

ProblemAnswers

November 9, 2016

0.1 Problem 1

```
In [10]: N = 10
        A = zeros(N,N)
        for i in 1:N, j in 1:N
            abs(i-j)<=1 ? A[i,j]+=1 : nothing
            i==j ? A[i,j]-=3 : nothing
        end
        A
```

```
Out[10]: 10×10 Array{Float64,2}:
 -2.0  1.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
  1.0 -2.0  1.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
  0.0  1.0 -2.0  1.0  0.0  0.0  0.0  0.0  0.0  0.0
  0.0  0.0  1.0 -2.0  1.0  0.0  0.0  0.0  0.0  0.0
  0.0  0.0  0.0  1.0 -2.0  1.0  0.0  0.0  0.0  0.0
  0.0  0.0  0.0  0.0  1.0 -2.0  1.0  0.0  0.0  0.0
  0.0  0.0  0.0  0.0  0.0  1.0 -2.0  1.0  0.0  0.0
  0.0  0.0  0.0  0.0  0.0  0.0  1.0 -2.0  1.0  0.0
  0.0  0.0  0.0  0.0  0.0  0.0  0.0  1.0 -2.0  1.0
  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  1.0 -2.0
```

```
In [17]: ##### Prepare Data

        X = rand(1000, 3)           # feature matrix
        a0 = rand(3)                # ground truths
        y = X * a0 + 0.1 * randn(1000); # generate response
```

```
Out[17]: 1000-element Array{Float64,1}:
 0.245515
 0.213645
 0.179037
-0.0252645
 0.327495
 0.1073
 0.284771
 0.134653
 0.32761
```

```

0.139108
0.321555
0.192148
0.124061
⋮
0.173127
0.203367
0.183517
0.107017
0.290129
0.203007
0.261345
0.205973
0.194457
0.0825708
0.180052
0.0156171

```

0.2 Problem 2

```

In [18]: X2 = hcat(X, ones(1000))
          println(X2\y)

[0.219939, 0.0336012, 0.090267, 0.00117261]

```

0.3 Problem 3

```

In [19]: using MultivariateStats
          llsq(X, y)

Out[19]: 4-element Array{Float64,1}:
          0.219939
          0.0336012
          0.090267
          0.00117261

```

0.4 Problem 4

```

In [20]: using DataFrames, GLM
          data = DataFrame(X1=X[:,1], X2=X[:,2], X3=X[:,3], Y=y)
          OLS = lm(Y ~ X1 + X2 + X3, data)

Out[20]: DataFrames.DataFrameRegressionModel{GLM.LinearModel{GLM.LmResp{Array{Float64,1}},
          Formula: Y ~ 1 + X1 + X2 + X3

          Coefficients:
              Estimate Std.Error t value Pr(>|t|)

```

(Intercept)	0.00117261	0.010462	0.112083	0.9108
X1	0.219939	0.0113648	19.3526	<1e-70
X2	0.0336012	0.0111465	3.01451	0.0026
X3	0.090267	0.0108559	8.315	<1e-15

0.5 Problem 5

```
In [21]: r = 2.9:.00005:4; numAttract = 150
        steady = ones(length(r),1)*.25
        for i=1:400 ## Get to steady state
            steady .= r.*steady.*(1-steady)
        end
        x = zeros(length(steady),numAttract)
        x[:,1] = steady
        @inbounds for i=2:numAttract ## Grab values at the attractor
            x[:,i] = r.*x[:,i-1].*(1-x[:,i-1])
        end
        using Plots
        plot(collect(r),x,seriestype=:scatter,markersize=.002,legend=false)
```

0.6 Metaprogramming Project

```
In [1]: macro ~(y,ex)
        new_ex = Meta.quot(ex)
        quote
            inner_ex = $(esc(new_ex))
            data_name = Symbol(string(inner_ex.args[end])[1])
            eval_ex = Expr(:(=),:data,data_name)
            eval(Main,eval_ex)
            new_X = Matrix{Float64}(size(data,1),length(inner_ex.args)-1)
            cur_spot = 0
            for i in 2:length(inner_ex.args)
                if inner_ex.args[i] == 1
                    new_X[:,i-1] = ones(size(data,1))
                else
                    col = parse{Int}(string(string(inner_ex.args[i])[2]))
                    new_X[:,i-1] = data[:,col]
                end
            end
            $(esc(y)),new_X
        end
    end

y = rand(10)
X = rand(10,4)
y~1+X1+X2+X4
```

```

function solve_least_squares(y,X)
    X\y
end
solve_least_squares(tup::Tuple) = solve_least_squares(tup...)
solve_least_squares(y~1+X1+X2+X4)

```

```

Out[1]: 4-element Array{Float64,1}:
 0.153788
 0.742984
-0.268836
 0.320996

```

0.7 Distribution Dispatch Problem

This is from Josh Day's talk: <https://www.youtube.com/watch?v=EwcTNzpQ6Sc>

Solution is from: https://github.com/joshday/Talks/blob/master/SLG2016_IntroToJulia/Slides.ipynb

```

In [ ]: function myquantile(d::UnivariateDistribution, q::Number)
    θ = mean(d)
    tol = Inf
    while tol > 1e-5
        θold = θ
        θ = θ - (cdf(d, θ) - q) / pdf(d, θ)
        tol = abs(θold - θ)
    end
    θ
end

for dist in [Gamma(5, 1), Normal(0, 1), Beta(2, 4)]
    @show myquantile(dist, .75)
    @show quantile(dist, .75)
    println()
end

```

0.8 LightGraphs Problem

```

In [ ]: using LightGraphs, Distributions
function mkTree(maxdepth::Int = 10, p::Float64 = 0.8, g::SimpleGraph = Graph{Int, Vector{Int}}())
    if (maxdepth <= 1) g
    else
        b = Binomial(2, p)
        nEdges = max(1, rand(b))
        for leaves in 1:nEdges
            add_vertex!(g)
            newnode = nv(g)
            add_edge!(g, currhead, newnode)
            mkTree(maxdepth-1, p, g, newnode)
        end
    end
end

```

```

        end
    g
end

```

0.9 Roots Problems

```

In [ ]: using Roots
        f(x) = 10 - x + e*sin(x)
        fzero(f,BigFloat(2.0))

In [ ]: f! = function (x,dx)
        dx[1] = x[1] + x[2] + x[3]^2 -12
        dx[2] = x[1]^2 - x[2] + x[3] - 2
        dx[3] = 2x[1] - x[2]^2 + x[3] - 1
    end
    using NLSolve
    res = nlsolve(f!, [1.0;1.0;1.0])
    res.zero
    res = nlsolve(f!, [1.0;1.0;1.0], autodiff=true)
    res.zero

```