

Title: PSI 2019/2020 - Computational Physics - Lecture 6

Speakers: Erik Schnetter

Collection: PSI 2019/2020 - Computational Physics

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URL: <http://pirsa.org/20010083>

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left):

Name	Last Modified
cmake-3.15.1-Linux-x86_64	6 months ago
compute	5 years ago
Cvanilla	12 days ago
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago
gnuplot.ipynb	9 months ago
gdfs-files-sorted.txt	3 months ago
gdfs-files.txt	3 months ago

Code Editor (Right):

```

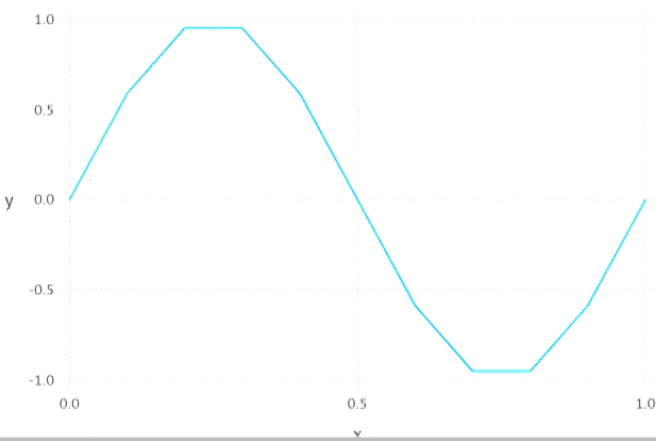
[20]: versioninfo()
Julia Version 1.3.1
Commit 2d5741174c* (2019-12-30 21:36 UTC)
Platform Info:
  OS: Linux (x86_64-linux-gnu)
  CPU: Intel(R) Xeon(R) Silver 4114 CPU @ 2.20GHz
  WORD_SIZE: 64
  LIBM: libopenlibm
  LLVM: libLLVM-6.0.1 (ORCJIT, skylake)
Environment:
  JULIA_MPI_PATH = /home/eschnetter/src/spack-view

[22]: using Gadfly

[23]: xs = [1/10 for i in 0:10]
      plot(x=xs, y=[exp((x-0.6)^2) for x in xs], Geom.line)

[23]:

```



Mode: Edit | Ln 2, Col 26 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/` with files like `cmake-3.15.1-Linux-x86_64`, `compute`, `Cvanilla`, `dist`, `ET_2019_10`, `etc`, `intel`, `Julia`, `mars`, `modules-4.15.0-47-generic...`, `Music`, `public_html`, `simulations`, `slurmstats`, `spaces-project`, `src`, `tmp`, `Tutorial`, `Wolfram Mathematica`, `Chebyshev.ipynb`, `CompPhys-2020-01-13.ipynb`, `CompPhys.2020-01-13.Che...`, `configuration.nix`, `FiniteDifferences.ipynb` (selected), `gnuplot.ipynb`, `gpf-files-sorted.txt`, and `gpf-files.txt`.

The code editor shows the following Julia code in `FiniteDifferences.ipynb`:

```
[20]: versioninfo()
Julia Version 1.3.1
Commit 2d5741174c* (2019-12-30 21:36 UTC)
Platform Info:
 OS: Linux (x86_64-linux-gnu)
 CPU: Intel(R) Xeon(R) Silver 4114 CPU @ 2.20GHz
 WORD_SIZE: 64
 LIBM: libopenlibm
 LLVM: libLLVM-6.0.1 (ORCJIT, skylake)
Environment:
 JULIA_MPI_PATH = /home/eschnetter/src/spack-view

[22]: using Gadfly

[28]: xs = [1/1000 for i in 0:10]
plot(x=xs, y=[exp(-40*(x-0.6)^2) for x in xs], Geom.line)
```

The output of the code is a plot showing a bell-shaped curve (Gaussian distribution) centered at $x = 0.6$. The x-axis ranges from 0.0 to 1.0, and the y-axis ranges from 0.0 to 1.0. The curve peaks at $y = 1.0$ when $x = 0.6$.

At the bottom of the interface, the status bar indicates: `Julia 1.3.1 | Idle`, `Mode: Edit`, `Ln 1, Col 28`, and `FiniteDifferences.ipynb`.

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left Panel):

Name	Last Modified
cmake-3.15.1-Linux-x86_64	6 months ago
compute	5 years ago
Cvanilla	12 days ago
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	a minute ago
gnuplot.ipynb	9 months ago
gpfs-files-sorted.txt	3 months ago
gpfs-files.txt	3 months ago

Code Editor (Right Panel):

```

[20]: versioninfo()
Julia Version 1.3.1
Commit 2d5741174c* (2019-12-30 21:36 UTC)
Platform Info:
  OS: Linux (x86_64-linux-gnu)
  CPU: Intel(R) Xeon(R) Silver 4114 CPU @ 2.20GHz
  WORD_SIZE: 64
  LIBM: libopenlibm
  LLVM: libLLVM-6.0.1 (ORCJIT, skylake)
Environment:
  JULIA_MPI_PATH = /home/eschnetter/src/spack-view

[22]: using Gadfly

[29]: xs = [1/1000 for i in 0:1000]
plot(x=xs, y=[exp(-40*(x-0.6)^2) for x in xs], Geom.line)

[29]:

```

The plot shows a Gaussian distribution curve centered at x=0.6, with a peak value of 1.0. The x-axis ranges from 0.0 to 1.0, and the y-axis ranges from 0.0 to 1.0.

Mode: Command | Ln 1, Col 1 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/` with files like `cmake-3.15.1-Linux-x86_64`, `compute`, `Cvanilla`, `dist`, `ET_2019_10`, `etc`, `intel`, `Julia`, `mars`, `modules-4.15.0-47-generic...`, `Music`, `public_html`, `simulations`, `slurmstats`, `spaces-project`, `src`, `tmp`, `Tutorial`, `Wolfram Mathematica`, `Chebyshev.ipynb`, `CompPhys-2020-01-13.ipynb`, `CompPhys.2020-01-13.Che...`, `configuration.nix`, `FiniteDifferences.ipynb` (selected), `gnuplot.ipynb`, `gpfs-files-sorted.txt`, and `gpfs-files.txt`.

The code editor shows the following code in `FiniteDifferences.ipynb`:

