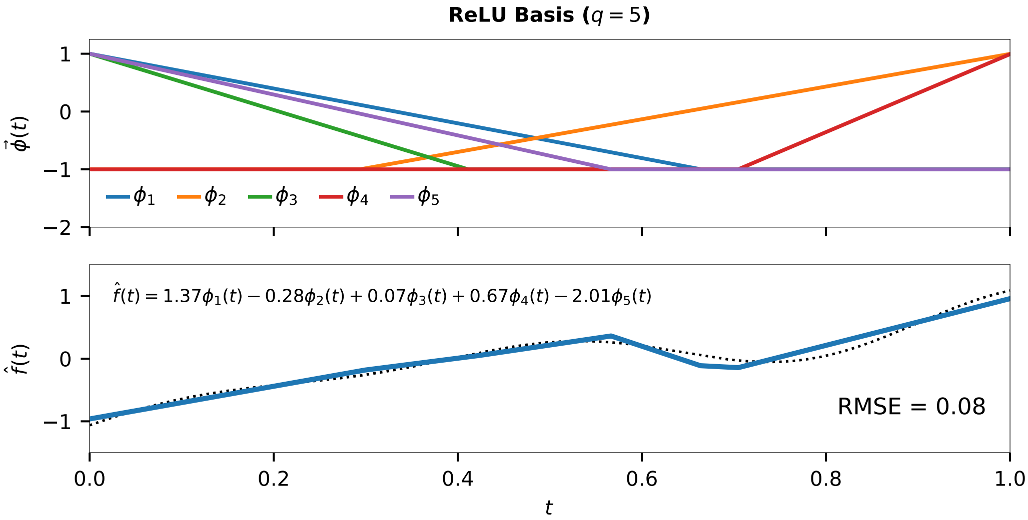

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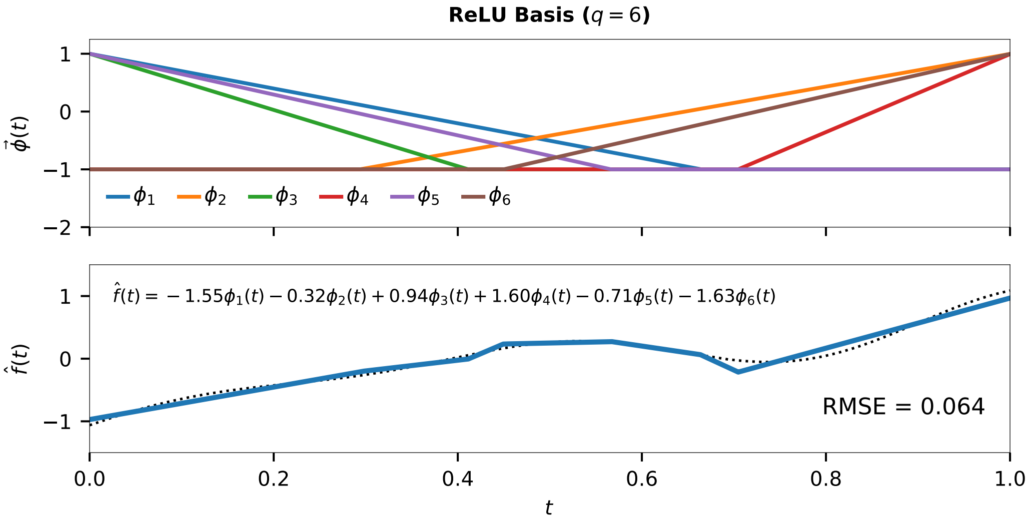
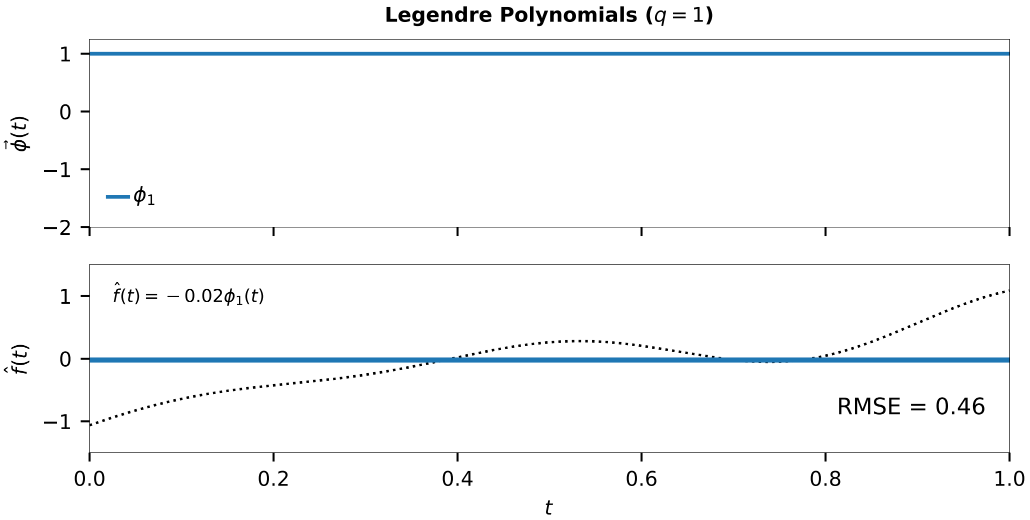


