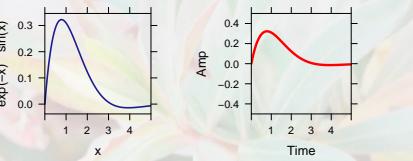


Graphics Commands

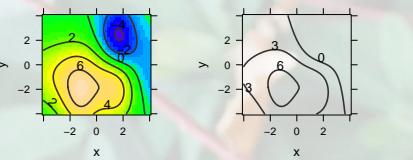
```
require(mosaic)  
plotFun(exp(-x)*sin(x)^x, x.lim=c(0,5))
```



Additional arguments:

Line color `col='red'`,
Line width `lwd=3`
Axis Labels `xlab='Time'`, `ylab='Amp'`,
Vert. axis limits `ylim=c(-.5,.5)`
Add to existing plot `add=TRUE`

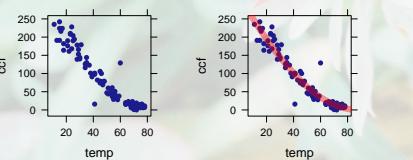
```
f = rfun(~x & y, seed=1930)  
plotFun(f(x=x, y=y) ~ x & y,  
        x.lim=c(-4,4), y.lim=c(-4,4))
```



Additional arguments:

Just contours `filled=FALSE`
Contour levels `levels=c(0,3,6)`
Translucent alpha=0.2
Surface plot `surface=TRUE`

```
utils = fetchData("utilities.csv")  
plotPoints(ccf ~ temp, data=utils)  
mod = smoother(ccf~temp,data=utils,span=2)  
plotFun(mod(temp) ~ temp,add=TRUE,lwd=3)
```



Today's students inhabit a world of big data and ubiquitous computation. As mathematics education moves to engage these trends, modern computing will be more and more tightly integrated into the curriculum. **Start R in Calculus** provides one route to do this.

Calculus and computing go hand in hand. Calculus provides an ideal setting for learning about computing notation, computing empowers students to apply ideas from calculus in realistic settings.

R is a free, open-source, professional-level scientific computing, graphics, and statistics environment. It is used in a broad range of fields and is rapidly expanding from the university into commerce and government. The `mosaic` package for R, written by Randall Pruim, Nicholas Horton, and the author, provides an easy-to-use command set for modeling, data analysis, numerical and symbolic calculus. www.r-project.org

RStudio is a free, open-source user interface for R with both desktop and web-browser versions. It also provides facilities for interactive, mouse-driven applets. www.rstudio.org

Project MOSAIC is a community of educators building stronger connections between modeling, statistics, computation, and calculus in order to prepare students for an era when mathematics will be more important than ever before.

www.mosaic-web.org

For additional exercises, interactive software, and instructor resources, visit www.mosaic-web.org/StartR.

Daniel Kaplan is DeWitt Wallace Professor of Mathematics, Statistics, and Computer Science at Macalester College where he directs the Applied Mathematics and Statistics program. A winner of Macalester's *Excellence in Teaching* award, he earned a B.A. in physics from Swarthmore College and a Ph.D. in biomedical physics from Harvard University.

Other books by the author:

