More Math in MATLAB

ENGR 151, Lecture 25: 8 Dec 14

Announcements

- Project 8 due Wed 10 Dec 11pm
- Final exam: Wed 17 Dec 4pm
  - Review: lecture of Wed 10 Dec
- Don't forget: course evaluations

'Gangnam Style' breaks YouTube

By **Brandon Griggs**, CNN
updated 1:50 PM EST, Wed December 3, 2014

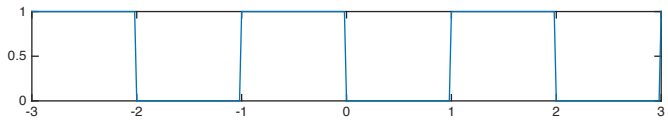
- Q:What happened?

A. Servers unexpectedly flooded due to spike in 2012 nostalgia
B. YouTube programmers afflicted by strange addiction to this video
C. View #2,147,483,648
D. North Korean hackers replace Psy face with Kim Jong-un
E. All of the above

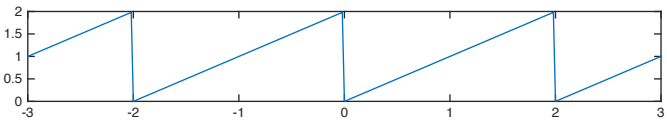
Which is plot of `mod(x,2)` ?

```
x = -3:.02:3
```

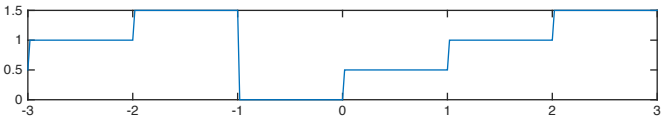
A



B



C



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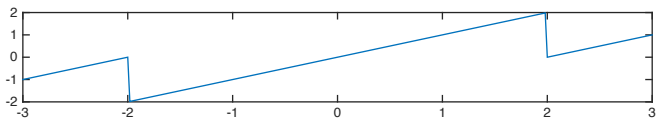
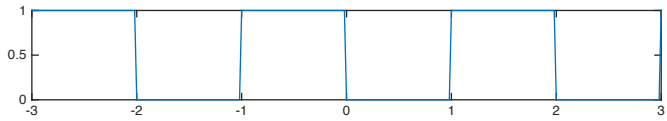


E none of the above

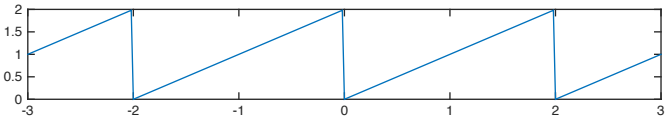
Which is plot of rem(x,2) ?

```
x = -3:.02:3
```

A



B



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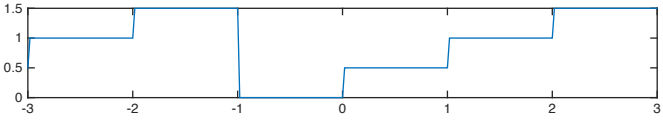
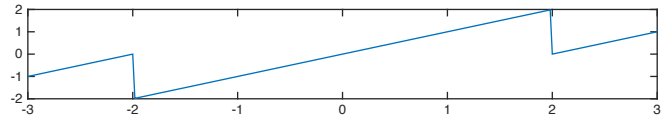


D



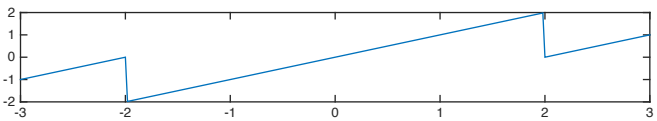
E none of the above

Remainder Functions

- `rem(x,y)` `x - (fix(x/y) * y)`
- `mod(x,y)` `x - (floor(x/y) * y)`

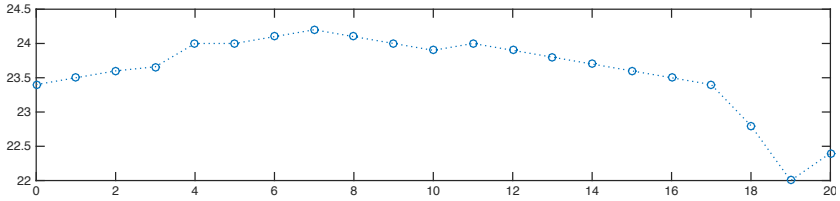
- Both are remainder of dividing x by y
  - `fix` rounds toward zero
  - `floor` rounds toward –Inf
- `rem` always same sign as x
- `mod` always same sign as y

`rem(x,2)`



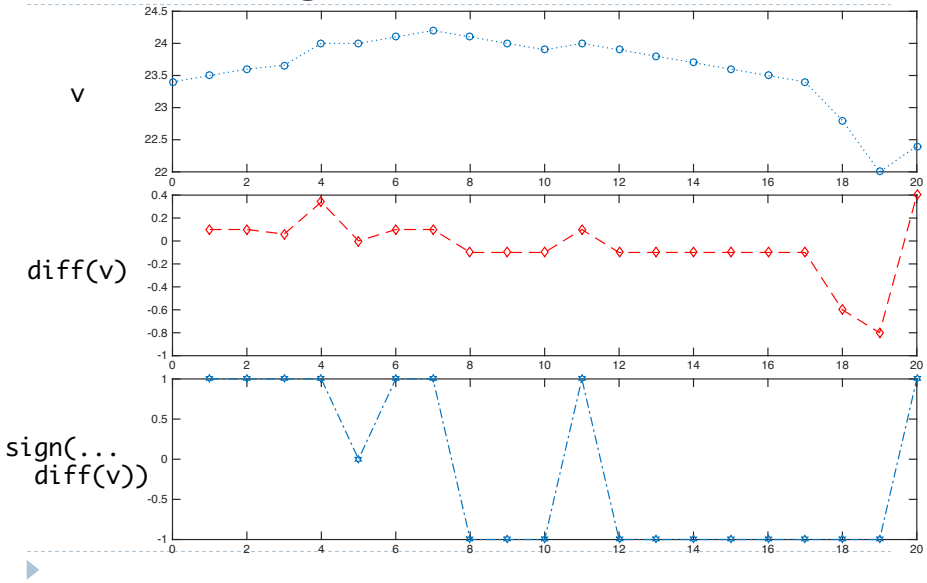
TrendAnalyze

- Given: A vector representing a series of data points
- Define positive (negative) trend: subsequence of data points in vector, in strictly increasing (decreasing) order



- Queries
  - How long is the longest (pos/neg) trend?
  - How many trend reversals?

diff and sign



find

- Returns indices of logical vector with value **true**
- For logical matrix, uses column indexing
- Examples:
  - `find(mod(1:22,5) == 0)`
    → [5 10 15 20]
  - `find(isprime(41:2:55))`
    → [1 2 4 7]
  - `find( [1:4; 5:8; 9:12] > 10 )`
    → [9; 12]

Back to Trend Analysis

- Given `trends = diff(v)`
- What does `find(trends <= 0)` return?

A. Number of nonnegative trends in v
B. Indices of v where a positive trend ends
C. Indices of v not part of a positive trend
D. Indices of v (offset by –1) not part of a positive trend
E. None of the above

Longest Positive Trend

- Given `nPosPts = find(diff(v) <= 0)`
- Which of the following gives length of longest positive trend?

A. `length(v) - nPosPts - 1`
B. `max(~nPosPts)`
C. `max(diff(nPosPts)) - 1`
D. `max(diff([0 nPosPts length(v)])) - 1`
E. None of the above

Number of Reversals

- Given

```
trends = sign(diff(v));
trends(trends == 0) = [ ];
```

- Which of the following gives the number of reversals?

A. `length(find(trends))`
B. `length(find(diff(trends)))`
C. `sum(diff(trends))`
D. `sum(diff(trends) ~= 0)`
E. None of the above

ENGR 151 Poll

- How should we change the focus of applications in this course?

A. More engineering
B. More computer science
C. More mathematics
D. More graphics / image processing
E. No change / something else

Poloynomials

- Which is a MATLAB representation of the polynomial $x^4 + 8x^2 + 17$?

A. [1 8 17]
B. [1 0 8 0 17]
C. [1 8 17; 4 2 0]
D. [4 1; 3 0; 2 8; 1 0; 0 17]

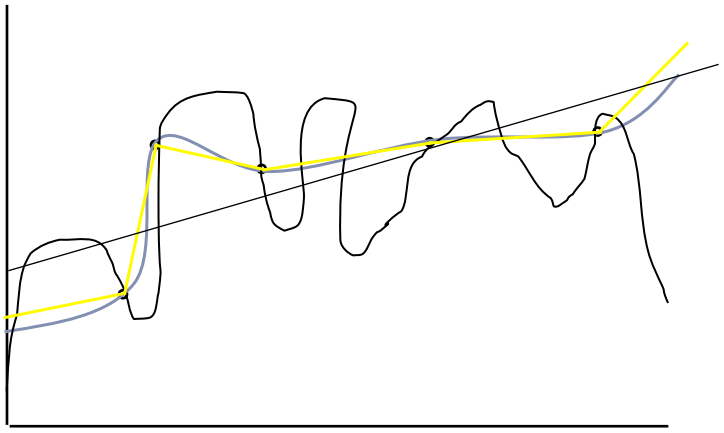
Evaluate a Polynomial at a Point

```
function y = PolyVal(poly, x)
  % evaluate polynomial poly at point x
  expts = length(poly)-1:-1:0;
  y = sum(poly .* (x.^expts));
end
```

- or, just use built-in function:

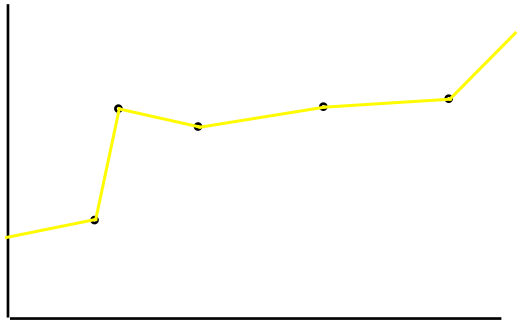
```
polyval([ 1 0 8 0 17 ], 3)  →   170
```

Curve Fitting



Interpolation

- Determine the y-value for an x-value between given (x,y) points
- Linear interpolation:
  - Assume y values linearly between the points
  - MATLAB fn: `interp1`



`interp1` Example

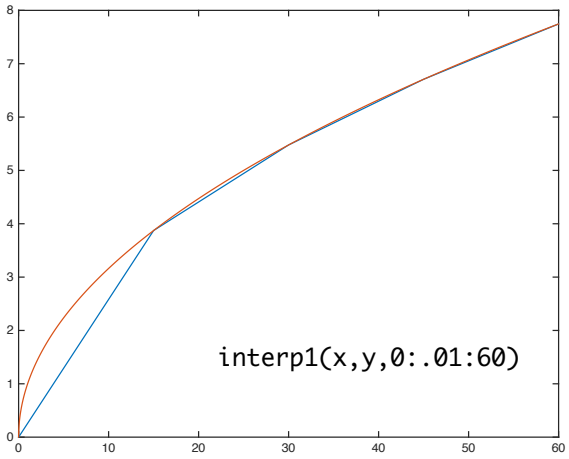
- Given `x = 7:9:100` and `y = sqrt(x)`
- What is `interp1(x,y,19)`?

A. 4.3333
B. 4.3589 (sqrt(19))
C. 4.5000
D. 5.0000
E. None of the above

interp1 Example

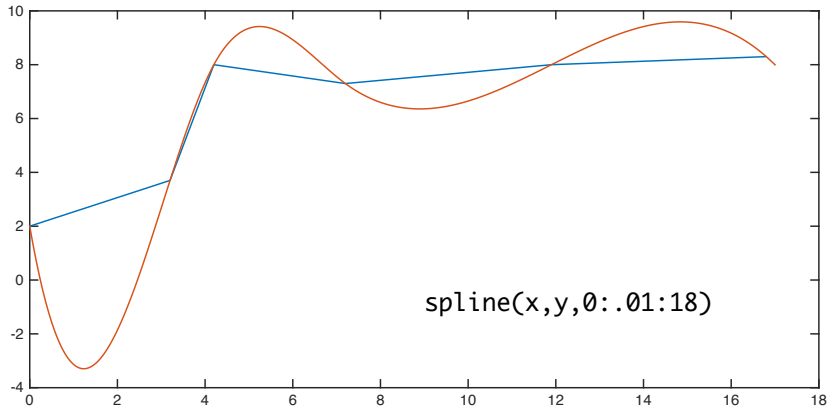
- `x = 0:15:60` and `y = sqrt(x)`

Plot of piecewise linear interpolation and actual sqrt



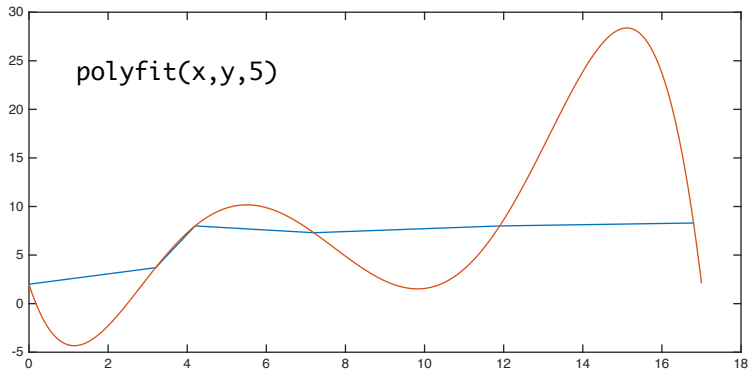
Spline Interpolation

- Fit connected cubic splines, to smooth out corner points



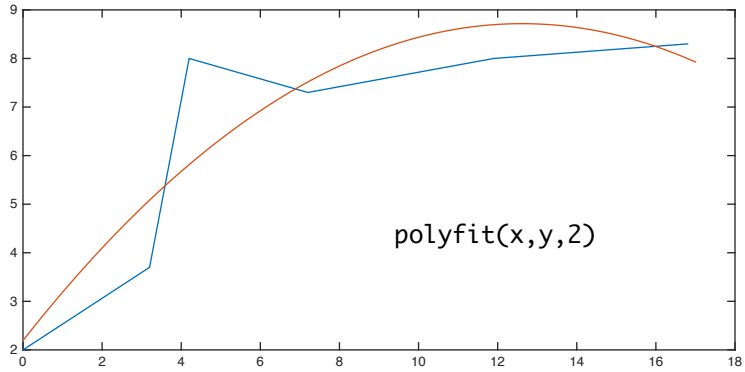
Polynomial Curve Fitting

- Can fit an nth-degree polynomial exactly to any series of n+1 points.
- 5th-degree polynomial for example points



Approximate Curve Fitting

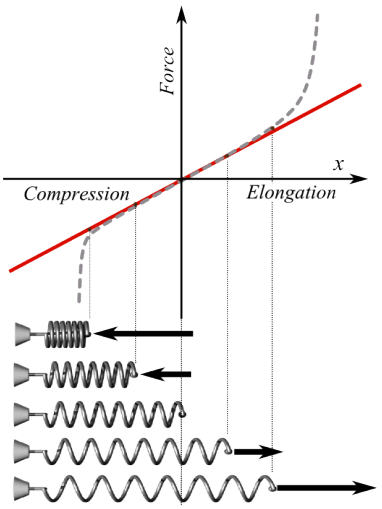
- Fitting a lower-degree polynomial entails errors on given points
- Approach: find curve minimizing sum of squared errors



Hooke's Law

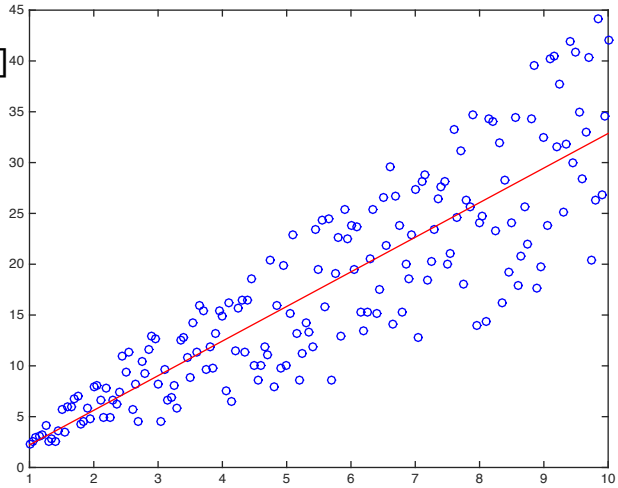
$$F = k\,x$$

- *k* a spring-specific constant
- How can we estimate *k* for particular string, from set of (*x*,*F*) measurements?



Fitting Noisy Data

```
polyfit(x,y,1)
→ [ 3.4 -1.2 ]
```



Pseudo-Random Numbers

- `rand(`*dim*`)` uniform double on [0,1]
- `randi(maxVal,`*dim*`)` uniform integer on [1,maxVal]
- `randn(`*dim*`)` normal with mean 0 stdev 1

- Which generates a uniform double on [10,20] ?

A. `rand(10,20)`
B. `10 + rand(20)`
C. `10 + 10 * rand()`
D. `20 * rand() – 10`
E. None of the above