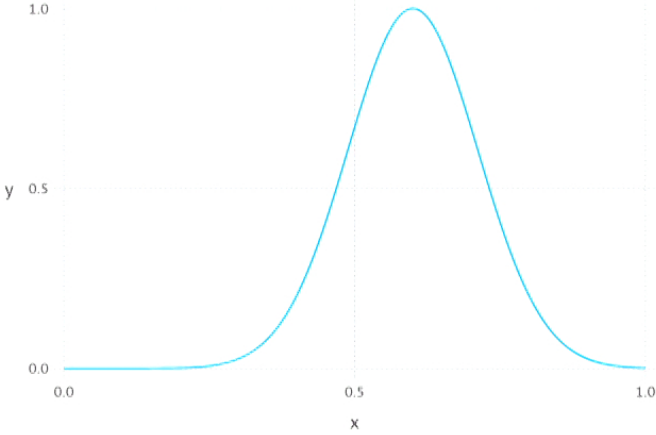
```
FiniteDifferences.ipynb
CPU: Intel(R) Xeon(R) Silver 4114 CPU @ 2.20GHz
WORD_SIZE: 64
LIBM: libopenlibm
LLVM: libLLVM-6.0.1 (ORCJIT, skylake)
Environment:
  JULIA_MPI_PATH = /home/eschnetter/src/spack-view

[*]: ]add Gadfly

[22]: using Gadfly

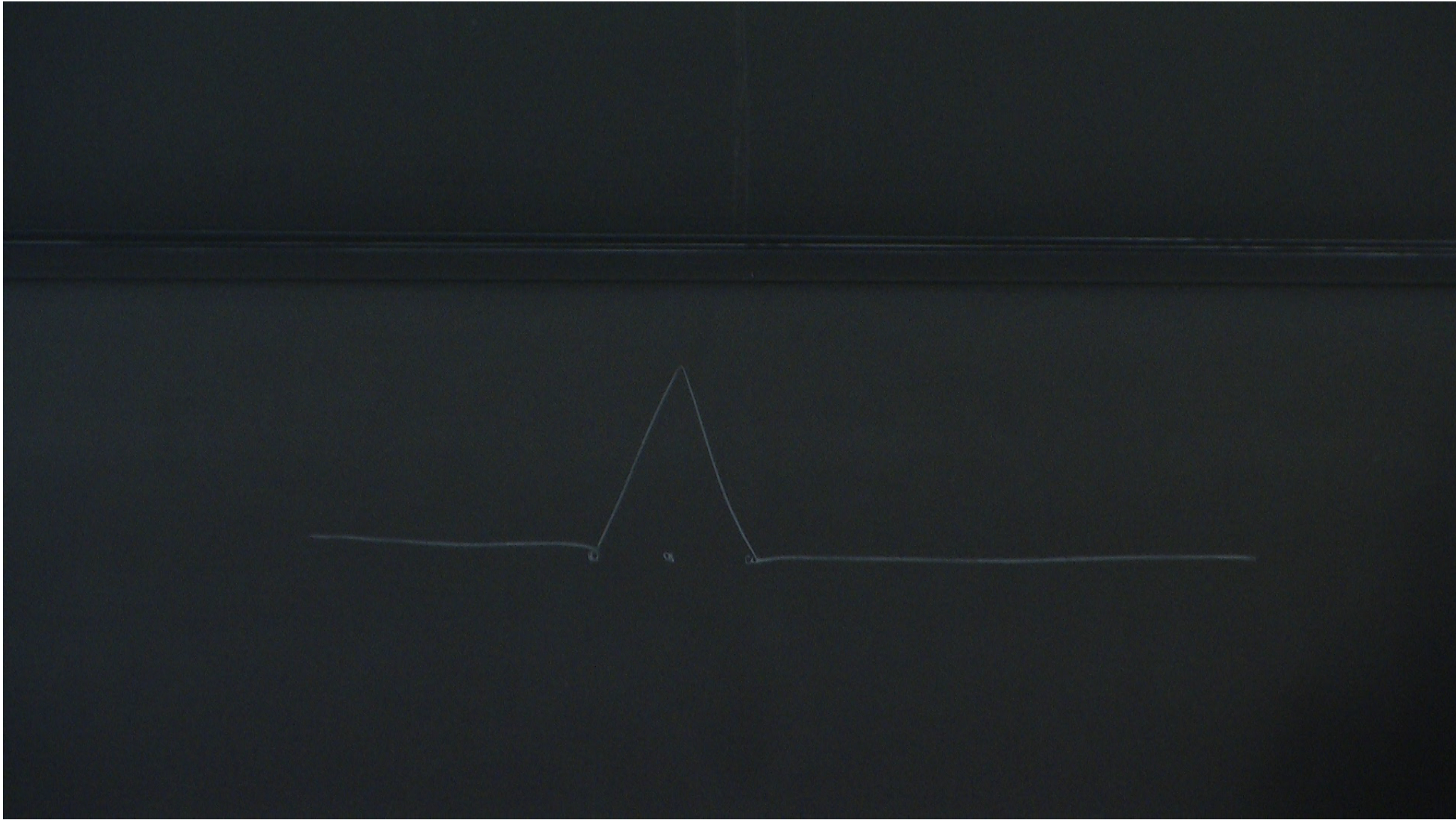
[29]: xs = [i/1000 for i in 0:1000]
      plot(x=xs, y=[exp(-40*(x-0.6)^2) for x in xs], geom=:line)

[29]:
```



The plot displays a Gaussian distribution curve (bell curve) centered at $x = 0.6$. The x-axis ranges from 0.0 to 1.0, and the y-axis ranges from 0.0 to 1.0. The curve starts near 0.0 at $x = 0.0$, reaches its peak of approximately 1.0 at $x = 0.6$, and returns to near 0.0 at $x = 1.0$.

Mode: Command Ln 1, Col 8 FiniteDifferences.ipynb



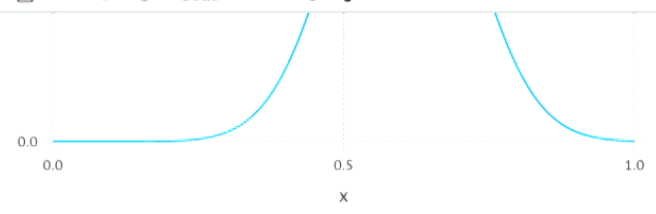
JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left Panel):

Name	Last Modified
cmake-3.15.1-Linux-x86_64	6 months ago
compute	5 years ago
Cvanilla	12 days ago
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	2 minutes ago
gnuplot.ipynb	9 months ago
gpfs-files-sorted.txt	3 months ago
gpfs-files.txt	3 months ago

Code Editor (Right Panel):

File: FiniteDifferences.ipynb | Julia 1.3.1

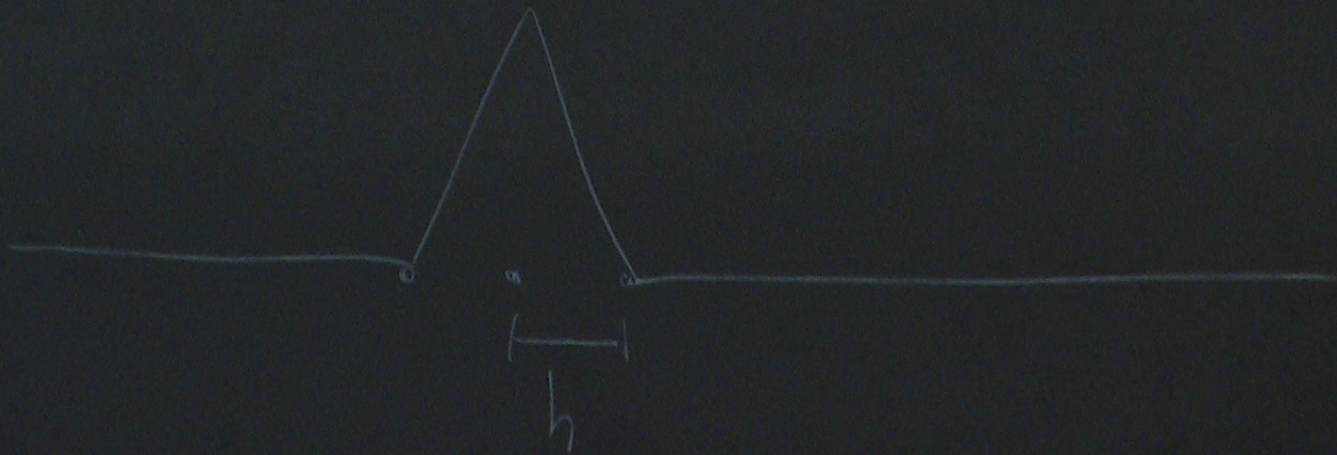


The plot displays two basis functions on the interval $x \in [0, 1]$. The x-axis is labeled 'x' and has tick marks at 0.0, 0.5, and 1.0. The y-axis has a tick mark at 0.0. The first function is zero for $x < 0.5$ and then increases linearly to 1.0 at $x = 1.0$. The second function is 1.0 for $x < 0.5$ and then decreases linearly to 0.0 at $x = 1.0$.

Basis functions (hat functions)

```
[ ]:
```

Mode: Edit | Ln 1, Col 1 | FiniteDifferences.ipynb



JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/` with files like `cmake-3.15.1-Linux-x86_64`, `compute`, `Cvanilla`, `dist`, `ET_2019_10`, `etc`, `intel`, `Julia`, `mars`, `modules-4.15.0-47-generic...`, `Music`, `public_html`, `simulations`, `slurmstats`, `spaces-project`, `src`, `tmp`, `Tutorial`, `Wolfram Mathematica`, `Chebyshev.ipynb`, `CompPhys-2020-01-13.ipynb`, `CompPhys.2020-01-13.Che...`, `configuration.nix`, `FiniteDifferences.ipynb` (selected), `gnuplot.ipynb`, `gdfs-files-sorted.txt`, and `gdfs-files.txt`.

