

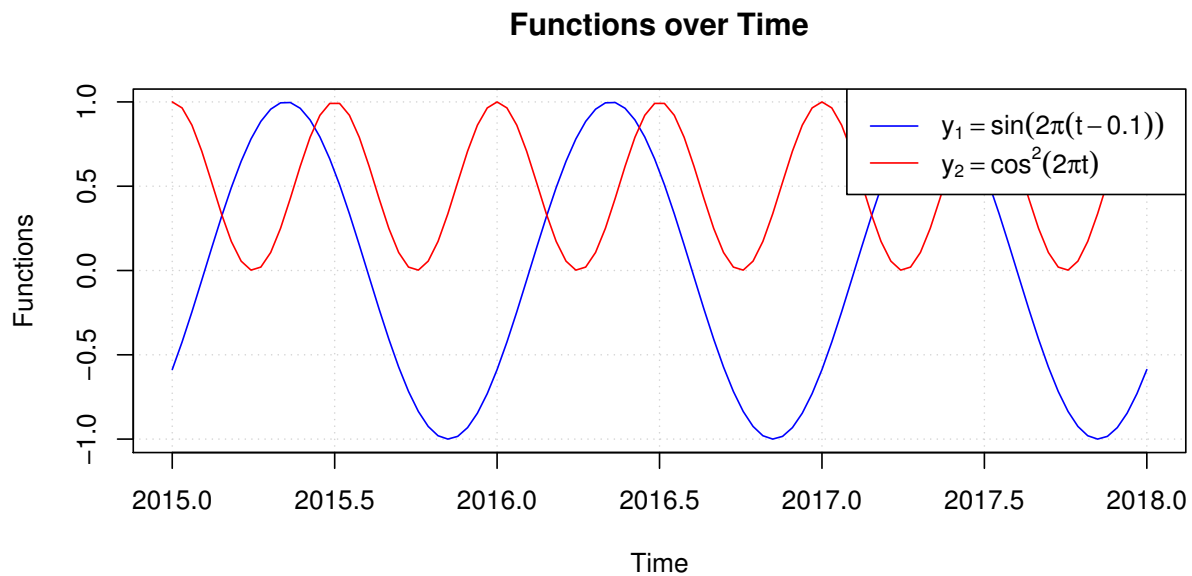
R Code
Intro to Math Modeling
Math 336
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Problem 6, Exercise 2.1:

```
t <- seq(2015,2018, length = 100)
y1 <- function(t) sin(2*pi*(t - .1))
y2 <- function(t) (cos(2*pi*t))^2

plot (t,y1(t), 'l', col='blue', ylab='Functions', xlab = 'Time',
      main = 'Functions over Time' ,panel.first=grid())
lines(t,y2(t), 'l', col='red')

text <- c(expression(y[1] == sin(2 *pi* (t - .1))),expression(y[2] == cos^2*(2*pi*t)))
legend('topright', legend=text , text.width = strwidth(text)[1]*1.2 ,
      col=c('blue','red') , lty=1 , cex=1 )
```



Problem 7, Exercise 2.4

```
A <- matrix(c(-3, -2, 2, 2, -1, 1, 1, 1, -4), nrow= 3)
```

```
b <- matrix(c(1, 2, 0))
```

```
x <- solve(A,b)
```

```
printAnswer <- c(paste('x =',x[1]),paste('y =',x[2]),paste('z =',x[3]))
```

```
matrix(printAnswer)
```

```
##      [,1]
```

```
## [1,] "x = -1"
```

```
## [2,] "y = -0.6666666666666667"
```

```
## [3,] "z = -0.6666666666666667"
```

Problem 8, Exercise 2.5

```
setwd('C:/Users/Stephen Giang/Documents/Math336Files/data')
readData <- read.csv('CA042239T.csv')

readData <- readData[85:dim(readData)[1],]
readData$TMAX..F. <- as.numeric(readData$TMAX..F.)
readData$TMEAN..F. <- as.numeric(readData$TMEAN..F.)
readData$TMIN..F. <- as.numeric(readData$TMIN..F.)

