

# IntermediateProblemAnswers

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## 1 Intermediate Problem Answers

### 1.1 MyRange and MyLinSpace Problem

#### 1.1.1 Part 1

```
In [8]: struct MyRange
        start
        step
        stop
    end

    function _MyRange(a::MyRange,i::Int)
        tmp = a.start + a.step*(i-1)
        if tmp > a.stop
            error("Index is out of bounds!")
        else
            return tmp
        end
    end
end
```

```
Out[8]: _MyRange (generic function with 1 method)
```

```
In [9]: a = MyRange(1,2,20)
        _MyRange(a,5) == (1:2:20)[5]
```

```
Out[9]: true
```

```
In [12]: Base.getindex(a::MyRange,i::Int) = _MyRange(a,i)
        a[5]
```

```
Out[12]: 9
```

#### 1.1.2 Part 2

```
In [13]: ?linspace
```

```
search: linspace LinSpace
```

Out [13]:

```
linspace(start, stop, n=50)
```

Construct a range of  $n$  linearly spaced elements from `start` to `stop`.

```
julia> linspace(1.3,2.9,9)
1.3:0.2:2.9
```

```
In [25]: struct MyLinSpace
          start
          stop
          n
        end

        function Base.getindex(a::MyLinSpace,i::Int)
          dx = (a.stop-a.start)/a.n
          a.start + dx*(i-1)
        end
```

```
In [26]: l = MyLinSpace(1,2,50)
          l[6]
```

Out [26]: 1.1

```
In [27]: linspace(1,2,50)[6]
```

Out [27]: 1.1020408163265305

### 1.1.3 Part 3

```
In [29]: (a::MyRange)(x) = a.start + a.step*(x-1)
          a = MyRange(1,2,20)
          a(1.1)
```

Out [29]: 1.2000000000000002

### 1.1.4 Part 4

```
In [32]: using Unitful
          a = MyRange(1u"kg",2u"kg",20u"kg")
          a[5]
```

Out [32]: 9 kg

```
search: end endof endswith ENDIAN_BOM send append! QuoteNode RangeIndex getindex
```

## 1.2 Operator Problem

```
In [56]: struct StrangMatrix end
        A = StrangMatrix()
```

```
function Base.A_mul_B!(C,A::StrangMatrix,B::AbstractVector)
    for i in 2:length(B)-1
        C[i] = B[i-1] - 2B[i] + B[i+1]
    end
    C[1] = -2B[1] + B[2]
    C[end] = B[end-1] - 2B[end]
    C
end
```

```
Base.:*(A::StrangMatrix,B::AbstractVector) = (C = similar(B); A_mul_B!(C,A
```

```
In [38]: A*ones(10)
```

```
Out[38]: 10-element Array{Float64,1}:
```

```
-1.0
 0.0
 0.0
 0.0
 0.0
 0.0
 0.0
 0.0
 0.0
 0.0
-1.0
```

```
In [64]: struct SizedStrangMatrix
        size
    end
```

```
Base.eltype(A::SizedStrangMatrix) = Float64
Base.size(A::SizedStrangMatrix) = A.size
Base.size(A::SizedStrangMatrix,i::Int) = A.size[i]
```

```
In [65]: b = sin.(0:0.1:2 $\pi$ )
```

```
Out[65]: 63-element Array{Float64,1}:
```

```
0.0
0.0998334
0.198669
0.29552
0.389418
0.479426
0.564642
0.644218
```

```

0.717356
0.783327
0.841471
0.891207
0.932039
⋮
-0.925815
-0.883455
-0.832267
-0.772764
-0.70554
-0.631267
-0.550686
-0.464602
-0.373877
-0.279415
-0.182163
-0.0830894

```

```
In [66]: A = SizedStrangMatrix((length(b),length(b)))
```

```

function Base.A_mul_B!(C,A::SizedStrangMatrix,B)
    for i in 2:length(B)-1
        C[i] = B[i-1] - 2B[i] + B[i+1]
    end
    C[1] = -2B[1] + B[2]
    C[end] = B[end-1] - 2B[end]
    C
end
Base.:*(A::SizedStrangMatrix,B::AbstractVector) = (C = similar(B); A_mul_B!(C,A,B); C)

```

```
In [73]: using IterativeSolvers
x = gmres(A,b,tol=1e-14)
```

```

Out[73]: 63-element Array{Float64,1}:
 -9.75574
-19.5118
-29.1685
-38.6273
-47.7917
-56.5679
-64.8662
-72.6018
-79.6955
-86.0744
-91.6729
-96.4332
-100.306

```

```

      :
    92.7311
    88.6305
    83.6451
    77.8263
    71.2334
    63.934
    56.0017
    47.5193
    38.5723
    29.2516
    19.6511
    9.86787

```

```
In [75]: A*x - b
```

```

Out[75]: 63-element Array{Float64,1}:
 -0.000289122
 -0.000548773
 -0.000747631
 -0.00109653
 -0.00121106
 -0.00156251
 -0.001876
 -0.00234776
 -0.00257171
 -0.0029435
 -0.0031805
 -0.00349519
 -0.00378336
      :
 -0.00139662
 -0.00132261
 -0.00122719
 -0.00123587
 -0.00103713
 -0.00164304
  0.000594124
  0.00010594
  9.1898e-5
 -0.000444569
 -0.000461939
 -0.00158795

```

### 1.3 Regression Problem

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

```

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

X2 = hcat(X, ones(1000))
println(X2\y)

using MultivariateStats
println(llsq(X,y))

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

X = rand(100);
y = 2X + 0.1 * randn(100);

using Plots
b = X\y
println(b)
gr()
scatter(X,y)
Plots.abline!(b[1],0.0, lw=3) # Slope, Intercept

```

## 1.4 Type Hierarchy Problem

```

In [80]: abstract type AbstractPerson end
         abstract type AbstractStudent <: AbstractPerson end

struct Person <: AbstractPerson
    name
end

struct Student <: AbstractStudent
    name
    grade
end

struct GraduateStudent <: AbstractStudent
    name
    grade
end

person_info(p::AbstractPerson) = println(p.name)
person_info(s::AbstractStudent) = (println(s.name); println(s.grade))

Out[80]: person_info (generic function with 2 methods)

```

```
In [78]: person_info(Person("Bob"))
```

Bob

```
In [81]: person_info(Student("Bob", 2))
```

Bob

2

```
In [82]: person_info(GraduateStudent("Bob", 2))
```

Bob

2

## 1.5 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](https://github.com/joshday/Talks/blob/master/SLG2016_IntroToJulia/Slides.ipynb)

```
In [ ]: function myquantile(d::UnivariateDistribution, q::Number)
     $\theta$  = mean(d)
    tol = Inf
    while tol > 1e-5
         $\theta_{old}$  =  $\theta$ 
         $\theta$  =  $\theta$  - (cdf(d,  $\theta$ ) - q) / pdf(d,  $\theta$ )
        tol = abs( $\theta_{old}$  -  $\theta$ )
    end
     $\theta$ 
end

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