Functional Data Analysis (Lecture 2) – FDA package: basics

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FDA toolkit

- Object-oriented Matlab/R toolbox.
- Link:

  `http://www.psych.mcgill.ca/misc/fda/downloads/FDAfuns/Matlab/fdaMatlab.zip`

Basis system: $\{\phi_k\}_{k=1}^{B}$

Create basis system: basis object

Relevant functions:

```
create_fourier_basis
create_bspline_basis
create_monomial_basis
create_constant_basis
```

Useful:

```
>>help myclass
>>doc myclass
```

Fourier basis

Ordering:

$$\phi_1(t) = 1, \phi_2(t) = \sin(\omega t), \phi_3(t) = \cos(\omega t), \ldots$$

On $[a, b]$ with $B = |\text{basis}|$ and given period$= \frac{2\pi}{\omega}$:

```
>>basis_Fourier  = create_fourier_basis([0,2*pi],5);
>>basis_Fourier2 = create_fourier_basis([0,2*pi],5,pi);

>>figure; plot(basis_Fourier);
>>figure; plot(basis_Fourier(1:3)); %drop basis functions
>>figure; plot(basis_Fourier2(1:3));
>>help create_fourier_basis; doc create_fourier_basis;
```

B-spline basis

On $[a, b]$, with $B = |\text{basis}| = m + (L - 1)$, order m, knots τ:

```
>>basis_spline13 = create_bspline_basis([0,10], 13);
>>plot(basis_spline13)
>>basis_spline2 = create_bspline_basis([0,2*pi], 5, 2);
>>basis_spline3 = create_bspline_basis([0,2*pi], 6, 3);
>>basis_spline4 = create_bspline_basis([0,2*pi], 7, 4);
>>figure; plot(basis_spline2);
>>figure; plot(basis_spline3);
>>figure; plot(basis_spline4);
>>tau=linspace(0,1,31); L=length(tau)-1; m=6; B=L-1+m;
>>basis_spline = create_bspline_basis([0,1], B, m, tau);
>>plot(basis_spline)
```

Monomial basis

$$\phi_1(t) = 1, \phi_2(t) = t, \phi_3(t) = t^2, \ldots$$

On $[a, b]$ with $B = |\text{basis}|$:

```
>>basis_monomial = create_monomial_basis([0,5],4);
>>figure; plot(basis_monomial);
>>figure; plot(basis_monomial(1:3)); %extract subset
>>help create_monomial_basis; doc create_monomial_basis;
```

Constant basis

On $[a, b]$:

```
>>basis_constant = create_constant_basis([0,1]);
>>plot(basis_constant);
```

Constant basis

Until now we

- created a basis object,
- plotted it.

The class' other methods:

```
>>methods basis #methods myclass
```

Evaluate basis: $\boldsymbol{\Phi} = [\phi_j(\boldsymbol{t}_i)] \in \mathbb{R}^{n \times B}$

Evaluation

Evaluate the r-order derivatives of the basis system at tvec:

```
>>eval_basis(tvec,basis_my);
>>eval_basis(tvec,basis_my,1);
```

Summary

We saw how to

- create a basis object,
- plot it,
- evaluate a basis system, or its derivatives.

Covered: Chapter 1-3 from [2].