# Representing Functions: Legendre Basis



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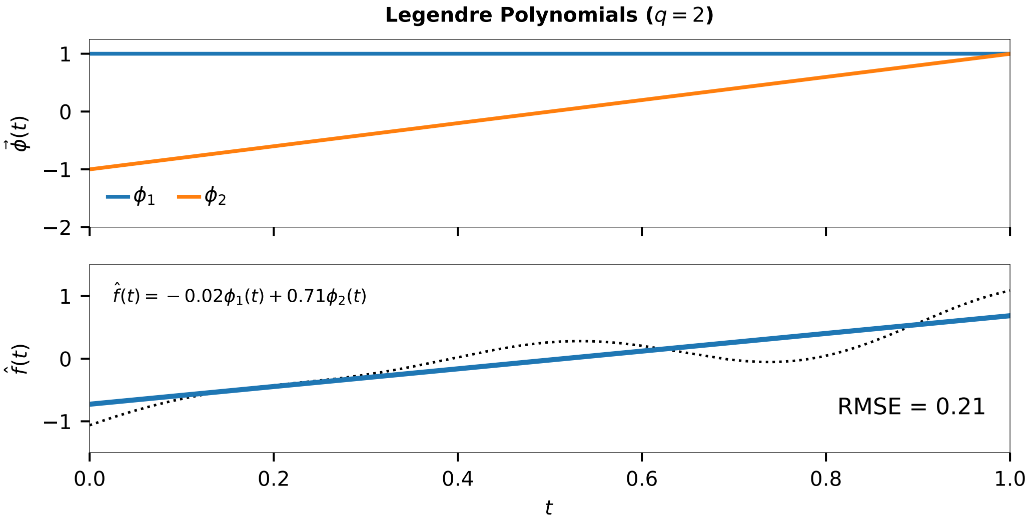

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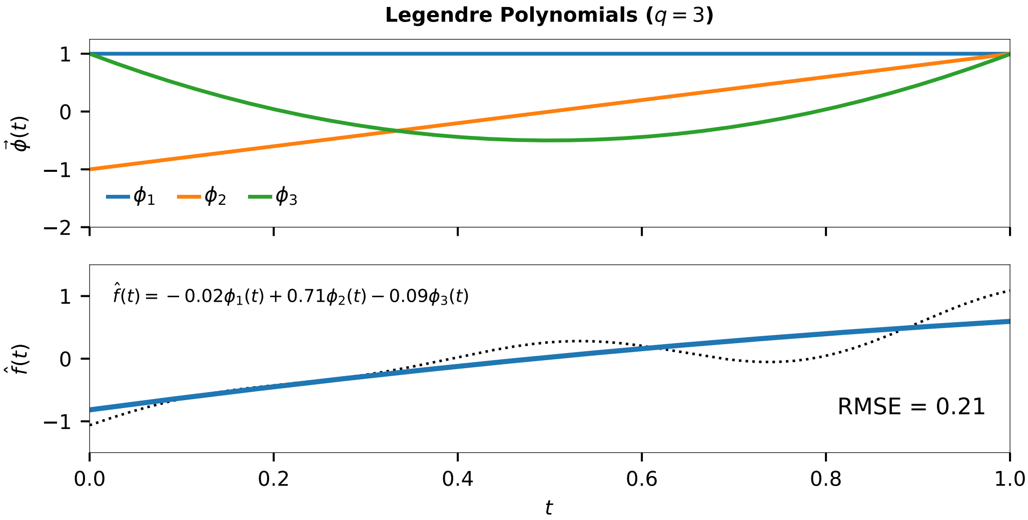

