Agent Based Model

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Introduction

Scullen et al. (2005) tests the Forced Distribution Rating System (FDRS) which is generally the idea of terminating a certain percentage of the workforce on an annual basis.

Load Necessary Libraries and Set Seed

```
library(tidyverse)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.3     v readr     2.1.4
v forcats   1.0.0     v stringr   1.5.0
v ggplot2   3.4.3     v tibble    3.2.1
v lubridate 1.9.2     v tidyr     1.3.0
v purrr     1.0.2
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to beco
```

```
set.seed(12345)
```

These libraries will allow me to use functions outside of base R.

Using set.seed will keep results consistent across users.

Design the Simulation

```
# set time to zero to begin anew
t <- 0

# This will create an easy-to-read output of results over time
org_outputs <- as.data.frame(matrix(ncol = 2, nrow = 1))

names(org_outputs) <- c("Iteration", "Mean_Potential")

# Create FDRS Function
fdrs <- function(validity, selection_ratio, turnover, fire_percent, reliability, t)
  {
  # Generate 100 current employees with randomized scores for performance potential
  org <- data.frame(potential_score = rnorm(n = 100, mean = 0, sd = 1)) %>%
    # Calculate applicant scores based on the validity of the selection system and the per
    mutate(applicant_score = validity * potential_score + sqrt(1-validity)^2*rnorm(1))
  # This for loop will iterate 10 times to simulate 10 years of the FDRS system
  for(t in 0:9){
    # Iterate time 1 year
    t = t+1
    # Randomly sample employees to remove from the organization, representing voluntary tu
    org <- org %>%
      slice_sample(n = (1-turnover)*nrow(org))
    # Simulate a randomized applicant pool of potential hires to replace voluntary turnove
    replace_turnover <- data.frame(potential_score = rnorm(n = 100-(100*(1-turnover))))
    # Calculate applicant scores for the applicant pool
    replace_scored <- replace_turnover %>%
      mutate(applicant_score = validity * potential_score + sqrt(1-validity)^2*rnorm(1))
    # Generate performance ratings for all employees and remove the lowest scorers
    org <- bind_rows(org, replace_scored) %>%
      mutate(rating = potential_score * sqrt(reliability) + rnorm(1)*sqrt(1-reliability))
      arrange(desc(rating)) %>%
      slice_head(n = (1-fire_percent)*nrow(org))
    # Specify how many applications to collect for the open positions based on the desired
    job_applicants <- (1/selection_ratio)*(100-nrow(org))
    # Generate an applicant pool with potential and applicant scores as well as performanc
    new_applicant <- data.frame(potential_score = rnorm(n = job_applicants, mean = 0, sd =
      mutate(applicant_score = validity * potential_score + sqrt(1-validity)^2*rnorm(1)) %
      mutate(rating = potential_score * sqrt(reliability) + rnorm(1)*sqrt(1-reliability))
      arrange(desc(applicant_score)) %>%
```

```
      slice_head(n = 100 - nrow(org))
    # Add new hires to the organization
    org <- bind_rows(org, new_applicant) %>%
      select(potential_score, applicant_score)
    # Print the outputs into a table
    print(mean(org$potential_score))
    org_outputs[t,"Iteration"] <- t
    org_outputs[t,"Mean_Potential"] <- mean(org$potential_score)
    }
  org_outputs
}
```

Run the Simulation

The above function can be fed different values for validity of the selection system, the desired selection ratio, the amount of expected voluntary turnover, the percentage of employees to fire per annum, and the reliability of the performance evaluations.

By specifying these values, we can test different combinations and see how the results vary between potential systems.

