Assignment 6

Stochastic Models

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The system is given by:

$$
\begin{aligned}
D &\xrightarrow{k_1} D + M \\
M &\xrightarrow{k_2} M + P \\
M &\xrightarrow{k_3} . \\
P &\xrightarrow{k_4} .
\end{aligned}
$$

In ODE form:

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

Part 1 - Dividing the system into discrete timesteps

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

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

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

# Define initial values
D <- 1
M <- 20

# Defien parameters
k1 <- 0.1
k3 <- 0.001
dt <- 0.1
Tend <- 10000
time <- seq(0, Tend, dt)

# Define teh cutoff probabilities for each event
p1 <- k1*dt
p2 <- k3*M*dt
```

```r
# Define vectore 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")
```