

# STAT 421 Homework 14

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1)

As the state  $i$  increases the birth rate increases linearly. Since the rate of death is a square function, the larger state  $i$ , the larger the death rate. When the state is above 25 the death rate is larger than the birth rate, which means the population is dying at a faster rate than it is growing. When  $i$  is under 25, the birth rate is larger than the death rate and the population is growing more than it is dying. This process will grow between 0 and 25, and grow the fastest at around state 10. The process will decay anywhere above state 25. It will decay the fastest when  $i$  tends to infinity.

2)

```
t <- 0
i <- 5
lambda_i <- (1/5)*i + 1
mu_i <- (1/100)*i^2

pop_list <- list()
time_list <- list()

for( j in seq(1:3)){

  t <- 0
  i <- 5

  q <- 1

  event_vec <- numeric()
  time_vec <- numeric()

  while(t<30){

    lambda_i <- (1/5)*i + 1
    mu_i <- (1/100)*i^2
    gamma_i <- lambda_i + mu_i

    arrival <- rexp(1, gamma_i)
    t <- t + arrival
    time_vec[q] <- t

    birth <- rbinom(1, 1, lambda_i/gamma_i)

    if (birth == 1){
      i <- i + 1
      event_vec[q] <- i
      q <- q + 1
    }
  }
}
```

```

    } else {
      i <- i - 1
      event_vec[q] <- i
      q <- q + 1
    }
  }

  pop_list[[j]] <- event_vec
  time_list[[j]] <- time_vec
}

plot(time_list[[1]], pop_list[[1]], col = "red", type = "b")
points(time_list[[2]], pop_list[[2]], col = "blue", type = "b")
points(time_list[[3]], pop_list[[3]], col = "green", type = "b")

```

