Jump process using DiffEqBiological

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Introduction

This implementation defines the model as a combination of two jump processes, infection and recovery, simulated using the Doob-Gillespie algorithm.

Libraries

```
using DiffEqBiological
using Random
using DataFrames
using StatsPlots
using BenchmarkTools
```

Transitions

```
sir_model = @reaction_network sir_rn begin
  0.5/1000, s + i --> 2i
  0.25, i --> r
end
```

```
(::Main.WeaveSandBox48.sir_rn) (generic function with 2 methods)
```

Time domain

```
tmax = 40.0
tspan = (0.0,tmax);
```

For plotting, we can also define a separate time series.

```
δt = 0.1
t = 0:δt:tmax;
```

Initial conditions

```
u0 = [990,10,0]; # S,I,R
```

Random number seed

We set a random number seed for reproducibility.

```
Random.seed!(1234);
```

Running the model

Running this model involves:

- Setting up the problem as a `DiscreteProblem`;
- Adding the jumps and setting the algorithm using `JumpProblem`; and
- Running the model, specifying `SSAStepper`

```
prob = DiscreteProblem(u0,tspan)
```

```
DiscreteProblem with uType Array{Int64,1} and tType Float64. In-place: true
timespan: (0.0, 40.0)
u0: [990, 10, 0]
```

```
prob_jump = JumpProblem(prob,Direct(),sir_model)
```

```
JumpProblem with problem DiscreteProblem and aggregator Direct
Number of constant rate jumps: 0
Number of variable rate jumps: 0
Have a mass action jump
```

```
sol_jump = solve(prob_jump,SSAStepper());
```

Post-processing

In order to get output comparable across implementations, we output the model at a fixed set of times.

```
out_jump = sol_jump(t);
```

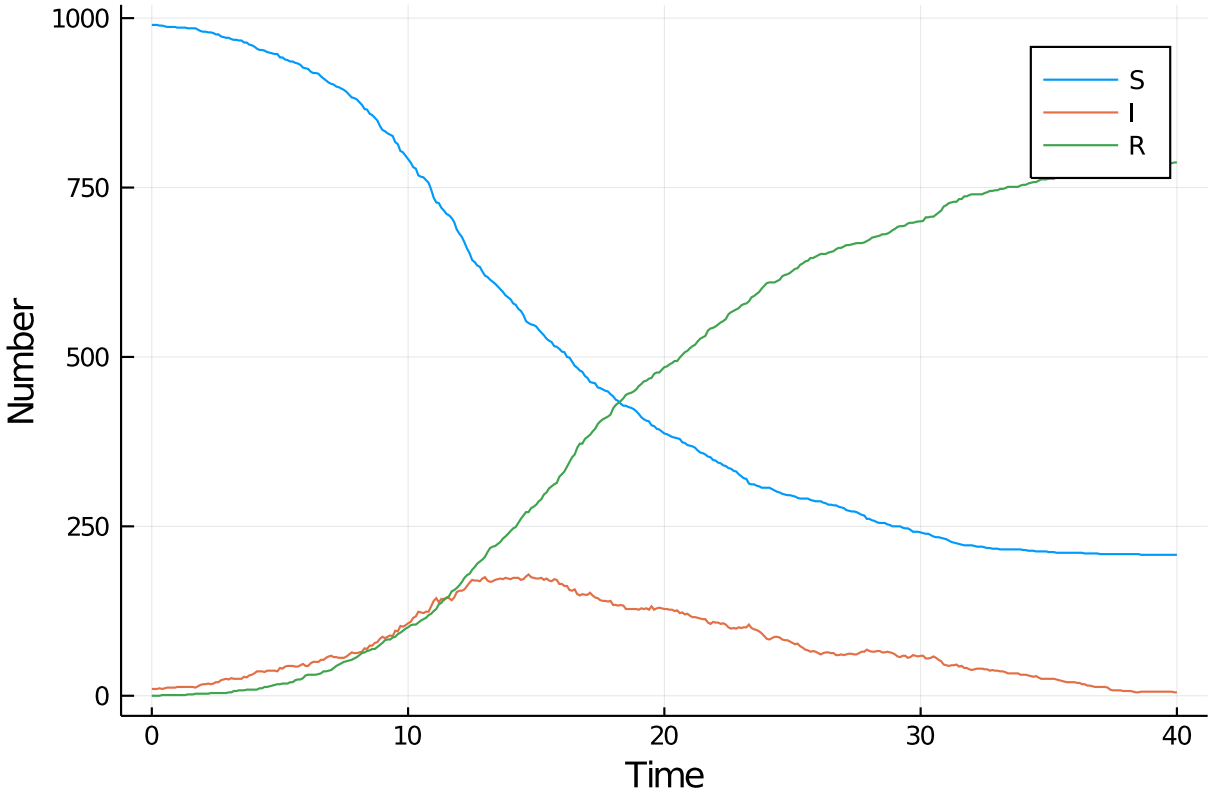
We can convert to a dataframe for convenience.

```
df_jump = DataFrame(out_jump')
df_jump[!,:t] = out_jump.t;
```

Plotting

We can now plot the results.

```
@df df_jump plot(:t,
    [:x1 :x2 :x3],
    label=["S" "I" "R"],
    xlabel="Time",
    ylabel="Number")
```



Benchmarking

```
@benchmark solve(prob_jump,FunctionMap())
```

```
Error: UndefVarError: FunctionMap not defined
```

Appendix

Computer Information

```
Julia Version 1.4.0
Commit b8e9a9ecc6 (2020-03-21 16:36 UTC)
Platform Info:
  OS: Windows (x86_64-w64-mingw32)
  CPU: Intel(R) Core(TM) i7-8550U CPU @ 1.80GHz
  WORD_SIZE: 64
  LIBM: libopenlibm
  LLVM: libLLVM-8.0.1 (ORCJIT, skylake)
Environment:
  JULIA_NUM_THREADS = 4
```

Package Information

```
Status `~\.julia\environments\v1.4\Project.toml`
```

```
[46ada45e-f475-11e8-01d0-f70cc89e6671] Agents 3.0.0
[b19378d9-d87a-599a-927f-45f220a2c452] ArrayFire 1.0.6
[c52e3926-4ff0-5f6e-af25-54175e0327b1] Atom 0.12.10
[6e4b80f9-dd63-53aa-95a3-0cdb28fa8baf] BenchmarkTools 0.5.0
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[3a865a2d-5b23-5a0f-bc46-62713ec82fae] CuArrays 2.0.1
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[c894b116-72e5-5b58-be3c-e6d8d4ac2b12] DiffEqJump 6.6.3
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[44d3d7a6-8a23-5bf8-98c5-b353f8df5ec9] Weave 0.9.4
[37e2e46d-f89d-539d-b4ee-838fcccc9c8e] LinearAlgebra
[cf7118a7-6976-5b1a-9a39-7adc72f591a4] UUIDs
```