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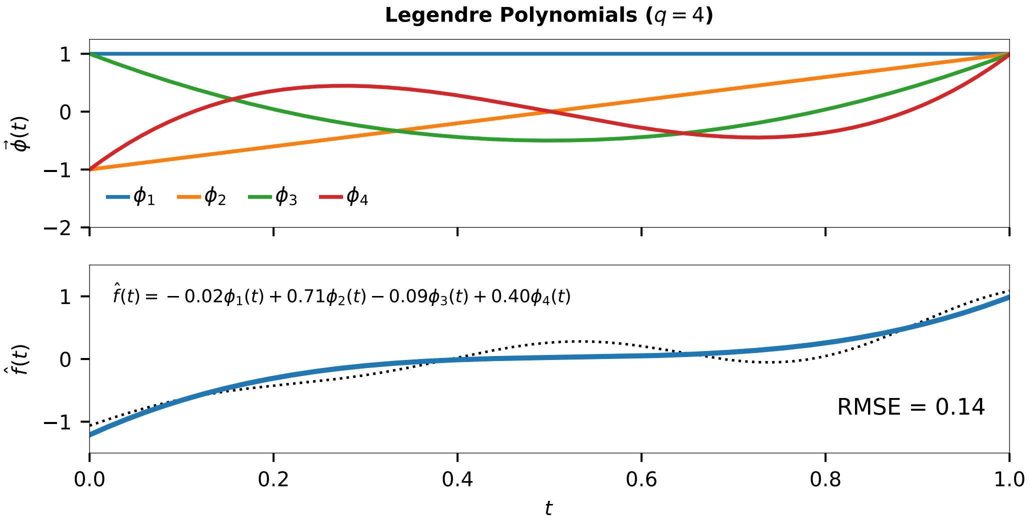

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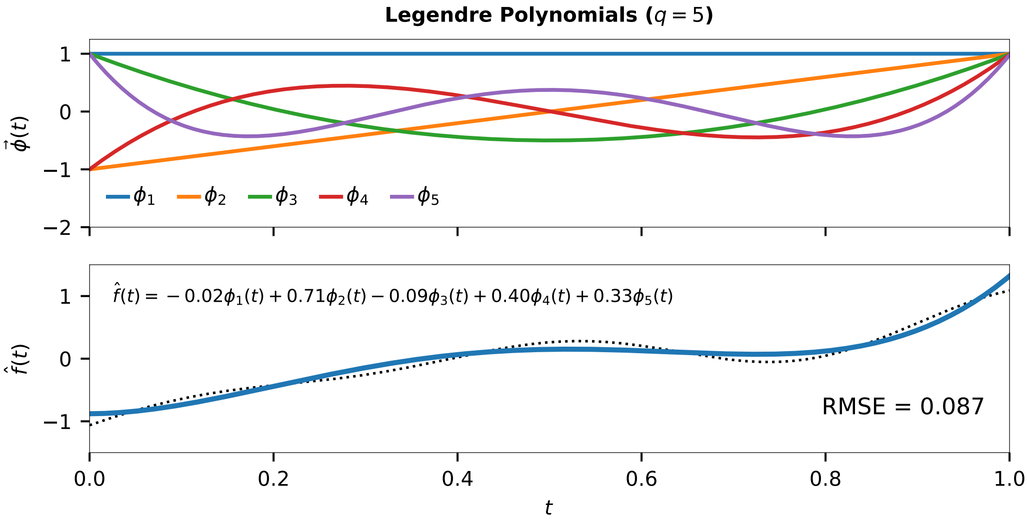

