

# SIR SDE using DifferentialEquations.jl

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```
using DifferentialEquations
using StochasticDiffEq
using Random
using SparseArrays
using Plots

function sir_ode(du,u,p,t)
    (S,I,R) = u
    ( $\beta$ , $\gamma$ ) = p
    N = S+I+R
    @inbounds begin
        du[1] = - $\beta$ *S*I/N
        du[2] =  $\beta$ *S*I/N -  $\gamma$ *I
        du[3] =  $\gamma$ *I
    end
    nothing
end

sir_ode (generic function with 1 method)

# Define a sparse matrix by making a dense matrix and setting some values as not zero
A = zeros(3,2)
A[1,1] = 1
A[2,1] = 1
A[2,2] = 1
A[3,2] = 1
A = SparseArrays.sparse(A)

3×2 SparseArrays.SparseMatrixCSC{Float64,Int64} with 4 stored entries:
 [1, 1]  =  1.0
 [2, 1]  =  1.0
 [2, 2]  =  1.0
 [3, 2]  =  1.0

# Make `g` write the sparse matrix values
function sir_noise(du,u,p,t)
    (S,I,R) = u
    ( $\beta$ , $\gamma$ ) = p
    N = S+I+R
    ifrac =  $\beta$ *I/N*S
    rfrac =  $\gamma$ *I
    du[1,1] = -sqrt(ifrac)
    du[2,1] = sqrt(ifrac)
    du[2,2] = -sqrt(rfrac)
    du[3,2] = sqrt(rfrac)
end
```

```

sir_noise (generic function with 1 method)

tspan = (0.0,50.0)
u0 = [999.0,1.0,0.0]
p = [0.5,0.25]
Random.seed!(1234)

Random.MersenneTwister(UInt32[0x000004d2], Random.DSFMT.DSFMT_state(Int32[-
1393240018, 1073611148, 45497681, 1072875908, 436273599, 1073674613, -20437
16458, 1073445557, -254908435, 1072827086 ... -599655111, 1073144102, 36765
5457, 1072985259, -1278750689, 1018350124, -597141475, 249849711, 382, 0]),
[0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0 ... 0.0, 0.0, 0.0, 0.0,
0.0, 0.0, 0.0, 0.0, 0.0, 0.0], UInt128[0x00000000000000000000000000000000,
0x00000000000000000000000000000000, 0x00000000000000000000000000000000, 0x0
00000000000000000000000000000000, 0x00000000000000000000000000000000, 0x0000
00000000000000000000000000000000, 0x00000000000000000000000000000000, 0x00000000
00000000000000000000000000000000, 0x00000000000000000000000000000000, 0x00000000
00000000000000000000000000000000, 0x00000000000000000000000000000000, 0x0000000000
00000000000000000000000000000000 ... 0x00000000000000000000000000000000, 0x0000000000
00000000000000000000000000000000, 0x00000000000000000000000000000000, 0x000000000000
00000000000000000000000000000000, 0x00000000000000000000000000000000, 0x000000000000
00000000000000000000000000000000, 0x00000000000000000000000000000000, 0x000000000000
00000000000000000000000000000000, 0x00000000000000000000000000000000, 0x000000000000
000000000000], 1002, 0)

prob_sir_sde = SDEProblem(sir_ode,sir_noise,u0,tspan,p,noise_rate_prototype=A)
sol_sir_sde = solve(prob_sir_sde,SRA1())

retcode: Success
Interpolation: 1st order linear
t: 2301-element Array{Float64,1}:
 0.0
 0.0028241570871901473
 0.0037569107538692
 0.004806258628883135
 0.005986774988273811
 0.007314855892588322
 0.008808946909942147
 0.0104897993044652
 0.012380758248303637
 0.014508087060121877
 ⋮
49.75523533431953
49.787415581163984
49.81967515909253
49.851758878619414
49.8839062607085
49.91606500714664
49.948319973891095
49.98060260983176
50.0
u: 2301-element Array{Array{Float64,1},1}:
 [999.0, 1.0, 0.0]
 [998.9731512423181, 1.0426734179343828, -0.01582466025245144]
 [998.9571056898658, 1.062769178992927, -0.019874868858805073]
 [998.9931164509287, 0.9949426129267545, 0.011940936144535994]
 [998.9635332153165, 1.001181429296603, 0.035285355386925565]
 [999.0165128733427, 0.9797075405293867, 0.0037795861280098472]
 [999.0083806313305, 0.9804900428476405, 0.011129325821887012]
 [999.0094318504565, 0.9887582028436326, 0.0018099466999458268]

```

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[999.0076815119223, 0.9703295746983102, 0.021988913379408483]
[998.9627192725673, 1.0360800852379282, 0.0012006421949703784]
⋮
[212.3796825632129, 12.858667879018249, 774.7616495577685]
[212.0494719127545, 12.8018730324737, 775.1486550547714]
[212.2231916845521, 12.613681416738066, 775.1631268987095]
[212.08412785194776, 12.554963118203451, 775.3609090298485]
[212.08777511051156, 12.721096009604155, 775.191128879884]
[212.02048198407414, 12.599698225757999, 775.3798197901675]
[211.99332296108477, 12.383552672149058, 775.6231243667658]
[212.0870564845884, 11.419181402058177, 776.493762113353]
[212.1876534892215, 11.33136093912622, 776.4809855716518]

```

```
plot(sol_sir_sde,vars=[(0,1),(0,2),(0,3)])
```