The code editor displays the following Julia code for a hat function:

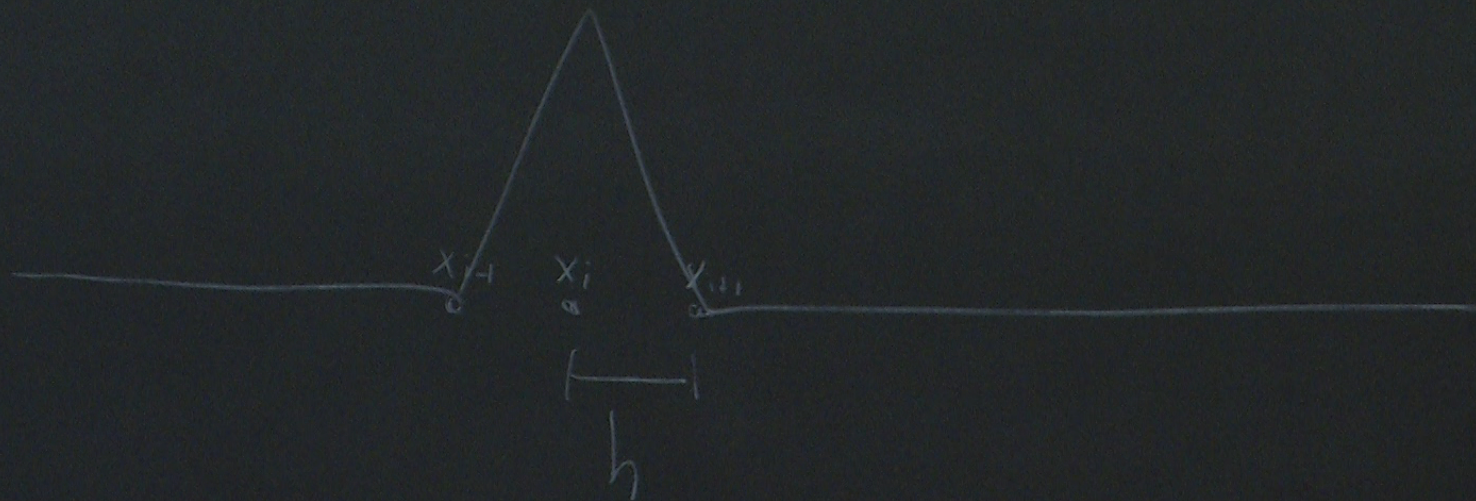
```

[ ]: function hat(i, N)
    @assert 0 <= i < N
    h = 1 / (N-1)
    xim1 = h * (i-1)
    xi = h * i
    h |
end

```

Below the code, a plot shows two blue curves representing basis functions (hat functions) on the interval $x \in [0, 1]$. The x-axis is labeled x and has tick marks at 0.0, 0.5, and 1.0. The y-axis has a tick mark at 0.0. The first curve starts at $x=0$ and increases to a peak at $x=0.5$. The second curve starts at a peak at $x=0.5$ and decreases to $x=1$.

At the bottom of the interface, the status bar shows: `Mode: Edit`, `Ln 6, Col 6`, and `FiniteDifferences.ipynb`.



JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/` with files like `cmake-3.15.1-Linux-x86_64`, `compute`, `Cvanilla`, `dist`, `ET_2019_10`, `etc`, `intel`, `Julia`, `mars`, `modules-4.15.0-47-generic...`, `Music`, `public_html`, `simulations`, `slurmstats`, `spaces-project`, `src`, `tmp`, `Tutorial`, `Wolfram Mathematica`, `Chebyshev.ipynb`, `CompPhys-2020-01-13.ipynb`, `CompPhys.2020-01-13.Che...`, `configuration.nix`, `FiniteDifferences.ipynb` (selected), `gnuplot.ipynb`, `gdfs-files-sorted.txt`, and `gdfs-files.txt`.

The code editor displays the following Julia code for a hat function:

```
[31]: function hat(i, N, x::T) where {T}
    @assert 0 <= i < N
    h = 1 / T(N-1)
    xim1 = h * (i-1)
    xi = h * i
    xip1 = h * (i+1)
    if x <= xim1
        return T(0)
    elseif x <= xi
        return (x - xim1) / h
    elseif x <= xip1
        return (x - xip1) / h
    else
        return T(0)
    end
end
```

The output shows the function `hat` is generic with 1 method. Below the code, there is an empty input prompt `[]:`.

At the top of the code editor, there is a plot of the hat function. The x-axis is labeled `x` and ranges from 0.0 to 1.0. The y-axis ranges from 0.0 to 1.0. The plot shows a blue curve that is zero for `x < 0.5` and `x > 1.0`, and increases linearly from 0 to 1 between `x = 0.5` and `x = 1.0`.

At the bottom of the JupyterLab interface, the status bar shows `Mode: Edit`, `Ln 1, Col 1`, and `FiniteDifferences.ipynb`.

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/` with files like `cmake-3.15.1-Linux-x86_64`, `compute`, `Cvanilla`, `dist`, `ET_2019_10`, `etc`, `intel`, `Julia`, `mars`, `modules-4.15.0-47-generic...`, `Music`, `public_html`, `simulations`, `slurmstats`, `spaces-project`, `src`, `tmp`, `Tutorial`, `Wolfram Mathematica`, `Chebyshev.ipynb`, `CompPhys-2020-01-13.ipynb`, `CompPhys.2020-01-13.Che...`, `configuration.nix`, `FiniteDifferences.ipynb` (selected), `gnuplot.ipynb`, `gdfs-files-sorted.txt`, and `gdfs-files.txt`.

The code editor displays the following Julia code for `FiniteDifferences.ipynb`:

```

[31]: function hat(i, N, x::T) where {T}
    @assert 0 <= i < N
    h = 1 / T(N-1)
    xim1 = h * (i-1)
    xi = h * i
    xip1 = h * (i+1)
    if x <= xim1
        return T(0)
    elseif x <= xi
        return (x - xim1) / h
    elseif x <= xip1
        return (x - xip1) / h
    else
        return T(0)
    end
end

[31]: hat (generic function with 1 method)

[32]: plot(ys=[hat(5, 11, x) for x in xs], Geom.line)
Warning: ys is not a recognized aesthetic. Ignoring.
@ Gadfly /home/eschnetter/.julia/packages/Gadfly/ISHWw/src/mapping.jl:63

[32]: Plot(...)

[ ]:

```

The status bar at the bottom indicates `Mode: Edit`, `Ln 1, Col 1`, and `FiniteDifferences.ipynb`.

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/` with files like `cmake-3.15.1-Linux-x86_64`, `compute`, `Cvanilla`, `dist`, `ET_2019_10`, `etc`, `intel`, `Julia`, `mars`, `modules-4.15.0-47-generic...`, `Music`, `public_html`, `simulations`, `slurmstats`, `spaces-project`, `src`, `tmp`, `Tutorial`, `Wolfram Mathematica`, `Chebyshev.ipynb`, `CompPhys-2020-01-13.ipynb`, `CompPhys.2020-01-13.Che...`, `configuration.nix`, `FiniteDifferences.ipynb` (selected), `gnuplot.ipynb`, `gpfs-files-sorted.txt`, and `gpfs-files.txt`.

The code editor displays the following Julia code in `FiniteDifferences.ipynb`:

```

return T(0)
elseif x <= xi
    return (x - xim1) / h
elseif x <= xip1
    return (x - xip1) / h
else
    return T(0)
end
end

```

Below the code, the execution output shows:

```

[31]: hat (generic function with 1 method)
[33]: plot(y=[hat(5, 11, x) for x in xs], Geom.line)
[33]:

```

The plot shows a function `y` versus `x`. The x-axis ranges from 0 to 1500, and the y-axis ranges from -1.0 to 1.0. The function is zero for `x < 500` and `x > 1000`. It has a sharp peak at `x = 500` with a value of 1.0 and a sharp trough at `x = 500` with a value of -1.0. The function is zero for `x < 500` and `x > 1000`.