The first example simulation will have a greater percentage of terminated employees, but greater reliability of performance scores compared to the second example simulation.

```
# Simulation 1

validity <- .3
selection_ratio <- .33
turnover <- .10
fire_percent <- 0.10
reliability <- 0.70

simulation_1 <- fdrs(validity, selection_ratio, turnover, fire_percent, reliability, t)
```

```
[1] 0.6731172
[1] 0.9588555
[1] 1.041553
[1] 1.170902
[1] 1.291606
[1] 1.237898
[1] 1.232485
```

```
[1] 1.284344
[1] 1.269367
[1] 1.317985
```

The second example simulation will terminate a lower percentage of employees, but utilize a lower selection ratio and improved selection system to maximize the potential of new employees.

```
# Simulation 2

validity <- .5
selection_ratio <- 0.1
turnover <- .20
fire_percent <- 0.05
reliability <- 0.5

simulation_2 <- fdrs(validity, selection_ratio, turnover, fire_percent, reliability, t)
```

```
[1] 0.6561263
[1] 1.109088
[1] 1.364823
[1] 1.495996
[1] 1.546769
[1] 1.63909
[1] 1.723954
[1] 1.749753
[1] 1.7695
[1] 1.850402
```

Comparing Results

Merge Datasets

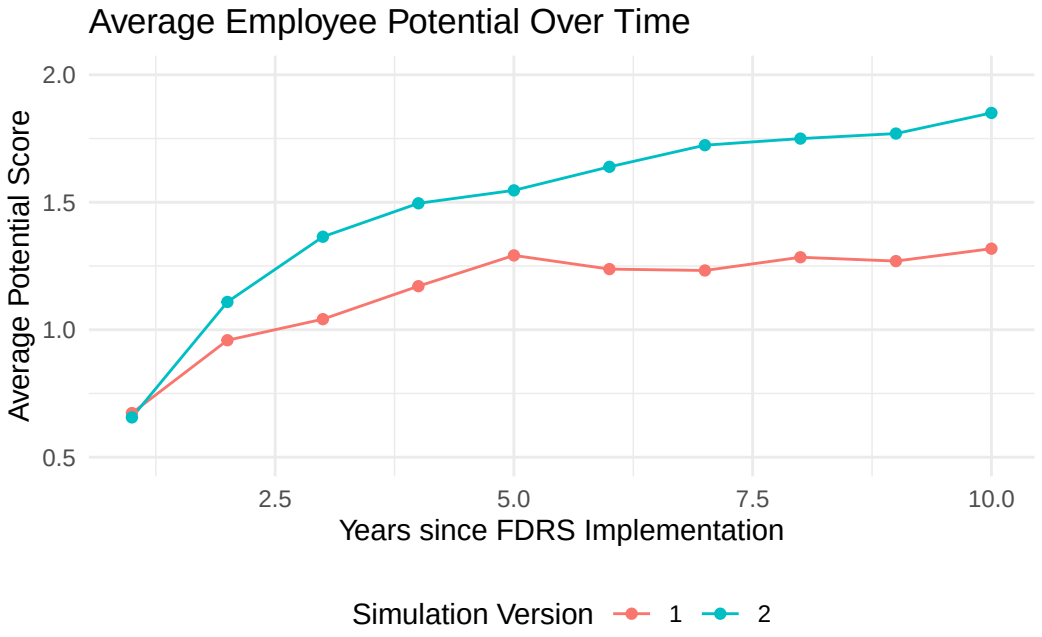
```
simulation_1 <- simulation_1 %>%
  mutate(Simulation_Version = "1")

simulation_2 <- simulation_2 %>%
  mutate(Simulation_Version = "2")

results <- rbind(simulation_1, simulation_2)
```

Vizualization of Results

```
ggplot(data=results, aes(x=Iteration, y=Mean_Potential, group=Simulation_Version)) +
  geom_line(aes(color=Simulation_Version)) +
  geom_point(aes(color=Simulation_Version)) +
  labs(title="Average Employee Potential Over Time", x="Years since FDRS Implementation",
  ylim(0.5, 2) +
  theme_minimal() +
  theme(legend.position="bottom")
```



Conclusion

This graph shows a clear advantage to the strategy used in Simulation 2. It is recommended that the organization implement an FDRS system with a 5% cutoff paired with a selection system with a greater validity and a more stringent selection ratio to maximize the growth of employee potential.

Reference:

Scullen, S. E., Bergey, P. K., & Aiman-Smith, L. (2005). Forced distribution rating systems and the improvement of workforce potential: A baseline simulation. *Personnel Psychology*, *58*(1), 1-32.