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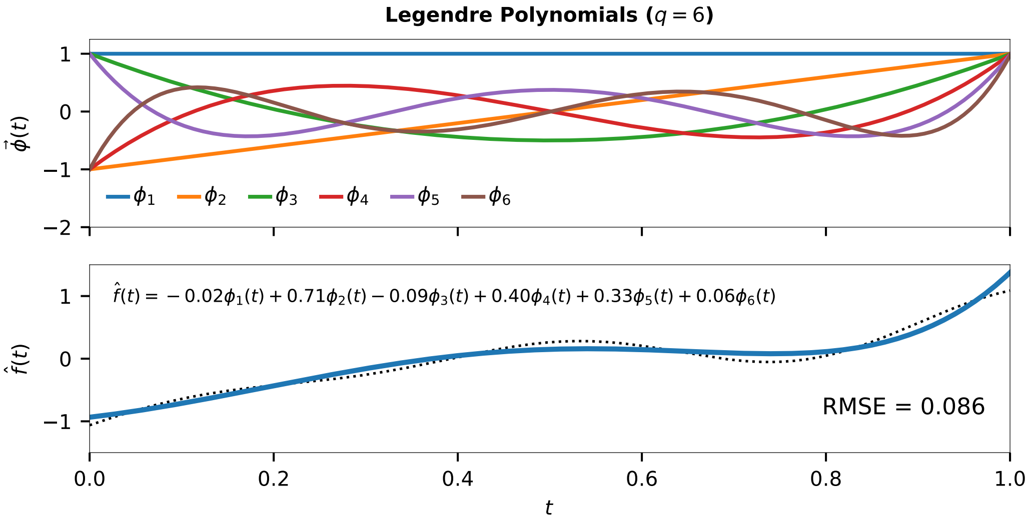
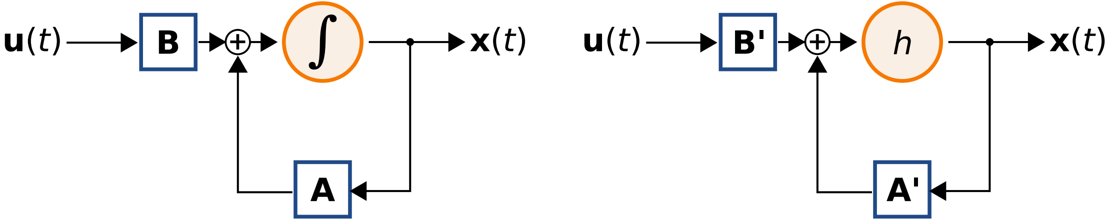