organize <- function(readData, yearStart, yearEnd, colNum) {
  rowStart <- 1 + 12*(yearStart - readData$YEAR[1])
  rowEnd <- 1 + 12*(yearEnd - readData$YEAR[1]) + 11

  dataRow <- matrix( c(readData[rowStart:(rowStart+11),colNum]),nrow=1)
  dataMatrix <- dataRow

  rowSeq <- seq((rowStart+12), rowEnd, by=12)
  for (row in rowSeq) {
    dataRow <- matrix( c(readData[row:(row+11),colNum]),nrow=1)
    dataMatrix <- rbind(dataMatrix, dataRow)
  }

  colnames(dataMatrix) <- c('Jan', 'Feb', 'Mar',
                           'Apr', 'May', 'Jun',
                           'Jul', 'Aug', 'Sep',
                           'Oct', 'Nov', 'Dec')

  return(dataMatrix)
}

PartA <- organize(readData, 1961, 1990, 4) #TMAX
PartA
```

##		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
##	[1,]	53.8	55.7	53.0	64.3	64.2	81.3	87.6	85.0	76.3	69.3	54.0	48.9
##	[2,]	48.2	47.0	46.7	68.3	63.6	74.9	83.8	88.1	82.5	70.6	64.3	54.9
##	[3,]	46.1	61.8	53.7	55.0	68.3	70.6	85.7	83.3	80.1	70.1	58.5	54.4
##	[4,]	48.7	52.2	49.7	55.6	62.3	74.9	86.8	85.3	80.4	75.3	51.9	50.8
##	[5,]	50.7	52.4	49.9	56.7	66.6	69.8	84.4	84.9	73.3	76.8	59.1	46.9
##	[6,]	46.9	46.2	58.7	66.5	72.5	78.4	84.7	86.6	80.5	69.6	58.9	50.2
##	[7,]	51.0	55.0	54.2	47.8	65.0	70.9	86.6	86.5	74.8	74.4	61.4	43.3
##	[8,]	47.6	57.0	55.7	59.5	67.6	76.0	83.8	78.9	78.9	69.4	58.6	47.0
##	[9,]	50.8	44.0	52.6	61.7	69.5	73.8	83.4	89.3	81.4	65.6	57.0	58.1
##	[10,]	53.1	55.5	55.1	56.5	69.4	77.2	86.6	86.6	78.6	67.3	58.5	47.9
##	[11,]	51.8	52.7	57.5	56.8	60.6	73.7	85.1	85.6	79.5	64.7	55.9	44.3
##	[12,]	51.6	56.8	66.8	63.1	71.2	77.3	86.0	81.6	77.7	62.8	54.0	47.8
##	[13,]	45.8	47.9	44.3	59.0	70.3	78.4	84.1	82.3	76.7	69.7	55.0	54.9
##	[14,]	47.6	53.3	55.3	59.6	67.3	81.3	81.7	82.2	81.9	67.0	58.3	50.6
##	[15,]	53.2	50.4	49.7	47.1	65.8	75.6	83.0	82.7	79.7	66.7	59.5	53.5
##	[16,]	54.7	52.7	52.8	56.2	69.1	76.8	83.1	78.5	72.0	67.1	60.5	54.6
##	[17,]	48.2	59.2	50.0	63.0	57.3	77.3	84.0	82.3	76.3	71.6	63.7	57.6
##	[18,]	50.5	50.3	54.6	55.0	66.3	78.6	84.7	82.7	75.2	74.1	54.1	