The status bar at the bottom indicates `Mode: Command`, `Ln 1, Col 1`, and `FiniteDifferences.ipynb`.

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left):

Name	Last Modified
cmake-3.15.1-Linux-x86_64	6 months ago
compute	5 years ago
Cvanilla	12 days ago
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	a minute ago
gnuplot.ipynb	9 months ago
gpfs-files-sorted.txt	3 months ago
gpfs-files.txt	3 months ago

Code Editor (Right):

```

return T(0)
elseif x <= xi
    return (x - xim1) / h
elseif x <= xip1
    return -(x - xip1) / h
else
    return T(0)
end
end

```

[34]: hat (generic function with 1 method)

[35]: plot(y=[hat(5, 11, x) for x in xs], Geom.line)

[35]:

Mode: Command Ln 1, Col 1 FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left Panel):

Name	Last Modified
cmake-3.15.1-Linux-x86_64	6 months ago
compute	5 years ago
Cvanilla	12 days ago
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13 invnb	23 days ago

Code Editor (Right Panel):

File: FiniteDifferences.ipynb | Julia 1.3.1

Basis functions (hat functions)

```
[34]: function hat(i, N, x::T) where {T}
    @assert 0 <= i < N
    h = 1 / T(N-1)
    xim1 = h * (i-1)
    xi = h * i
    xip1 = h * (i+1)
    if x <= xim1
        return T(0)
    elseif x <= xi
        return (x - xim1) / h
    elseif x <= xip1
        return -(x - xip1) / h
    else
        return T(0)
    end
end
```

```
[34]: hat (generic function with 1 method)
```

```
[36]: plot(x=xs, y=[hat(5, 11, x) for x in xs], Geom.line)
```

[36]:

Mode: Edit | Ln 1, Col 24 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays the directory structure of `/home/eschnetter/`. The code editor shows a Julia script named `FiniteDifferences.ipynb` with a function `hat` and a plot command. An error message is displayed below the plot command.

File Browser:

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	2 minutes ago

Code Editor:

```

elseif x <= xi
    return (x - xim1) / h
elseif x <= xip1
    return -(x - xip1) / h
else
    return T(0)
end
end

```

[34]: hat (generic function with 1 method)

[37]: `plot(x=xs, y=[hat(50, 11, x) for x in xs], Geom.line)`

AssertionError: 0 <= i < N

Stacktrace:

```

[1] hat(::Int64, ::Int64, ::Float64) at ./In[34]:2
[2] (::var"#73#74")(::Float64) at ./none:0
[3] iterate at ./generator.jl:47 [inlined]
[4] collect(::Base.Generator{Array{Float64,1},var"#73#74"}) at ./array.jl:622
[5] top-level scope at In[37]:1

```

[]:

Mode: Command | Ln 1, Col 21 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor shows a Julia function `hat` and a plot command, with an error message displayed below.

File Browser:

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	3 minutes ago

Code Editor:

Basis functions (hat functions)

```
[34]: function hat(i, N, x::T) where {T}
      @assert 0 <= i < N
      h = 1 / T(N-1)
      xim1 = h * (i-1)
      xi = h * i
      xip1 = h * (i+1)
      if x <= xim1
          return T(0)
      elseif x <= xi
          return (x - xim1) / h
      elseif x <= xip1
          return -(x - xip1) / h
      else
          return T(0)
      end
      end
```

```
[34]: hat (generic function with 1 method)
```

```
[37]: plot(x=xs, y=[hat(50, 11, x) for x in xs], Geom.line)
```

AssertionError: 0 <= i < N

Stacktrace:

```
[1] hat(::Int64, ::Int64, ::Float64) at ./In[34]:2
```

Mode: Command | Ln 1, Col 21 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left Panel):

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	4 minutes ago

Code Editor (Right Panel):

Basis functions (hat functions)

```
[39]: function hat(i, N, x::T) where {T}
      @assert 0 <= i < N
      # calculate grid spacing
      h = 1 / T(N-1)
      # collocation points
      xim1 = h * (i-1)
      xi = h * i
      xip1 = h * (i+1)
      # case distinction (piecewise linear!)
      if x <= xim1
          return T(0)
      elseif x <= xi
          return (x - xim1) / h
      elseif x <= xip1
          return -(x - xip1) / h
      else
          return T(0)
      end
      end
```

```
[39]: hat (generic function with 1 method)
```

```
[38]: plot(x=xs, y=[hat(5, 11, x) for x in xs], Geom.line)
```

```
[38]:
```

Mode: Command | Ln 1, Col 20 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left): Shows the directory structure of `/home/eschnetter/`. The file `FiniteDifferences.ipynb` is selected and highlighted in blue.

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago

Code Editor (Right): Shows the code for `FiniteDifferences.ipynb` in Julia. The code defines a basis function `hat` and uses it in a plot.

```

# calculate grid spacing
h = 1 / T(N-1)
# collocation points
xim1 = h * (i-1)
xi = h * i
xip1 = h * (i+1)
# case distinction (piecewise linear!)
if x <= xim1
    return T(0)
elseif x <= xi
    return (x - xim1) / h
elseif x <= xip1
    return -(x - xip1) / h
else
    return T(0)
end
end

```

Execution output:

```

[40]: hat
[41]: ?hat
search: hat hcat eachmatch hvcat Cwchar_t hasmethod catch_backtrace hasproperty
[41]: Basis function hat(i, N, x)
[38]: plot(x=xs, y=[hat(5, 11, x) for x in xs], Geom.line)
[38]:

```

The plot shows a single peak at `x=5` with a height of `1.0`.

Bottom status bar: `0 $ 1 Julia 1.3.1 | Idle Mode: Command Ln 1, Col 5 FiniteDifferences.ipynb`

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left): Shows the directory structure of `/home/eschnetter/`. The file `FiniteDifferences.ipynb` is selected.

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago

Code Editor (Right): Shows the code for `FiniteDifferences.ipynb` in Julia. The code defines a function `hat` for basis functions.

```

[40]: """
Basis function hat(i, N, x)
"""
function hat(i, N, x::T) where {T}
    @assert 0 <= i < N
    # calculate grid spacing
    h = 1 / T(N-1)
    # collocation points
    xim1 = h * (i-1)
    xi = h * i
    xip1 = h * (i+1)
    # case distinction (piecewise linear!)
    if x <= xim1
        return T(0)
    elseif x <= xi
        return (x - xim1) / h
    elseif x <= xip1
        return -(x - xip1) / h
    else
        return T(0)
    end
end

[40]: hat
[41]: ?hat

```

Mode: Command | Ln 1, Col 5 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left Panel):

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	a minute ago

Code Editor (Right Panel):

File: FiniteDifferences.ipynb | Julia 1.3.1

```
[40]: hat
[43]: plot(x=xs, y=[hat(10, 11, x) for x in xs], Geom.line)
[43]:
```

The plot displays a function $\hat{h}(x)$ defined as:

$$\hat{h}(x) = \begin{cases} 0 & 0 \leq x < 0.9 \\ \frac{x - 0.9}{1.0 - 0.9} & 0.9 \leq x \leq 1.0 \end{cases}$$

The x-axis is labeled 'x' and ranges from 0.0 to 1.0. The y-axis is labeled 'y' and ranges from 0.0 to 1.0. The plot shows a blue line that is zero for x from 0.0 to approximately 0.9, and then increases linearly to 1.0 at $x = 1.0$.

Terminal: 0 \$ 1 Julia 1.3.1 | Idle | Mode: Command | Ln 1, Col 1 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right.

