MATH 420

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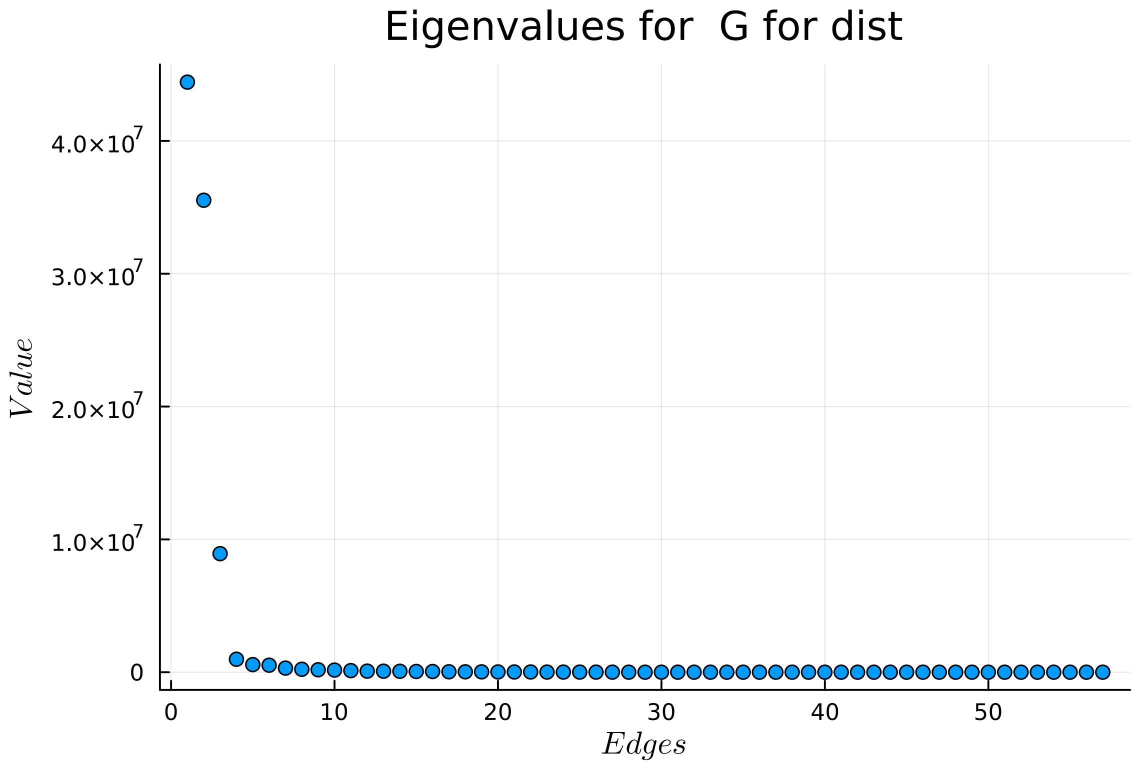
Team HW 1