47.5
##	[19,]	43.2	47.9	51.2	60.8	66.1	78.5	82.7	79.4	83.9	69.9	55.6	56.2
##	[20,]	49.8	54.4	50.2	59.3	57.6	74.3	85.1	81.5	80.0	70.4	62.9	57.8
##	[21,]	54.6	56.8	52.0	63.3	67.4	83.6	85.3	87.2	80.5	63.7	62.7	58.1
##	[22,]	47.2	53.1	51.3	59.5	66.5	71.9	81.7	85.6	76.1	67.8	54.2	50.4
##	[23,]	52.4	51.4	51.2	52.1	67.1	73.4	82.0	81.2	80.0	68.4	56.5	52.6
##	[24,]	53.8	58.4	60.5	60.0	76.2	76.3	82.3	81.2	79.3	63.3	55.2	45.4
##	[25,]	47.7	51.7	53.5	66.2	68.2	79.5	84.7	84.1	70.7	67.4	55.0	53.5
##	[26,]	58.7	53.5	59.2	61.5	68.2	78.2	79.5	86.6	71.4	65.3	62.8	55.5
##	[27,]	52.6	53.1	50.5	68.1	67.8	79.7	80.0	81.5	79.8	70.8	57.3	47.5
##	[28,]	52.0	58.6	62.1	60.6	69.0	78.2	86.1	83.0	79.5	77.5	58.5	50.8
##	[29,]	47.0	50.1	62.6	69.9	66.8	77.3	87.4	80.9	80.5	68.8	64.4	54.7
##	[30,]	51.3	48.8	57.5	62.0	63.2	77.5	83.5	81.9	79.6	73.7	58.9	47.9

```
PartB <- organize(readData, 1961, 1990, 6) #TMIN
PartB
```

```
##      Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
## [1,] 26.7 28.8 31.7 35.0 37.4 52.4 54.6 53.2 41.4 36.7 28.7 27.3
## [2,] 27.1 30.4 27.1 39.0 38.3 44.3 50.1 53.5 45.8 35.6 28.5 25.5
## [3,] 24.9 33.7 28.4 29.4 39.8 44.2 53.2 52.8 46.7 40.1 32.5 24.8
## [4,] 25.8 24.4 25.3 31.0 37.3 43.1 52.4 52.4 43.1 42.9 27.8 32.0
## [5,] 30.0 28.4 28.6 33.3 37.8 39.6 50.8 52.1 40.4 38.6 33.3 29.0
## [6,] 25.4 25.9 31.6 37.0 39.9 45.2 52.0 53.8 45.9 37.5 32.6 31.7
## [7,] 30.2 29.9 32.9 28.2 39.4 42.2 54.3 55.1 48.7 36.1 32.6 23.3
## [8,] 27.1 34.8 31.3 31.9 38.6 47.6 54.2 49.8 45.7 37.4 31.4 23.4
## [9,] 31.6 28.4 29.2 38.0 37.0 44.5 52.7 55.0 49.5 35.1 36.2 26.6
## [10,] 28.6 28.2 30.0 28.5 39.6 45.8 55.5 56.4 45.0 37.1 30.9 26.1
## [11,] 25.4 28.4 31.3 30.0 35.8 44.1 54.3 53.7 45.5 33.4 28.7 24.3
## [12,] 24.2 30.1 33.2 34.6 37.7 45.8 56.4 51.9 44.5 38.5 28.7 26.6
## [13,] 24.9 28.0 26.7 31.6 40.5 49.2 51.7 51.4 43.2 34.6 31.4 30.7
## [14,] 27.2 27.4 31.4 32.8 38.9 50.4 55.5 50.9 49.6 39.0 32.4 26.0
## [15,] 27.9 27.1 28.1 29.0 38.8 46.4 54.1 51.8 48.7 34.8 30.8 28.0
## [16,] 27.0 30.5 28.7 30.0 41.0 47.8 52.2 47.7 47.8 39.8 34.8 25.1
## [17,] 29.6 27.8 26.0 34.0 35.0 49.4 53.1 55.0 47.9 39.5 33.5 33.8
## [18,] 31.6 32.6 35.7 33.7 40.9 51.9 54.7 53.0 45.8 42.0 30.3 24.9
## [19,] 26.6 24.2 31.0 35.4 39.5 50.9 53.1 50.8 50.2 40.0 31.5 29.6
## [20,] 34.6 34.8 31.5 35.5 36.8 47.9 56.6 52.0 47.6 42.5 34.6 33.2
## [21,] 31.6 30.7 31.7 36.2 40.9 52.3 55.7 55.9 49.9 36.2 34.3 31.7
## [22,] 28.3 31.2 31.9 34.9 39.8 43.9 52.7 55.2 46.0 35.0 31.6 28.4
## [23,] 30.6 31.8 34.5 32.5 41.0 45.2 52.3 54.4 53.3 43.1 35.8 33.9
## [24,] 32.9 29.0 34.8 34.8 45.1 46.9 56.6 54.7 50.4 36.4 30.7 29.0
## [25,] 29.6 29.0 29.3 39.7 40.2 48.3 55.7 52.5 42.7 37.9 31.5 30.7
## [26,] 33.4 31.2 35.4 36.4 41.9 49.4 51.7 56.3 42.8 36.8 33.7 28.6
## [27,] 26.7 28.5 30.9 37.7 41.0 47.9 49.7 51.1 46.1 43.0 32.6 25.2
## [28,] 28.5 31.0 31.4 34.7 39.1 46.7 54.6 53.3 44.8 41.2 32.4 28.5
## [29,] 26.6 28.6 35.9 39.6 40.1 46.9 55.1 51.1 45.5 38.5 34.7 28.9
## [30,] 28.0 25.7 32.2 38.2 40.4 48.6 55.9 52.0 48.9 38.7 32.8 24.7
```

```
PartC <- organize(readData, 1961, 1990, 5) #TMEAN
PartC
```

```
##      Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
## [1,] 40.2 42.2 42.4 49.7 50.8 66.8 71.1 69.1 58.9 53.0 41.4 38.1
## [2,] 37.6 38.7 36.9 53.7 51.0 59.6 67.0 70.8 64.1 53.1 46.4 40.2
## [3,] 35.5 47.8 41.0 42.2 54.1 57.4 69.5 68.1 63.4 55.1 45.5 39.6
## [4,] 37.2 38.3 37.5 43.3 49.8 59.0 69.6 68.8 61.8 59.1 39.8 41.4
## [5,] 40.4 40.4 39.2 45.0 52.2 54.7 67.6 68.5 56.9 57.7 46.2 38.0
## [6,] 36.2 36.1 45.1 51.8 56.2 61.8 68.4 70.2 63.2 53.5 45.8 40.9
## [7,] 40.6 42.4 43.6 38.0 52.2 56.6 70.5 70.8 61.7 55.3 47.0 33.3
## [8,] 37.3 45.9 43.5 45.7 53.1 61.8 69.0 64.3 62.3 53.4 45.0 35.2
## [9,] 41.2 36.2 40.9 49.8 53.3 59.2 68.1 72.2 65.5 50.4 46.6 42.3
## [10,] 40.9 41.9 42.5 42.5 54.5 61.5 71.1 71.5 61.8 52.2 44.7 37.0
## [11,] 38.6 40.6 44.4 43.4 48.2 58.9 69.7 69.7 62.5 49.0 42.4 34.3
## [12,] 37.9 43.4 50.0 48.8 54.4 61.6 71.2 66.7 61.1 50.6 41.4 37.2
## [13,] 35.4 38.0 35.5 45.3 55.4 63.8 67.9 66.8 59.9 52.2 43.2 42.8
## [14,] 37.4 40.3 43.3 46.2 53.1 65.8 68.6 66.6 65.7 53.0 45.4 38.3
## [15,] 40.5 38.8 38.9 38.0 52.3 61.0 68.6 67.2 64.2 50.7 45.2 40.7
## [16,] 40.8 41.6 40.7 43.1 55.1 62.3 67.6 63.1 59.9 53.5 47.6 39.9
## [17,] 38.9 43.5 38.0 48.5 46.1 63.4 68.6 68.6 62.1 55.5 48.7 45.7
## [18,] 41.0 41.5 45.2 44.4 53.6 65.3 69.7 67.9 60.5 58.0 42.2 36.2
## [19,] 34.9 36.0 41.1 48.1 52.8 64.7 67.9 65.1 67.0 54.9 43.5 42.9
## [20,] 42.2 44.6 40.8 47.4 47.2 61.1 70.8 66.8 63.8 56.5 48.7 45.5
## [21,] 43.1 43.7 41.9 49.8 54.1 67.9 70.5 71.5 65.2 49.9 48.5 44.9
## [22,] 37.8 42.2 41.6 47.2 53.2 57.9 67.2 70.4 61.1 51.4 42.9 39.4
## [23,] 41.5 41.6 42.9 42.3 54.0 59.3 67.2 67.8 66.6 55.8 46.2 43.2
## [24,] 43.3 43.7 47.7 47.4 60.7 61.6 69.4 68.0 64.9 49.9 42.9 37.2
## [25,] 38.6 40.4 41.4 53.0 54.2 64.0 70.2 68.3 56.7 52.6 43.3 42.1
## [26,] 46.1 42.3 47.3 49.0 55.0 63.8 65.6 71.4 57.1 51.0 48.2 42.1
## [27,] 39.7 40.8 40.7 52.9 54.4 63.8 64.9 66.3 63.0 56.9 44.9 36.4
## [28,] 40.2 44.8 46.8 47.7 54.1 62.4 70.4 68.1 62.2 59.3 45.5 39.7
## [29,] 36.8 39.4 49.2 54.7 53.4 62.1 71.3 66.0 63.0 53.7 49.5 41.8
## [30,] 39.7 37.3 44.9 50.1 51.8 63.1 69.7 67.0 64.3 56.2 45.9 36.3
```

#Problem 9, Exercise 2.7

```
setwd('C:/Users/Stephen Giang/Documents/Math336Files/data')
readData <- read.csv('CA042239T.csv')

readData <- readData[85:dim(readData)[1],]
readData$TMAX..F. <- as.numeric(readData$TMAX..F.)
readData$TMEAN..F. <- as.numeric(readData$TMEAN..F.)
readData$TMIN..F. <- as.numeric(readData$TMIN..F.)

TMinMatrix <- function(readData, yearStart, yearEnd) {
  rowStart <- 1 + 12*(yearStart - readData$YEAR[1])
  rowEnd <- 1 + 12*(yearEnd - readData$YEAR[1]) + 11

  yearCol <- matrix( c( readData[rowStart:rowEnd, 2] +
                        ((readData[rowStart:rowEnd, 3] - 1) / 12) ), ncol=1 )
  TMinCol <- matrix( c( readData[rowStart:rowEnd, 6]), ncol=1 )

  dataMatrix <- yearCol
  dataMatrix <- cbind(dataMatrix, TMinCol)

  return(dataMatrix)
}

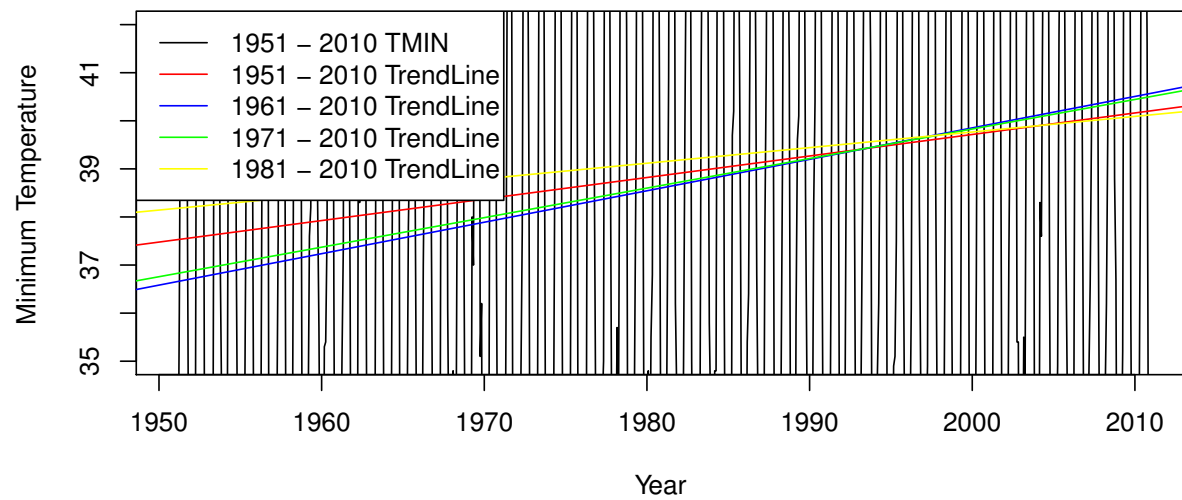