# Implementing the Delay Network

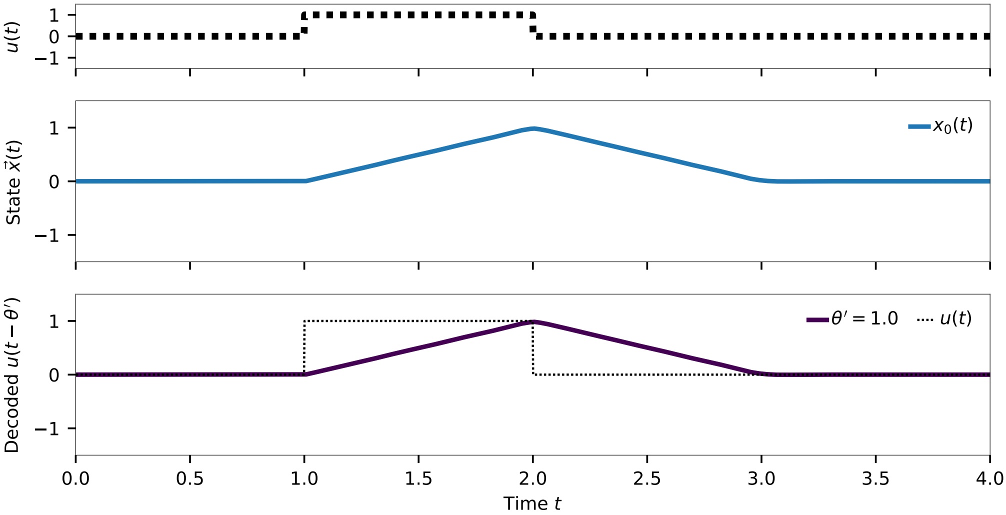



$$\theta\mathbf{A} = a_{ij} \in \mathbb{R}^{q\times q}\,, \qquad a_{ij} = \begin{cases} (2i+1)(-1) & i < j\,, \\ (2i+1)(-1)^{i-j+1} & i \geq j \end{cases}$$

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

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

# Delay Network: Step Function



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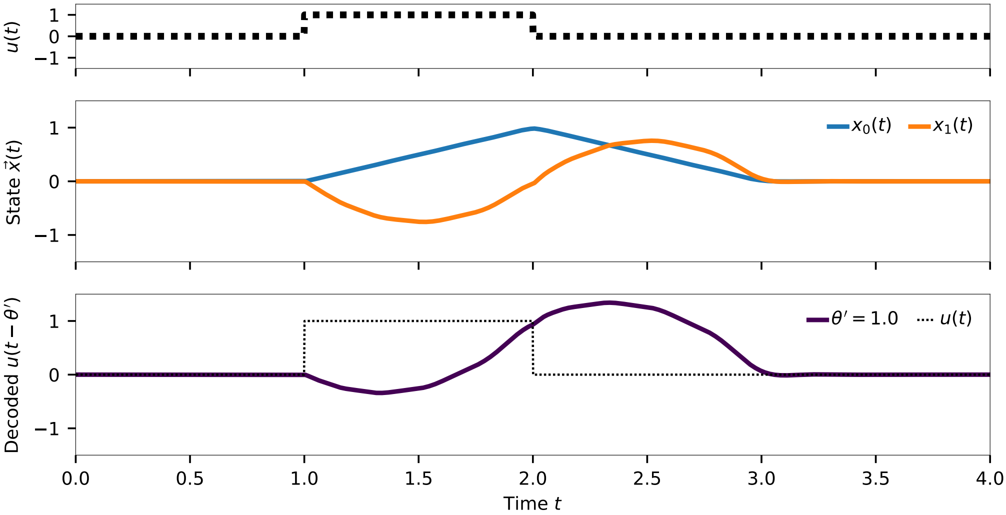

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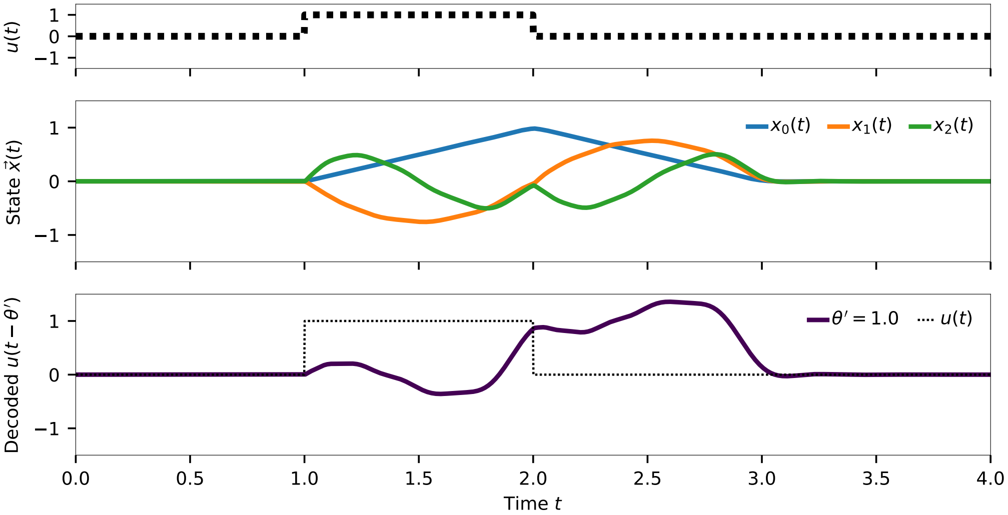