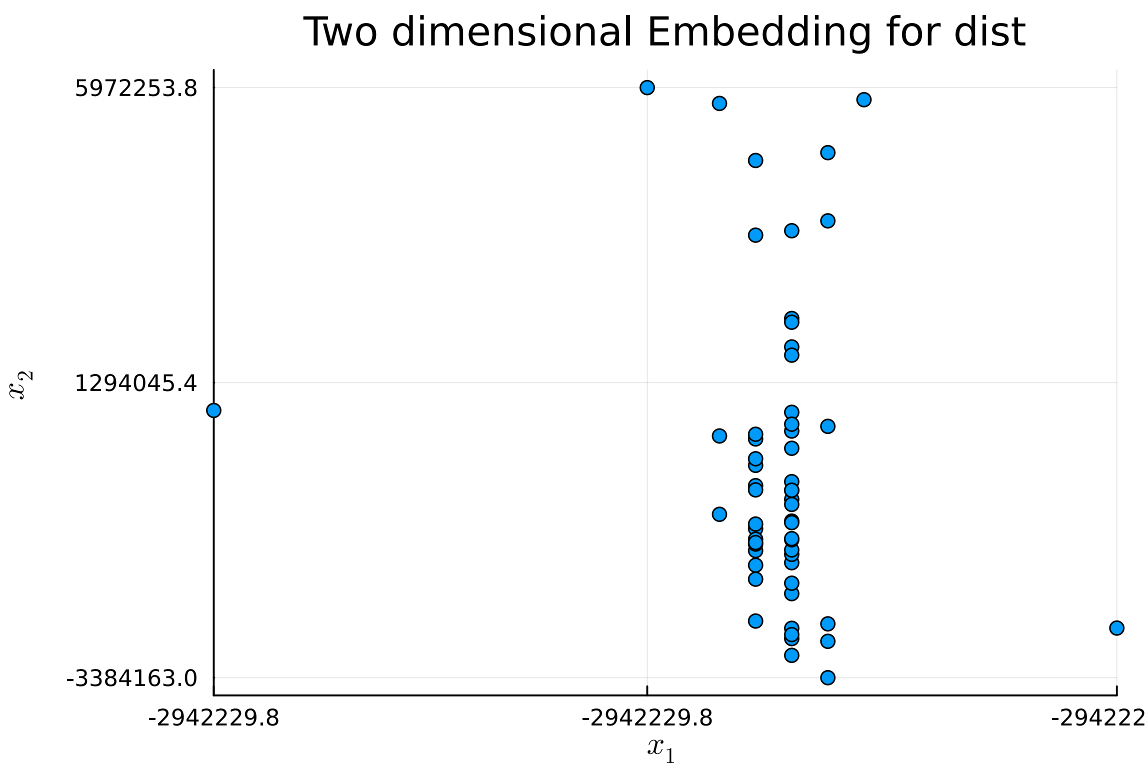
In [1]:
```
using Pkg
Pkg.activate("../p2")
Pkg.instantiate()
```

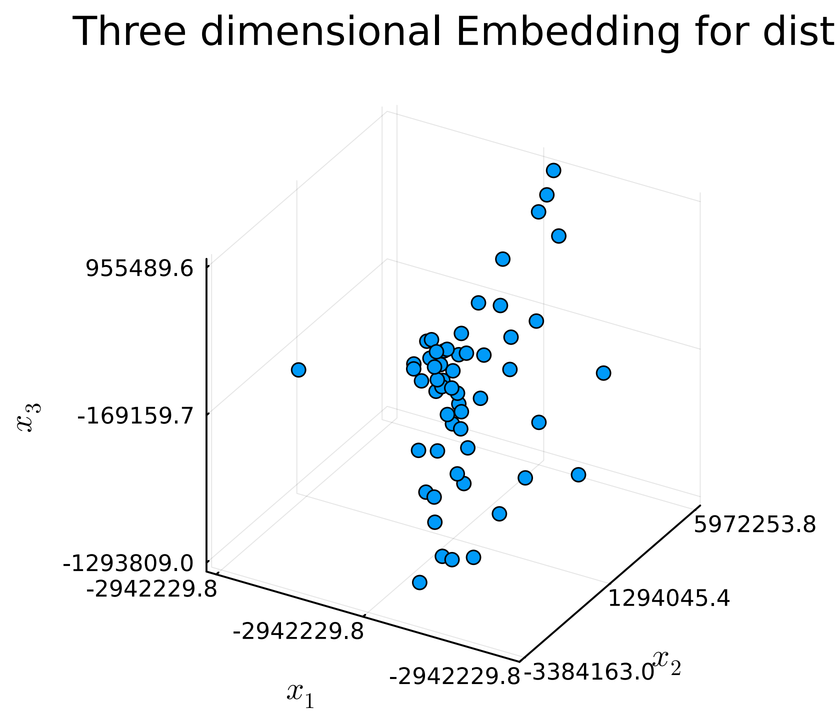
```
  Activating project at `~/MATH420/p2`
```