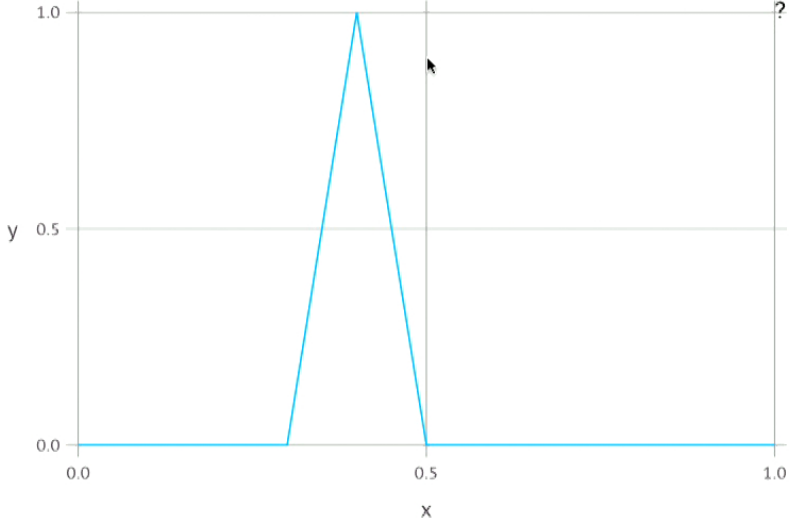
File Browser (Left Panel):

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	2 minutes ago

Code Editor (Right Panel):

File: FiniteDifferences.ipynb | Julia 1.3.1

```
[40]: hat
[44]: plot(x=xs, y=[hat(4, 11, x) for x in xs], Geom.line)
[44]:
```



Mode: Command | Ln 1, Col 1 | FiniteDifferences.ipynb

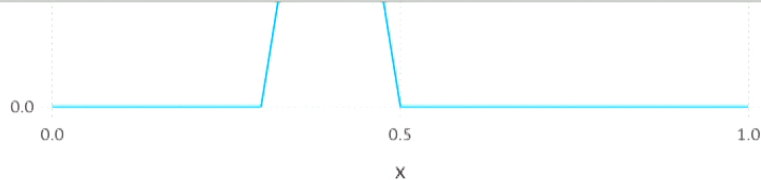
JupyterLab interface showing a file browser on the left and a code editor on the right. The browser displays the directory structure of `/home/eschnetter/`. The code editor shows a Julia notebook titled `FiniteDifferences.ipynb` with a plot and code cells.

File Browser:

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago

Code Editor (FiniteDifferences.ipynb):

Julia 1.3.1



Discrete functions

```
[45]: struct Fun{T}
      coeffs::Vector{T}
      end
```

```
[48]: function sample(f, N)
      T = typeof(f(0))
      h = 1 / T(N-1)
      coeffs = T[f(h*i) for i in 0:N-1]
      Fun{T}(coeffs)
      end
```

```
[48]: sample (generic function with 1 method)
```

[]:

Mode: Edit | Ln 1, Col 1 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor shows a Julia notebook titled `FiniteDifferences.ipynb` with the following content:

```

Discrete functions

[45]: struct Fun{T}
      coeffs::Vector{T}
      end

[48]: function sample(f, N)
      T = typeof(f(0))
      h = 1 / T(N-1)
      coeffs = T[f(h*i) for i in 0:N-1]
      Fun{T}(coeffs)
      end

[48]: sample (generic function with 1 method)

[51]: sample(x->x^2, 5)

InexactError: Int64{0.0625}

Stacktrace:
 [1] Int64 at ./float.jl:709 [inlined]
 [2] convert at ./number.jl:7 [inlined]
 [3] setindex! at ./array.jl:782 [inlined]
 [4] sample(::var"#87#88", ::Int64) at ./In[48]:4
 [5] top-level scope at In[51]:1

[ ]:

```

The bottom status bar indicates `Mode: Command`, `Ln 1, Col 1`, and `FiniteDifferences.ipynb`.

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor is editing `FiniteDifferences.ipynb` in Julia 1.3.1.

File Browser:

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago

Code Editor (FiniteDifferences.ipynb):

```

[45]: struct Fun{T}
      coeffs::Vector{T}
      end

[55]: function sample(f, N)
      h = 1 / (N-1)
      coeffs = Float64[f(h*i) for i in 0:N-1]
      Fun{Float64}(coeffs)
      end

[55]: sample (generic function with 2 methods)

[56]: sample(x->x^2, 5)

[56]: Fun{Float64}([0.0, 0.0625, 0.25, 0.5625, 1.0])

[57]: g(x) = exp(-40*(x-0.6)^2)

[57]: g (generic function with 1 method)

[ ]:

```

Mode: Edit | Ln 1, Col 1 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left):

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago

Code Editor (Right): FiniteDifferences.ipynb (Julia 1.3.1)

```

COETTS::VECTOR{I}
end

[55]: function sample(f, N)
      h = 1 / (N-1)
      coeffs = Float64[f(h*i) for i in 0:N-1]
      Fun{Float64}(coeffs)
      end

[55]: sample (generic function with 2 methods)

[56]: sample(x->x^2, 5)

[56]: Fun{Float64}([0.0, 0.0625, 0.25, 0.5625, 1.0])

[57]: g(x) = exp(-40*(x-0.6)^2)

[57]: g (generic function with 1 method)

[58]: g11coeffs = sample(g, 11)

[58]: Fun{Float64}([5.573903692694606e-7, 4.539992976248485e-5, 0.0016615572731739367, 0.02732372244729
2607, 0.20189651799465558, 0.6703200460356394, 1.0, 0.6703200460356389, 0.20189651799465516, 0.02
7323722447292535, 0.0016615572731739324])

[ ]:

```

Bottom status bar: 0 Julia 1.3.1 | Idle Mode: Edit Ln 1, Col 1 FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left): Shows the directory structure of `/home/eschnetter/`. The file `FiniteDifferences.ipynb` is highlighted, with a last modified time of "a minute ago".

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	a minute ago

Code Editor (Right): Shows the contents of `FiniteDifferences.ipynb` in Julia 1.3.1. The code is as follows:

```
[55]: function sample(f, N)
      h = 1 / (N-1)
      coeffs = Float64[f(h*i) for i in 0:N-1]
      Fun{Float64}(coeffs)
      end

[55]: sample (generic function with 2 methods)

[56]: sample(x->x^2, 5)

[56]: Fun{Float64}([0.0, 0.0625, 0.25, 0.5625, 1.0])

[57]: g(x) = exp(-40*(x-0.6)^2)

[57]: g (generic function with 1 method)

[58]: g11coeffs = sample(g, 11)

[58]: Fun{Float64}([5.573903692694606e-7, 4.539992976248485e-5, 0.0016615572731739367, 0.027323722447292607, 0.20189651799465558, 0.6703200460356394, 1.0, 0.6703200460356389, 0.20189651799465516, 0.027323722447292535, 0.0016615572731739324])

[ ]:
```

Mode: Edit | Ln 3, Col 44 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor shows the contents of `FiniteDifferences.ipynb`, which includes Julia code for defining a function `g`, sampling coefficients, evaluating a function, and plotting the result.

File Browser:

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	2 minutes ago

Code Editor (FiniteDifferences.ipynb):

```

[56]: Fun{Float64}([0.0, 0.0625, 0.25, 0.5625, 1.0])

[57]: g(x) = exp(-40*(x-0.6)^2)

[57]: g (generic function with 1 method)

[58]: g11coeffs = sample(g, 11)

[58]: Fun{Float64}([5.573903692694606e-7, 4.539992976248485e-5, 0.0016615572731739367, 0.027323722447292607, 0.20189651799465558, 0.6703200460356394, 1.0, 0.6703200460356389, 0.20189651799465516, 0.027323722447292535, 0.0016615572731739324])

[61]: function evaluate(f::Fun{T}, x) where {T}
      N = length(f.coeffs)
      sum(f.coeffs[i-1] * hat(i, N, x) for i in 0:N-1)
      end

[61]: evaluate (generic function with 1 method)

[60]: g11(x) = evaluate(g11coeffs, x)

[60]: g11 (generic function with 1 method)

[ ]: plot(g11)

```

Mode: Command | Ln 1, Col 32 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left Panel):

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago

Code Editor (Right Panel):

File: FiniteDifferences.ipynb | Julia 1.3.1

```
[66]: plot(x=xs, y=[g11(x) for x in xs], Geom.line)
```

```
[66]:
```

Mode: Command | Ln 1, Col 1 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left):

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago

Code Editor (Right): FiniteDifferences.ipynb (Julia 1.3.1)

```

[58]: g11coeffs = sample(g, 11)

[58]: Fun{Float64}([5.573903692694606e-7, 4.539992976248485e-5, 0.0016615572731739367, 0.02732372244729
2607, 0.20189651799465558, 0.6703200460356394, 1.0, 0.6703200460356389, 0.20189651799465516, 0.02
7323722447292535, 0.0016615572731739324])

[64]: function evaluate(f::Fun{T}, x) where {T}I
      N = length(f.coeffs)
      sum(f.coeffs[i+1] * hat(i, N, x) for i in 0:N-1)
      end

[64]: evaluate (generic function with 1 method)

[65]: g11(x) = evaluate(g11coeffs, x)

[65]: g11 (generic function with 1 method)

[66]: plot(x=xs, y=[g11(x) for x in xs], Geom.line)

[66]:

```

Mode: Command | Ln 1, Col 1 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays the directory structure of `/home/eschnetter/`. The code editor shows the contents of `FiniteDifferences.ipynb`, which includes Julia code for sampling, function evaluation, and plotting.

