ICA Tuesday

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Question 1

a.

Modify and run the board game example simulation (without bonus) so that it runs 100,000 times. Give the percentage each of the 3 players wins. All problems below will be run with 100,000 simulations.

```
sim <- 100000
win <- replicate(sim,0)
for(i in 1:sim){
  P <- c(0,0,0)
  while(max(P) < 8){
    for(j in 1:3){
      roll <- sample(1:6,1)
      P[j] = P[j] + roll
      if(P[j] >= 8){
        break
      }
    }
  }
  win[i] <- j
}
print(paste("Probability that player one wins",round(100*(sum(win == 1)/sim),1),"%"))
```

```
## [1] "Probability that player one wins 56.6 %"
```

```
print(paste("Probability that player two wins",round(100*(sum(win == 2)/sim),1),"%"))
```

```
## [1] "Probability that player two wins 28.3 %"
```

```
print(paste("Probability that player third wins",round(100*(sum(win == 3)/sim),1),"%"))
```

```
## [1] "Probability that player third wins 15.1 %"
```

b.

Modify and run the board game example simulation so that the winner is the first to 50. How do the winning percentages compare to (a)? Why?

```
sim <- 100000
win <- replicate(sim,0)
for(i in 1:sim){
  P <- c(0,0,0)
  while(max(P) < 50){
    for(j in 1:3){
      roll <- sample(1:6,1)
      P[j] = P[j] + roll
      if(P[j] >= 50){
        break
      }
    }
  }
  win[i] <- j
}

print(paste("Probability that player one wins",round(100*(sum(win == 1)/sim),1),"%"))
```

```
## [1] "Probability that player one wins 41.8 %"
```

```
print(paste("Probability that player two wins",round(100*(sum(win == 2)/sim),1),"%"))
```

```
## [1] "Probability that player two wins 32.4 %"
```

```
print(paste("Probability that player third wins",round(100*(sum(win == 3)/sim),1),"%"))
```

```
## [1] "Probability that player third wins 25.8 %"
```

The percentage moves closer to fair distribution, where winning chances are equal for all (33%). This is becuase the game is played for longer duration as winning target is 50. This gives enough tries.

c.

Modify and run the board game example simulation in (b) (winner is first to 50) so that a 4-sided die is used instead. How do the winning percentages compare to (b)? Why?

```
sim <- 100000
win <- replicate(sim,0)
for(i in 1:sim){
  P <- c(0,0,0)
  while(max(P) < 50){
    for(j in 1:3){
      roll <- sample(1:4,1)
      P[j] = P[j] + roll
      if(P[j] >= 50){
        break
      }
    }
  }
  win[i] <- j
}

print(paste("Probability that player one wins",round(100*(sum(win == 1)/sim),1),"%"))
```

```
## [1] "Probability that player one wins 41 %"
```

```
print(paste("Probability that player two wins",round(100*(sum(win == 2)/sim),1),"%"))
```

```
## [1] "Probability that player two wins 32.5 %"
```

```
print(paste("Probability that player third wins",round(100*(sum(win == 3)/sim),1),"%"))
```

```
## [1] "Probability that player third wins 26.5 %"
```

The winning percentage remains same as it is independent to the number of sides on the dice, in cases when larger amount of simulations are run.

d

Modify and run the board game example simulation in (a) so that if any player lands on the 4th square, they get an extra turn (play to 8).

```
sim <- 100000
win <- replicate(sim,0)
for(i in 1:sim){
  P <- c(0,0,0)
  while(max(P) < 8){
    for(j in 1:3){
      roll <- sample(1:6,1)
      P[j] = P[j] + roll
      if(P[j] == 4){
        roll <- sample(1:6,1)
        P[j] = P[j] + roll
      }
      if(P[j] >= 8){
        break
      }
    }
  }
  win[i] <- j
}

print(paste("Probability that player one wins",round(100*(sum(win == 1)/sim),1),"%"))
```

```
## [1] "Probability that player one wins 54.1 %"
```

```
print(paste("Probability that player two wins",round(100*(sum(win == 2)/sim),1),"%"))
```

```
## [1] "Probability that player two wins 28.6 %"
```

```
print(paste("Probability that player third wins",round(100*(sum(win == 3)/sim),1),"%"))
```

```
## [1] "Probability that player third wins 17.4 %"
```

e.

Modify and run the board game example simulation in (d) so that there are 5 players. Plot a histogram of the wins by each player.

```
sim <- 100000
win <- replicate(sim,0)
for(i in 1:sim){
  P <- c(0,0,0,0,0)
  while(max(P) < 8){
    for(j in 1:5){
      roll <- sample(1:6,1)
      P[j] = P[j] + roll
      if(P[j] == 4){
        roll <- sample(1:6,1)
        P[j] = P[j] + roll
      }
      if(P[j] >= 8){
        break
      }
    }
  }
  win[i] <- j
}

hist(win)
```