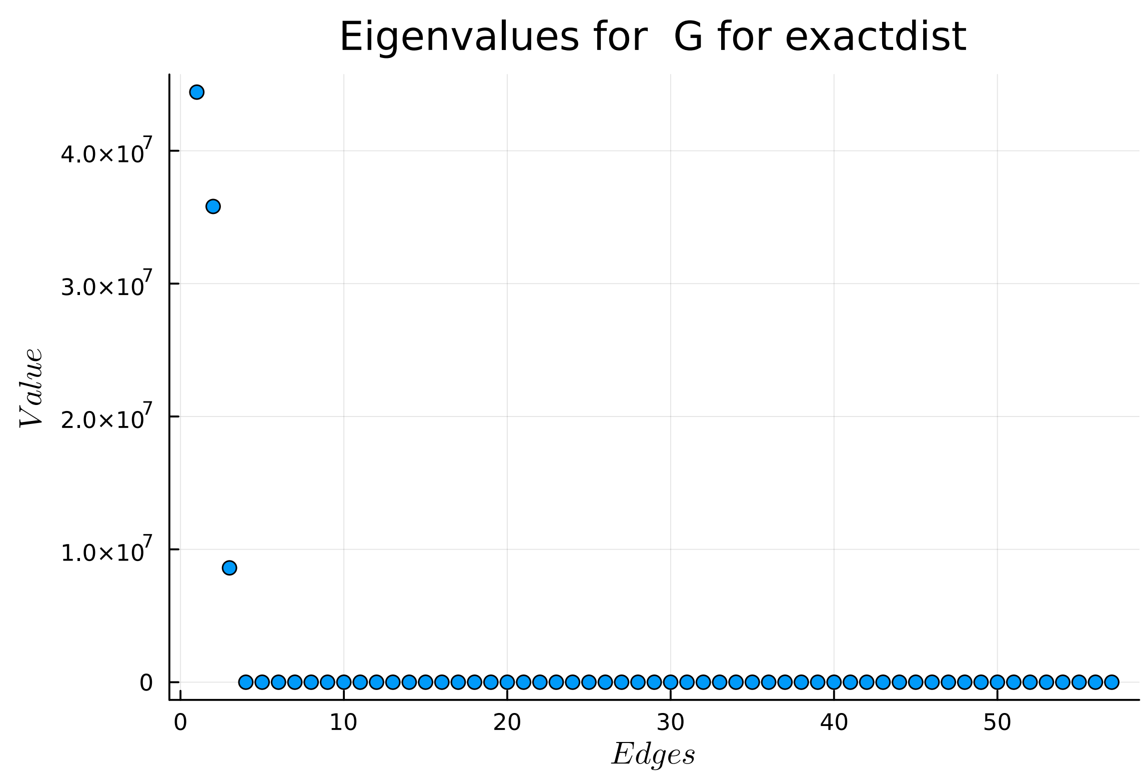
In [22]:
```
using DelimitedFiles
using LinearAlgebra
using Plots
using LaTeXStrings
using Printf

for name = ("dist", "exactdist")
    (R, num_vert_) = readdlm("./kn57Nodes1to57_" * name * ".txt", Float64, h
    num_vert = parse(Float64, num_vert_[1])
    # S = zeros(size(R))
    # rho = 0;
    # for i = 1:57, j = 1:57
    #     global S, R, rho
    #     S[i, j] = R[i, j]^2
    #     rho += S[i, j]
    # end
    S = R .^ 2
    rho = norm(S, 1)
    rho \= (2 * num_vert)
    one_col = ones(57, 1)
    v = (S - rho * I) * one_col / num_vert
    function getGram(n::Real, S::Matrix, rho::Real)::Matrix
        r = 1 / 2n * (S - rho * I) * one_col * one_col' + 1 / 2n * one_col *
        @assert issymmetric(r)
        return r
    end
    G = getGram(num_vert, S, rho)
    ev, Q = eigen(G, sortby=x -> -x)
    index = findfirst(x -> x < 0, ev)
    ev[index-1:end] .= 0
    display(scatter(ev, labels = nothing, title="Eigenvalues for  G for $(na
    print("The 10 largest eigenvalues are $(first(ev, 10))")
    Λ = Diagonal(ev)
    lambda = Λ
    Q[:, 1:2]

    Y::Dict{Int,Matrix} = Dict([])
    R_hat::Dict{Int,Matrix} = Dict([])
```

```julia
    R_norm::Dict{Int,Real} = Dict([])
    ϵ::Dict{Int,Real} = Dict([])
    σ::Dict{Int,Real} = Dict([])

    println("For data " * name)
    for d = (2, 3)
        println("d = $(d)")
        Q_1 = Q[:, 1:d]
        Λ_1 = Λ[1:d, 1:d]
        Y[d] = Λ_1^1 / 2 * Q_1'
        R_hat[d] = zeros(57, 57)
        for i = 1:57, j = 1:57
            R_hat[d][i, j] = norm(Y[d][1:d, j] - Y[d][1:d, i])
        end
        R_norm[d] = norm(R - R_hat[d])
        println("Norm = $(R_norm[d])")
        ϵ[d] = norm(G - Y[d]'Y[d])
        println("ϵ = $(ϵ[d])")
        σ[d] = sqrt(sum(ev[d+1:end] .^ 2))
        println("σ = $(σ[d])")
        println("Difference = $(ϵ[d] - σ[d])")
    end
    function minmax(v::Vector{<:Real})
        r1 = [minimum(v), minimum(v)+(maximum(v)-minimum(v))/2, maximum(v)]
        r2 = [ @sprintf("%.1f",x) for x in r1 ]
        return (r1, r2)
    end

    display(scatter(Y[2][1, :], Y[2][2, :], labels=nothing,title="Two dimens
    yticks = minmax(Y[2][2,:]), xaxis = L"x_{1}", yaxis=L"x_{2}"))
    display(scatter3d(Y[3][1, :], Y[3][2, :], Y[3][3, :], title="Three dimen
    yticks = minmax(Y[3][2,:]), zticks = minmax(Y[3][3,:]), labels=nothing,
    yaxis=L"x_{2}", zaxis=L"x_{3}"))
    # scatter3d(Y[3][1,:], Y[3][2,:], Y[3][3,:], camera=[0,0,0])
end
```