Understanding Nonlinear Dynamics

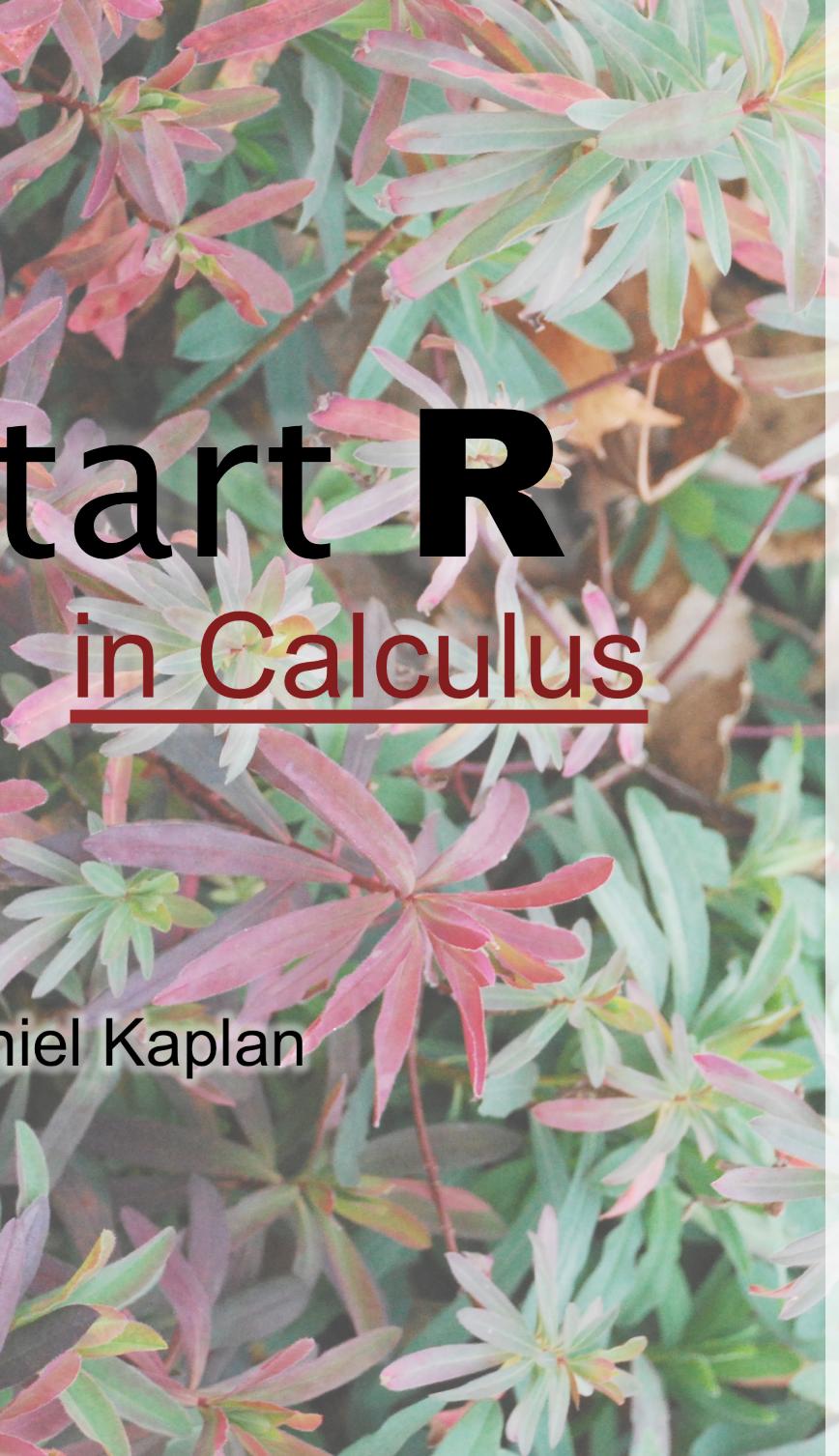
Introduction to Scientific Computation and Programming

Statistical Modeling: A Fresh Approach



Start R in Calculus

Daniel Kaplan



R/mosaic Calculus Commands

Preliminaries

Load the `mosaic` package.

```
require(mosaic)
```

Define a math function

```
f = makeFun(a * x^2 ~ x)
```

```
g = makeFun(sin(y * x) ~ x & y)
```

Generate random function

```
h = rfun(~x&y, seed=6732)
```

Read data file

```
utils = fetchData("utilities.csv")
```

Fit a model

```
m=fitModel(ccf ~ A+B*temp, data=utils)
```

```
coef(m)
```

Smoothers & splines

```
s1 = smoother(ccf ~ temp, data=utils)
```

```
s2 = spliner(ccf ~ temp, data=utils)
```

Differentiation

```
df = D(f(x) ~ x)
```

```
dgxy = D(g(x=x,y=y) ~ x & y)
```

Anti-differentiation / Integration

```
F = antid(f(x,a=2) ~ x)
```

```
F(3)-F(1)
```

Solve equations / find zeros.

```
findZeros(sin(x^2) - 0.5 ~ x,  
          x.lim=c(0,5))
```

Solve Differential Equations

```
s = integrateODE(dx ~ r*x*(K - x),  
                 x=1.3,  
                 r=.1, K=3, tdur=10)
```

```
s$x(3) # eval x at time 3
```

Linear algebra

```
b = c(5,2,1)
```

```
v1 = c(3,7,2)
```

```
v2 = c(2,0,1)
```

```
project(b ~ v1 + v2)
```