

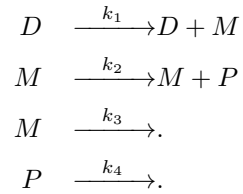
Assignment 6

Stochastic Models

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The system is given by:



In ODE form:

$$\begin{aligned} \frac{dM}{dt} &= k_1 D - k_3 M \\ \frac{dP}{dt} &= k_2 M - k_4 P \end{aligned}$$

Part 1 - Dividing the system into discrete timesteps

The system can be divided into discrete steps expressed as probabilities of gaining M , losing M , or M staying the same:

- $P(M \rightarrow M + 1): k_1 D \Delta t$
- $P(M \rightarrow M - 1): k_3 M \Delta t$
- $P(M \rightarrow M): (1 - k_1 D \Delta t - k_3 M \Delta t)$

```
# Set a seed for consistent random realizations
set.seed(43)
```

```
# Define initial values
```

```
D <- 1
```

```
M <- 20
```

```
# Define parameters
```

```
k1 <- 0.1
```

```
k3 <- 0.001
```

```
dt <- 0.1
```

```
Tend <- 10000
```

```
time <- seq(0, Tend, dt)
```

```
# Define the cutoff probabilities for each event
```

```
p1 <- k1*dt
```

```
p2 <- k3*M*dt
```

```
# Define vector where M_t will be saved  
Msave <- numeric(length(time))
```

```
for(i in 1:length(time)){  
  Msave[i] <- M  
  
  p2 <- k3*M*dt  
  
  u <- runif(1)  
  
  if(u < p1){  
    M <- M + 1  
  } else if(u < (p1 + p2)){  
    M <- M-1  
  } else {  
    M <- M  
  }  
}
```

```
plot(time, Msave, type = "l")
```