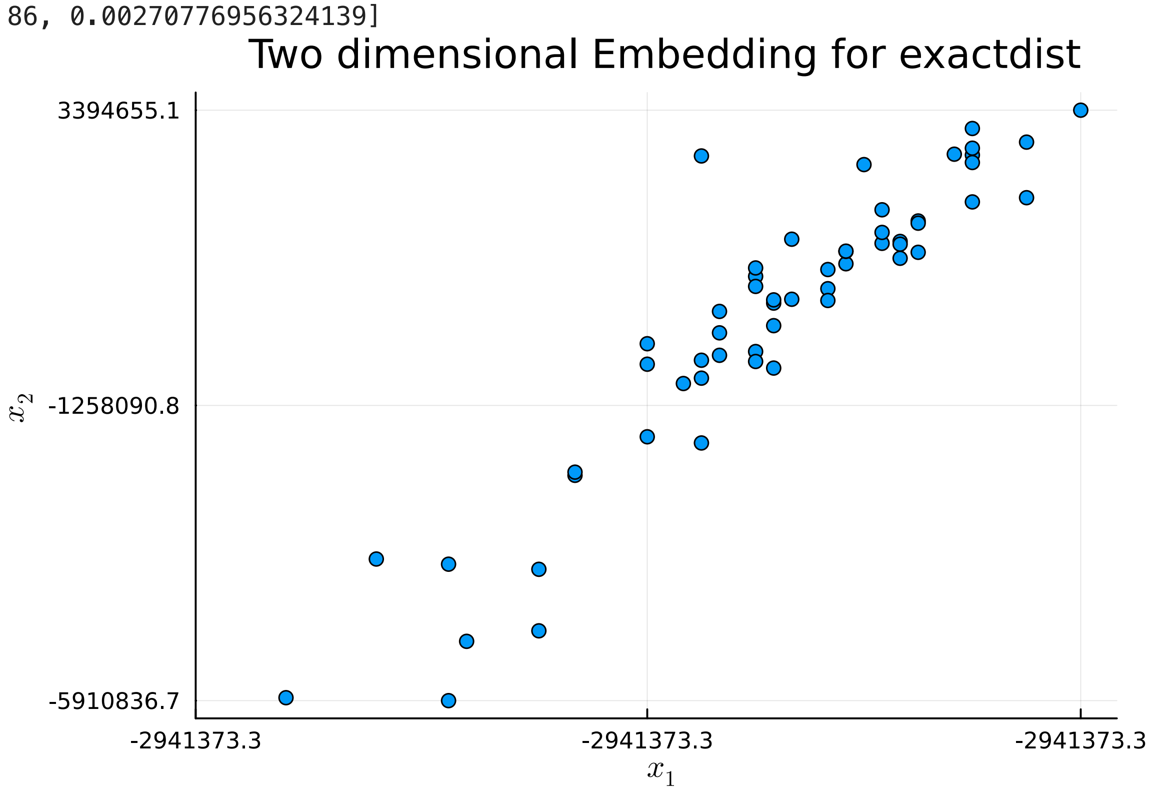

Eigenvalues for G for dist
4.0×10^7
3.0×10^7
2.0×10^7
1.0×10^7
0
Value
0
10
20
30
40
50
Edges