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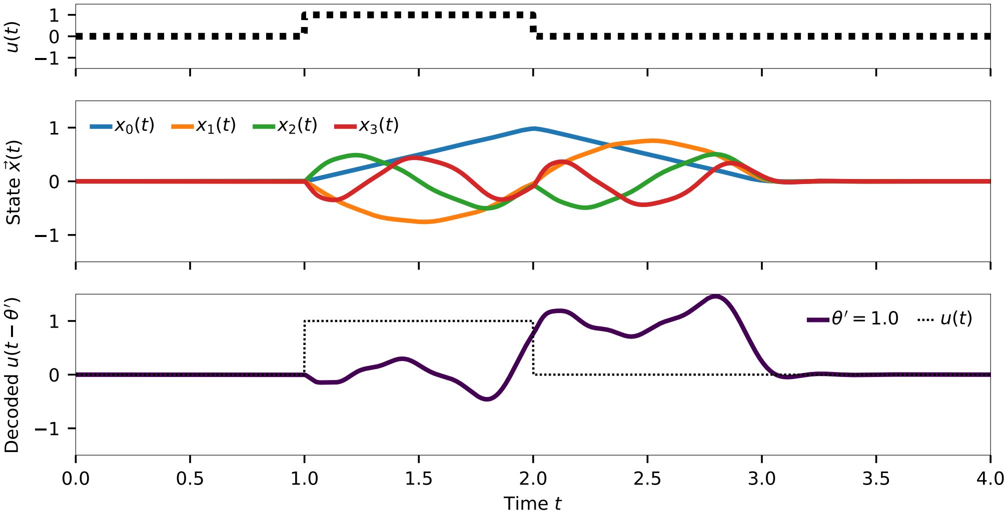

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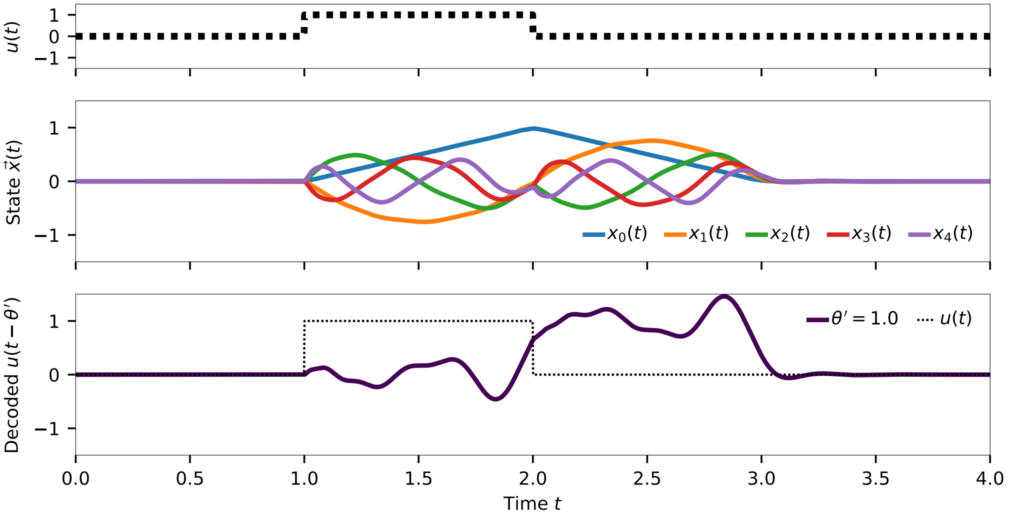

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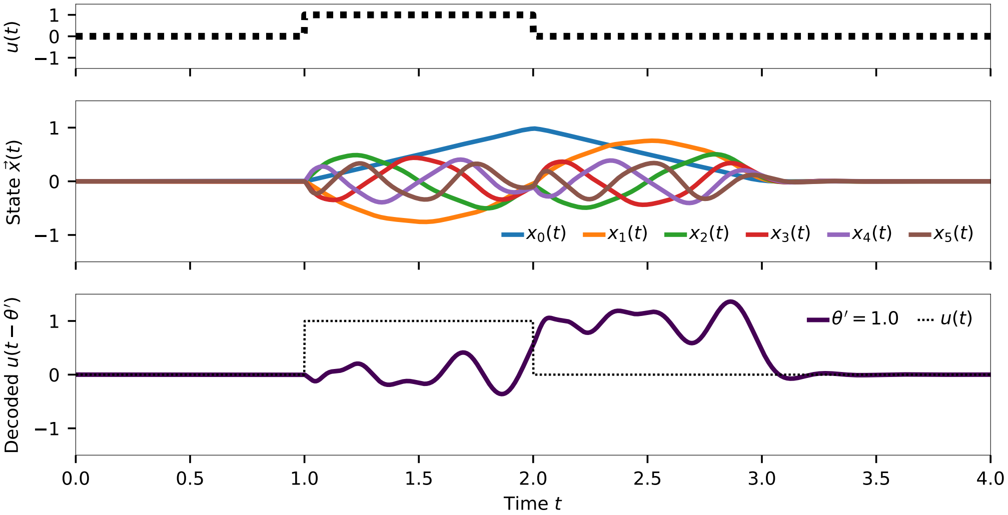

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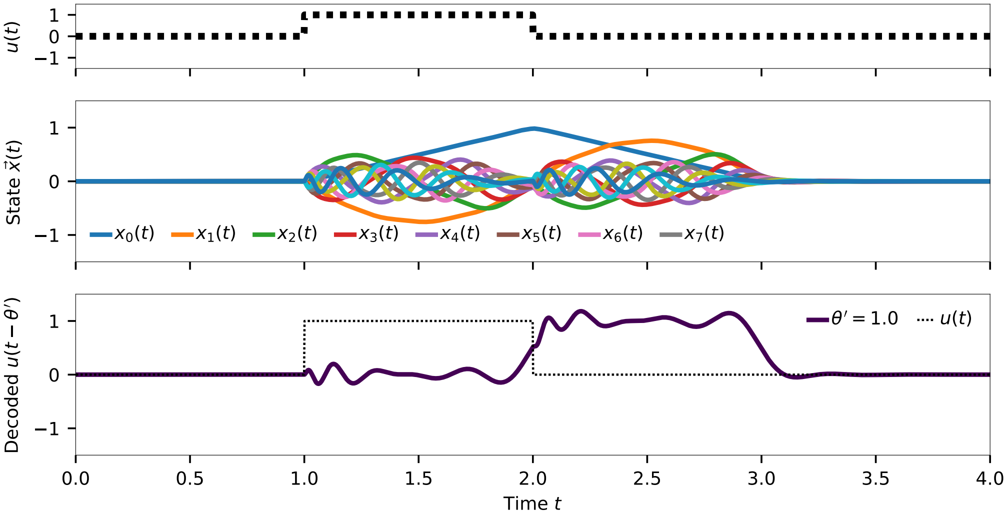
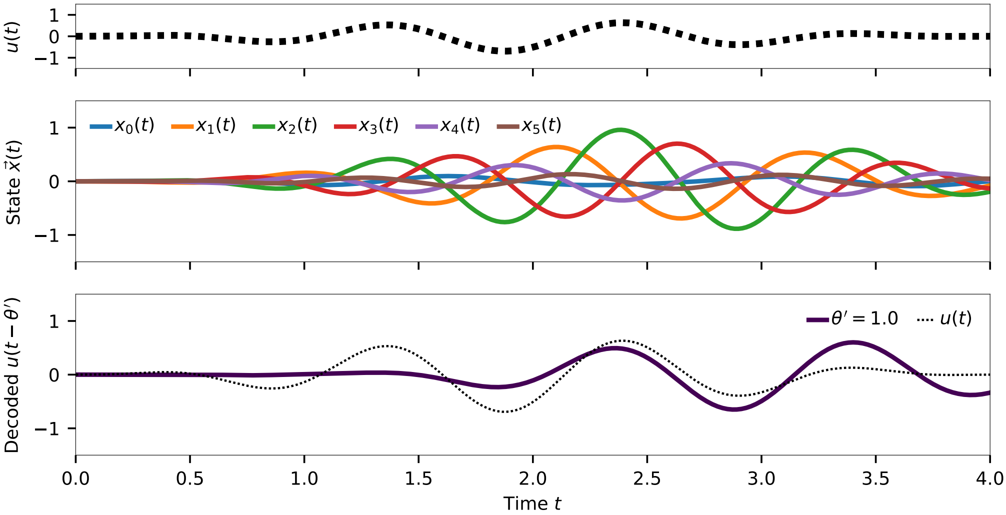