File Browser:

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	5 minutes ago

Code Editor (FiniteDifferences.ipynb):

```

[56]: sample(x->x^2, 5)
[56]: Fun{Float64}([0.0, 0.0625, 0.25, 0.5625, 1.0])

[57]: g(x) = exp(-40*(x-0.6)^2)
[57]: g (generic function with 1 method)

[58]: g11coeffs = sample(g, 11)
[58]: Fun{Float64}([5.573903692694606e-7, 4.539992976248485e-5, 0.0016615572731739367, 0.027323722447292607, 0.20189651799465558, 0.6703200460356394, 1.0, 0.6703200460356389, 0.20189651799465516, 0.027323722447292535, 0.0016615572731739324])

[64]: function evaluate(f::Fun{T}, x) where {T}
      N = length(f.coeffs)
      sum(f.coeffs[i+1] * hat(i, N, x) for i in 0:N-1)
      end
[64]: evaluate (generic function with 1 method)

[65]: g11(x) = evaluate(g11coeffs, x)
[65]: g11 (generic function with 1 method)

[66]: plot(x=xs, y=[g11(x) for x in xs], Geom.line)
[66]:
      1.5
  
```

Mode: Edit | Ln 1, Col 18 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor shows a Julia notebook titled `FiniteDifferences.ipynb` with the following content:

```

Discrete functions

[45]: struct Fun{T}
      coeffs::Vector{T}
      end

[67]: Fun{Float64}("hello")

MethodError: Cannot `convert` an object of type String to an object of type Array{Float64,1}
Closest candidates are:
  convert(::Type{Array{T,N}}, !Matched::FillArrays.Zeros{V,N,Axes} where Axes) where {T, V, N} at
/home/eschnetter/.julia/packages/FillArrays/Aj0C4/src/FillArrays.jl:339
  convert(::Type{Array{T,N}}, !Matched::FillArrays.Ones{V,N,Axes} where Axes) where {T, V, N} at
/home/eschnetter/.julia/packages/FillArrays/Aj0C4/src/FillArrays.jl:339
  convert(::Type{Array{T,N}}, !Matched::FillArrays.AbstractFill{V,N,Axes} where Axes) where {T,
V, N} at /home/eschnetter/.julia/packages/FillArrays/Aj0C4/src/FillArrays.jl:331
  ...

Stacktrace:
 [1] Fun{Float64}(::String) at ./In[45]:2
 [2] top-level scope at In[67]:1

[55]: function sample(f, N)
      h = 1 / (N-1)
      coeffs = Float64[f(h*i) for i in 0:N-1]
      Fun{Float64}(coeffs)
      end

[55]: sample (generic function with 2 methods)

```

The bottom status bar shows `Julia 1.3.1 | Idle` and `Mode: Command Ln 1, Col 18 FiniteDifferences.ipynb`.

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor is titled `FiniteDifferences.ipynb` and contains Julia code for discrete functions.

File Browser:

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	7 minutes ago

Code Editor:

Discrete functions

```
[45]: struct Fun{T}
      coeffs::Vector{T}
      end

[68]: Fun{Float64}([1,2,3])

[68]: Fun{Float64}([1.0, 2.0, 3.0])

[55]: function sample(f, N)
      h = 1 / (N-1)
      coeffs = Float64[f(h*i) for i in 0:N-1]
      Fun{Float64}(coeffs)
      end

[55]: sample (generic function with 2 methods)

[56]: sample(x->x^2, 5)

[56]: Fun{Float64}([0.0, 0.0625, 0.25, 0.5625, 1.0])

[57]: g(x) = exp(-40*(x-0.6)^2)

[57]: g (generic function with 1 method)

[58]: g11coeffs = sample(g, 11)

[58]: Fun{Float64}([5.573903692694606e-7, 4.539992976248485e-5, 0.0016615572731739367, 0.02732372244729
```

Mode: Edit | Ln 1, Col 14 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left Panel):

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	8 minutes ago

Code Editor (Right Panel):

```

[64]: evaluate (generic function with 1 method)
[65]: g11(x) = evaluate(g11coeffs, x)
[65]: g11 (generic function with 1 method)
[66]: plot(x=xs, y=[g11(x) for x in xs], Geom.line)
[66]:

```

The code editor displays a plot of a function y versus x . The x-axis ranges from 0.0 to 1.0, and the y-axis ranges from 0.0 to 1.5. The plot shows a smooth curve that starts at (0,0), rises to a peak of approximately 1.0 at $x \approx 0.6$, and then falls back to 0 at $x = 1.0$.

Mode: Command | Ln 1, Col 5 | FiniteDifferences.ipynb

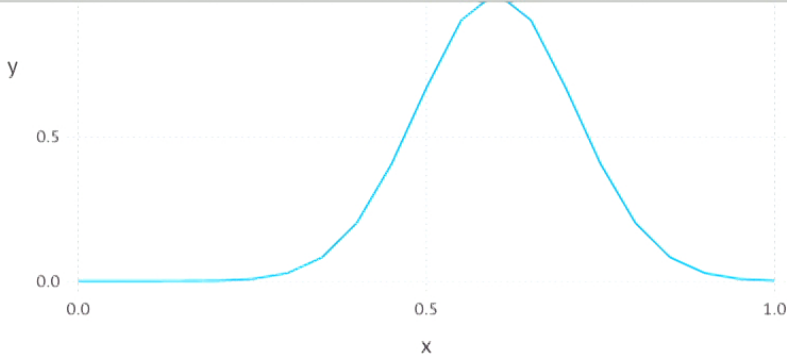
JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left):

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	a minute ago

Code Editor (Right):

File: FiniteDifferences.ipynb | Julia 1.3.1



Code:

```
[72]: function quad(f::Fun{T}) where {T}
      N = length(f.coeffs)
      h = 1 / T(N-1)
      |
      end
```

Output:

```
[72]: quad (generic function with 1 method)
```

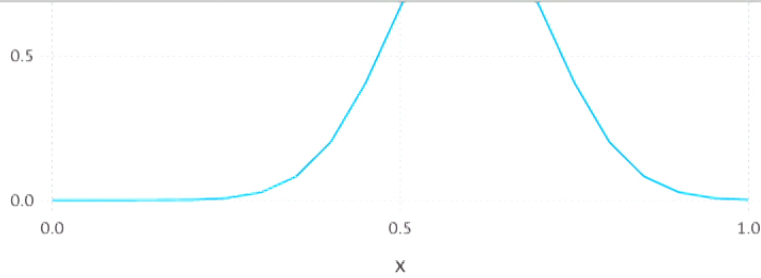
[]:

Mode: Edit | Ln 4, Col 5 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor shows a Julia function for quadrature and its execution output.

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago

FiniteDifferences.ipynb



Quadrature

```
[72]: function quad(f::Fun{T}) where {T}
      N = length(f.coeffs)
      h = 1 / T(N-1)
      s = T(0)
      for i in 0:N
          w = (i==0 || i==N-1 ? T(0.5) : T(1)) * h
          s += h * f.coeffs[i+1]
      end
      s
end
```

```
[72]: quad (generic function with 1 method)
```

Mode: Edit | Ln 9, Col 6 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor shows a Julia script named `FiniteDifferences.ipynb` with a plot and a function definition.