slope <- seq(0,0,len=4)
slopeCount <- 1
colorList <- c('black', 'red', 'blue', 'green', 'yellow')
colorCount <- 2

TMinVals <- TMinMatrix(readData, 1951, 2010)
plot(TMinVals[,1], TMinVals[,2], 'l', xlab='Year', ylab='Minimum Temperature',
     main='Minimum Temperature per Year', col= colorList[1], ylim=range(35,42))

yearStartSeq <- seq(1951, 1981, by=10)
for (yearStart in yearStartSeq) {
  TMinVals <- TMinMatrix(readData, yearStart, 2010)
  x <- TMinVals[,1]
  y <- TMinVals[,2]
  linMod <- lm(y~x)
  abline(linMod, col=colorList[colorCount])
  slope[slopeCount] <- linMod$coefficients[2]
  slopeCount <- slopeCount + 1
  colorCount <- colorCount + 1
}

text <- c( '1951 - 2010 TMIN', '1951 - 2010 TrendLine', '1961 - 2010 TrendLine',
           '1971 - 2010 TrendLine', '1981 - 2010 TrendLine')
legend('topleft', legend=text , col=colorList , lty=1, cex=1)
```

Minimum Temperature per Year



```
printPartC <- c(paste('Slope for 1951-2010 TrendLine:',slope[1]),
                paste('Slope for 1961-2010 TrendLine:',slope[2]),
                paste('Slope for 1971-2010 TrendLine:',slope[3]),
                paste('Slope for 1981-2010 TrendLine:',slope[4]))
matrix(printPartC)
```

```
##      [,1]
## [1,] "Slope for 1951-2010 TrendLine: 0.0447627020885443"
## [2,] "Slope for 1961-2010 TrendLine: 0.0654045150125415"
## [3,] "Slope for 1971-2010 TrendLine: 0.0614426494906739"
## [4,] "Slope for 1981-2010 TrendLine: 0.0324715468483712"
```


#Problem 10, Exercise 2.9

```
setwd('C:/Users/Stephen Giang/Documents/Math336Files/data')
readData <- read.csv('NOAAGlobalT.csv')

t <- seq(1880,2017, by=(1/12))
y1 <- readData[1800,4:dim(readData)[2]]
y2 <- readData[1810,4:dim(readData)[2]]

plot(t, y1, 'l',col='red',ylab = 'Temperature', xlab = 'Year' ,
     main = 'Temperature Anomaly Time Series')
lines(t, y2, 'l',col='blue')

text <- c('Lat: 32.5, Lon: 357.5', 'Lat: 37.5, Lon: 47.5')
legend('topleft', legend = text, col = c('red','blue'), lty=1, cex=1)
```

Temperature Anomaly Time Series