# Delay Network: Windowed Sine Function



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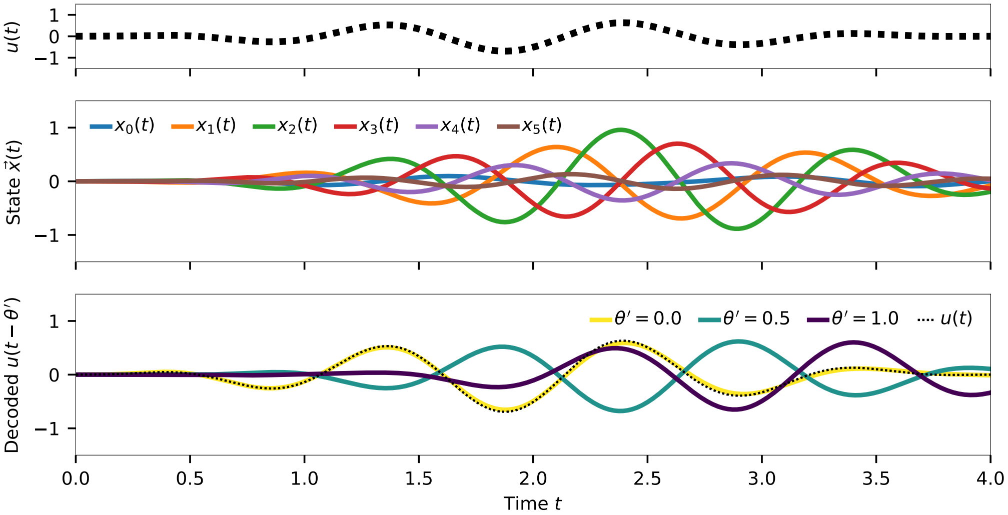

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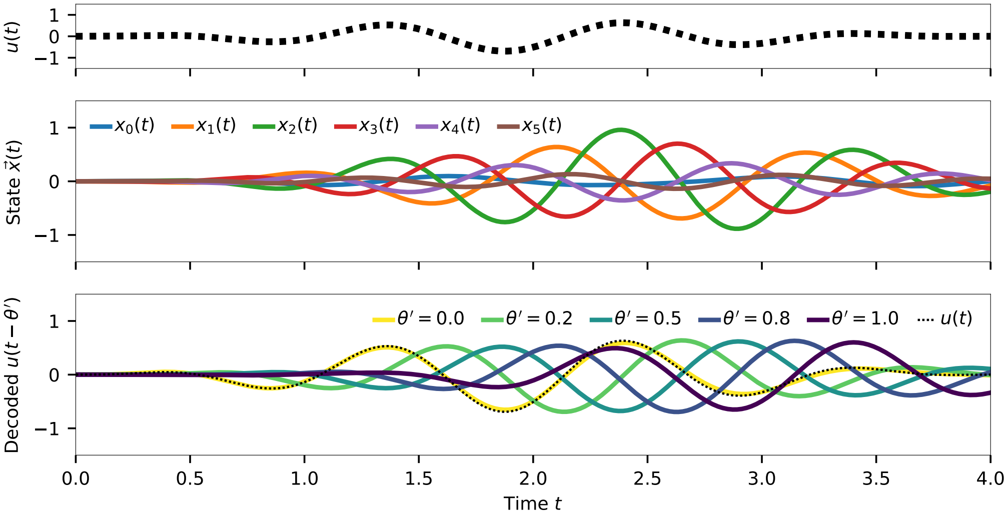

# Image sources

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