File Browser:

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago

Code Editor:

FiniteDifferences.ipynb | Julia 1.3.1

Quadrature

```
[72]: function quad(f::Fun{T}) where {T}
      N = length(f.coeffs)
      h = 1 / T(N-1)
      s = T(0)
      for i in 0:N-1
          w = (i==0 || i==N-1 ? T(0.5) : T(1)) * h
          s += w * f.coeffs[i+1]
      end
      s
    end
```

```
[72]: quad (generic function with 1 method)
```

```
[ ]:
```

Mode: Edit | Ln 7, Col 15 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor shows a Julia function for quadrature and its execution output.

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	2 minutes ago

```

[73]: function quad(f::Fun{T}) where {T}
      N = length(f.coefs)
      h = 1 / T(N-1)
      # initialize sum to zero
      s = T(0)
      for i in 0:N-1
        # boundary basis functions have half the area
        if i==0 || i==N-1
          w = T(0.5)
        else
          w = T(1)
        end
        # add up contributions from all basis functions
        s += w * h * f.coefs[i+1]
      end
      s
    end

[73]: quad (generic function with 1 method)

[ ]: |
  
```

Mode: Edit | Ln 1, Col 1 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor shows a Julia function `quad` for numerical quadrature, followed by its execution and output.

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	2 minutes ago

```

[73]: function quad(f::Fun{T}) where {T}
      N = length(f.coeffs)
      h = 1 / T(N-1)
      # initialize sum to zero
      s = T(0)
      for i in 0:N-1
        # boundary basis functions have half the area
        if i==0 || i==N-1
          w = T(0.5)
        else
          w = T(1)
        end
        # add up contributions from all basis functions
        s += w * h * f.coeffs[i+1]
      end
      s
    end

[73]: quad (generic function with 1 method)

[77]: quad(g11coeffs) | I
[77]: 0.28016185874898825

[78]: quad(g21coeffs)
[78]: 0.2801902502541984
  
```

Mode: Edit | Ln 1, Col 16 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left): Shows the directory structure under `/home/eschnetter/`. The file `FiniteDifferences.ipynb` is highlighted.

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	a minute ago

Code Editor (Right): Shows the code in `FiniteDifferences.ipynb`.

```

w = T(1)
end
# add up contributions from all basis functions
s += w * h * f.coeffs[i+1]
end
s
end

```

Execution results:

```

[73]: quad (generic function with 1 method)
[77]: quad(g11coeffs)
[77]: 0.28016185874898825
[78]: quad(g21coeffs)
[78]: 0.2801902502541984

```

L2 norm

```

[79]: function l2norm(f::Fun{T}) where {T}
      coeffs_abs2 = [abs(c)^2 for c in f.coeffs]
      sqrt(quad(Fun{T})(coeffs_abs2)))
end

```

Execution results:

```

[79]: l2norm (generic function with 1 method)
[ ]:

```

Bottom status bar: Mode: Edit | Ln 3, Col 36 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left):

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	2 minutes ago

Code Editor (Right):

File: FiniteDifferences.ipynb | Julia 1.3.1

```

[77]: 0.2801902502541984
[78]: quad(g21coeffs)
[78]: 0.2801902502541984

L2 norm

[80]: function l2norm(f::Fun{T}) where {T}
      coeffs_abs2 = [abs(c)^2 for c in f.coeffs]
      sqrt(quad(Fun{T})(coeffs_abs2))
      end
[80]: l2norm (generic function with 1 method)

[81]: l2norm(g11coeffs)
[81]: 0.4451606059646446

[82]: l2norm(g21coeffs)
[82]: 0.445158725792901

[ ]:

```

Mode: Command | Ln 1, Col 1 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor shows the contents of `FiniteDifferences.ipynb`, which includes Julia code for discrete functions.

File Browser:

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago

Code Editor (FiniteDifferences.ipynb):

```

[45]: struct Fun{T}
      coeffs::Vector{T}
      end

[69]: dump(Fun{Float64}([1,2,3]))
      Fun{Float64}
      coeffs: Array{Float64}((3,)) [1.0, 2.0, 3.0]

[83]: function Base.:+(f::Fun{T}, g::Fun{T}) where {T}
      Fun{T}(f.coeffs + g.coeffs)
      end

[85]: function Base.-:(f::Fun{T}, g::Fun{T}) where {T}
      Fun{T}(f.coeffs - g.coeffs)
      end

[ ]:

[55]: function sample(f, N)
      h = 1 / (N-1)
      coeffs = Float64[f(h*i) for i in 0:N-1]
      Fun{Float64}(coeffs)
      end

[55]: sample (generic function with 2 methods)
  
```

Mode: Edit | Ln 1, Col 17 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays the directory structure of `/home/eschnetter/`. The code editor shows the contents of `FiniteDifferences.ipynb`, which includes a Julia function definition and its execution results.

File Browser:

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago

Code Editor (FiniteDifferences.ipynb):

```
[80]: function l2norm(f::Fun{T}) where {T}
      coeffs_abs2 = [abs(c)^2 for c in f.coeffs]
      sqrt(quad(Fun{T})(coeffs_abs2))
      end

[80]: l2norm (generic function with 1 method)

[81]: l2norm(g11coeffs)

[81]: 0.4451606059646446

[82]: l2norm(g21coeffs)

[82]: 0.445158725792901

[ ]: |
```

Julia 1.3.1 | Idle Mode: Edit Ln 1, Col 1 FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor shows a Julia notebook with the following content:

```

[81]: l2norm(g11coeffs)
[81]: 0.4451606059646446
[82]: l2norm(g21coeffs)
[82]: 0.445158725792901

Comparing resolutions

[86]: g11_21_coeffs = sample(g11, 21)
[86]: Fun{Float64}([5.573903692694606e-7, 2.2978660065877155e-5, 4.539992976248485e-5, 0.00085347860146
8211, 0.0016615572731739367, 0.01449263986023327, 0.027323722447292614, 0.11461012022097405, 0.20
189651799465552, 0.4361082820151474 ... 0.8351600230178204, 1.0000000000000009, 0.835160023017819
4, 0.6703200460356388, 0.4361082820151472, 0.2018965179946551, 0.11461012022097372, 0.02732372244
7292528, 0.014492639860233216, 0.001661557273173932])

[ ]: plot(evaluate(g11_21_coeffs - g21coeffs)
[88]: l2norm(g11_21_coeffs - g21coeffs)
[88]: 0.02614412247904877

[ ]:

```

The status bar at the bottom indicates the current mode is Edit, the cursor is at line 1, column 15, and the file is `FiniteDifferences.ipynb`.

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left):

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	4 minutes ago

Code Editor (Right):

```

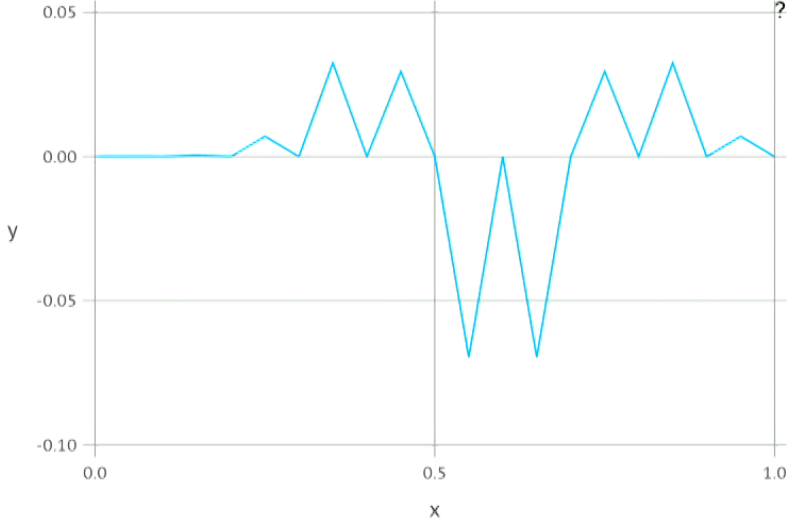
[86]: g11_21_coeffs = sample(g11, 21)

[86]: Fun{Float64}([5.573903692694606e-7, 2.2978660065877155e-5, 4.539992976248485e-5, 0.00085347860146
8211, 0.0016615572731739367, 0.01449263986023327, 0.027323722447292614, 0.11461012022097405, 0.20
189651799465552, 0.4361082820151474 ... 0.8351600230178204, 1.0000000000000009, 0.835160023017819
4, 0.6703200460356388, 0.4361082820151472, 0.2018965179946551, 0.11461012022097372, 0.02732372244
7292528, 0.014492639860233216, 0.001661557273173932])

[89]: plot(x=xs, y=[evaluate(g11_21_coeffs - g21coeffs, x) for x in xs], geom=line)

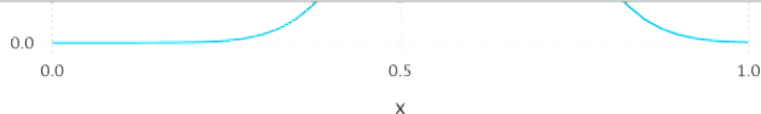
[89]:

```



Mode: Command Ln 1, Col 33 FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor shows a Julia script named `FiniteDifferences.ipynb` with the following content:



```

[91]: g11_41_coeffs = sample(g11, 41)
      g21_41_coeffs = sample(g21, 41)

[91]: Fun{Float64}([5.573903692694606e-7, 3.0584518054598085e-6, 5.559513241650156e-6, 2.54797215020675
04e-5, 4.539992976248485e-5, 0.00017446953392067608, 0.00030353913807886737, 0.000982548205626401
7, 0.0016615572731739363, 0.004554070172049139 ... 0.30423308886762734, 0.20189651799465533, 0.14
199075830927702, 0.08208499862389869, 0.05470436053559556, 0.0273237224472925, 0.0173851527591084
44, 0.007446583070924325, 0.004554070172049112, 0.0016615572731739302])

[95]: l2norm(g11_21_coeffs - g21coeffs)

[95]: 0.02614412247904877

[96]: l2norm(g21_41_coeffs - g41coeffs)

[96]: 0.006744517160093091

[ ]:

```

The status bar at the bottom indicates the current mode is Command, the cursor is at line 1, column 1, and the active file is `FiniteDifferences.ipynb`.



3
5

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/` with various folders and files, including `FiniteDifferences.ipynb` (6 minutes ago).

The code editor displays the following code in `FiniteDifferences.ipynb`:

```
[90]: g41coeffs = sample(g, 41)
      g41(x) = evaluate(g41coeffs, x)
      plot(x=xs, y=[g41(x) for x in xs], Geom.line)
```

The plot shows a smooth, bell-shaped curve (Gaussian distribution) centered at $x = 0.5$, with a peak value of $y = 1.0$. The x-axis ranges from 0.0 to 1.0, and the y-axis ranges from 0.0 to 1.5.

```
[91]: g11_41_coeffs = sample(g11, 41)
      g21_41_coeffs = sample(g21, 41)
```

The status bar at the bottom indicates the current mode is Command, and the cursor is at Line 1, Column 1 in `FiniteDifferences.ipynb`.

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays the directory structure of `/home/eschnetter/`. The code editor shows the contents of `FiniteDifferences.ipynb`, which includes Julia code for sampling coefficients and calculating L2 norms.

File Browser:

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago

Code Editor (FiniteDifferences.ipynb):

```
[91]: g11_41_coefs = sample(g11, 41)
      g21_41_coefs = sample(g21, 41)

[91]: Fun{Float64}([5.573903692694606e-7, 3.0584518054598085e-6, 5.559513241650156e-6, 2.54797215020675
04e-5, 4.539992976248485e-5, 0.00017446953392067608, 0.00030353913807886737, 0.000982548205626401
7, 0.0016615572731739363, 0.004554070172049139 ... 0.30423308886762734, 0.20189651799465533, 0.14
199075830927702, 0.08208499862389869, 0.05470436053559556, 0.0273237224472925, 0.0173851527591084
44, 0.007446583070924325, 0.004554070172049112, 0.0016615572731739302])

[95]: l2norm(g11_21_coefs - g21coefs)

[95]: 0.02614412247904877

[96]: l2norm(g21_41_coefs - g41coefs)

[96]: 0.006744517160093091

[ ]: g201coefs = sample(g, 201)
      g201(x) = evaluate(g201coefs, x)
      g401coefs = sample(g, 401)
      g401(x) = evaluate(g401coefs, x)
      g201_401_coefs = sample(g201, 401)
```

Julia 1.3.1 | Idle | Mode: Edit | Ln 5, Col 36 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right. The file browser displays a directory structure under `/home/eschnetter/`. The code editor shows the contents of `FiniteDifferences.ipynb` with several code cells and their outputs.

File Browser:

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	seconds ago

Code Editor (FiniteDifferences.ipynb):

```
[91]: g11_41_coefs = sample(g11, 41)
      g21_41_coefs = sample(g21, 41)

[91]: Fun{Float64}([5.573903692694606e-7, 3.0584518054598085e-6, 5.559513241650156e-6, 2.54797215020675
04e-5, 4.539992976248485e-5, 0.00017446953392067608, 0.00030353913807886737, 0.000982548205626401
7, 0.0016615572731739363, 0.004554070172049139 ... 0.30423308886762734, 0.20189651799465533, 0.14
199075830927702, 0.08208499862389869, 0.05470436053559556, 0.0273237224472925, 0.0173851527591084
44, 0.007446583070924325, 0.004554070172049112, 0.0016615572731739302])

[95]: l2norm(g11_21_coefs - g21coefs)

[95]: 0.02614412247904877

[96]: l2norm(g21_41_coefs - g41coefs)

[96]: 0.006744517160093091

[97]: g201coefs = sample(g, 201)
      g201(x) = evaluate(g201coefs, x)
      g401coefs = sample(g, 401)
      g401(x) = evaluate(g401coefs, x)
      g201_401_coefs = sample(g201, 401)
      l2norm(g401coefs - g201_401_coefs)

[97]: 6.814208679883738e-5

[ ]:
```

Julia 1.3.1 | Idle | Mode: Edit | Ln 1, Col 1 | FiniteDifferences.ipynb

JupyterLab interface showing a file browser on the left and a code editor on the right.

File Browser (Left):

Name	Last Modified
dist	7 days ago
ET_2019_10	3 months ago
etc	a year ago
intel	3 years ago
Julia	4 years ago
mars	3 months ago
modules-4.15.0-47-generic-...	10 months ago
Music	6 years ago
public_html	5 years ago
simulations	a year ago
slurmstats	3 years ago
spaces-project	8 years ago
src	7 days ago
tmp	3 years ago
Tutorial	5 months ago
Wolfram Mathematica	5 months ago
Chebyshev.ipynb	3 years ago
CompPhys-2020-01-13.ipynb	23 days ago
CompPhys.2020-01-13.Che...	23 days ago
configuration.nix	2 years ago
FiniteDifferences.ipynb	a minute ago

Code Editor (Right): FiniteDifferences.ipynb (Julia 1.3.1)

```

[97]: g201coeffs = sample(g, 201)
      g201(x) = evaluate(g201coeffs, x)
      g401coeffs = sample(g, 401)
      g401(x) = evaluate(g401coeffs, x)
      g201_401_coeffs = sample(g201, 401)
      l2norm(g401coeffs - g201_401_coeffs)

[97]: 6.814208679883738e-5

[98]: g20001coeffs = sample(g, 20001)
      g20001(x) = evaluate(g20001coeffs, x)
      g40001coeffs = sample(g, 40001)
      g40001(x) = evaluate(g40001coeffs, x)
      g20001_40001_coeffs = sample(g20001, 40001)
      l2norm(g40001coeffs - g20001_40001_coeffs)

[98]: 6.814918093947815e-9

[ ]:

```

Mode: Edit | Ln 1, Col 1 | FiniteDifferences.ipynb