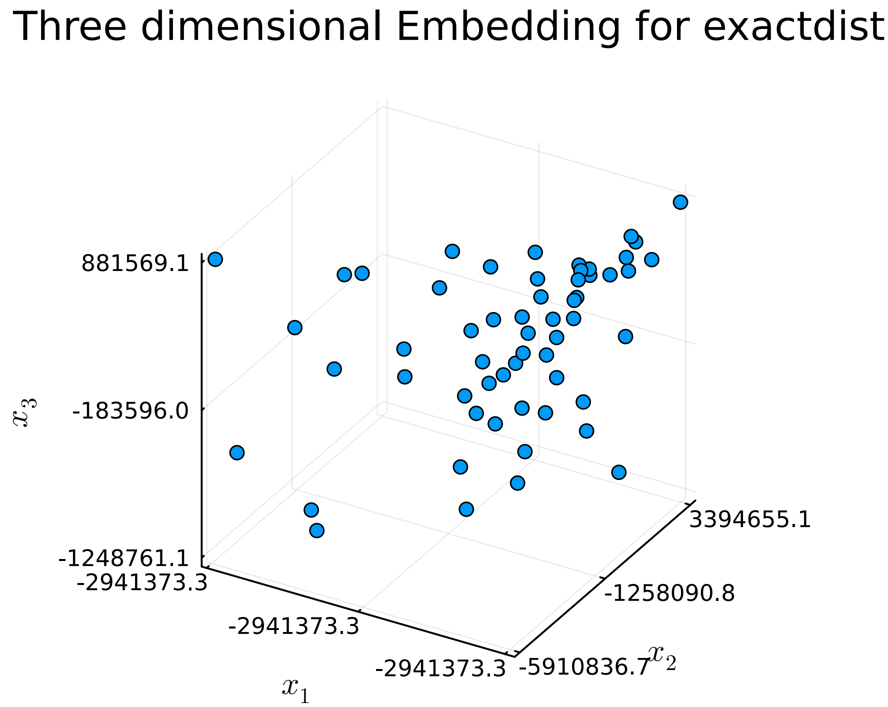

Two dimensional Embedding for dist
5972253.8
1294045.4
-3384163.0
x_2
-2942229.8
-2942229.8
x_1


Three dimensional Embedding for dist
955489.6
-169159.7
-1293809.0
x_3
-2942229.8
-2942229.8
-2942229.8
x_1
5972253.8
1294045.4
-3384163.0
x_2


Eigenvalues for G for exactdist
4.0×10^7
3.0×10^7
2.0×10^7
1.0×10^7
0
$Value$
0
10
20
30
40
50
$Edges$

```
The 10 largest eigenvalues are [4.4426695982456006e7, 3.553255787649086e7,
8.924037549458053e6, 975952.6526310504, 570066.7976405374, 526331.606866790
4, 307163.98573833145, 220021.71828191355, 183279.62093742122, 159784.48540
360644]For data dist
d = 2
Norm = 1.896225110335917e8
ϵ = 5.85751586682671e14
σ = 9.024155748387313e6
Difference = 5.857515776585152e14
d = 3
Norm = 1.9551248363265747e8
ϵ = 5.860898511131469e14
σ = 1.3405002003037904e6
Difference = 5.860898497726466e14
The 10 largest eigenvalues are [4.4413762881676525e7, 3.580839780809973e7,
8.605365074929608e6, 0.005358653489918885, 0.004923177616982107, 0.00465742
8327942904, 0.003988382612363017, 0.0036938404803705353, 0.0033920099123119
86, 0.00270776956324139]
```






```
For data exactdist
d = 2
Norm = 1.9109507984747455e8
ϵ = 5.881763597301269e14
σ = 8.605365074929608e6
Difference = 5.881763511247618e14
d = 3
Norm = 1.965366018568468e8
ϵ = 5.884676404420568e14
σ = 0.012847672061037731
Difference = 5.884676404420568e14
```

In [ ]: