

Milestone 5: Simulation Runs and Data Collection

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Simulation Run Report

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A Simulation Run Table

1. Introduction

Overview: This project specifically aims to represent the pace of play issue that occurs on every common golf course. The specific use case for this project and its simulation is the case of a large tournament being played where the golf course is completely full in terms of tee-time slots and groups per slot. The main objective is to construct this program farther into a research tool that eventually a golf course may be able to use for its own specific use cases.

Purpose: The purpose of the sim runs provided is to show a baseline amount of functionality in that the program can manage a course and the carts that traverse it.

2. Simulation Outline

2.1 Simulation Description

The simulation that is provided for this milestone is made up of several different components that measure the performance of the course's pace management. It can be observed throughout the simulation how the program mimics the real-world nature of humans in randomness of times that it takes to complete certain holes according to lengths, according to waits, and according to how fast that group plays in general based on an individual level. This simulation specifically, however, deals with the nature of how tournaments in the golf world are affected by the slow pace of play. In reality,

2.2 Execution Instructions

The simulation can be run in the terminal by the use of commands for execution or in an IDE of choice that supports python. As it sits, the simulation functions as intended with every line of output being an event log. One of the parameters that can be observed within the simulation is the number of times that the marshal is sent out to a group on the course for slow play, the amount of time that it takes for a group to finish a round from starting time stamp to finishing time stamp, and the number of times that groups fall behind or ahead of pace. In measuring the amount of time the marshal is sent out; this mainly serves as a benchmark for how the program ran for that specific run of the simulation. Then, there will be a by-group pace standard that explains or shows how frequently a group falls ahead, stays within, or falls behind pace. For the length of time that it takes for groups to finish the round, this is mainly utilized as a dependency upon the course's and the group's overall pace standard. As the simulation sits there are not any significant changes to configurations as you step through runs. These changes will be noted later as a reference to the Sensitivity and Scenario analysis. Currently there are no user inputs required. There will be two runs of the simulation used for example on the study of times in the data. These runs will compare a high stress marshal situation vs a low stress marshal situation.

The main step of execution that I took in execution is executing the data.py file that uses the re import to gather relevant information about the actual simulation itself from a series of 10 different text output files.

2.3 Assumptions and Limitations

Currently the main limitation that this simulation run has is that there are a few discrepancies in the time to complete a hole where certain groups, if they get ahead of pace, will pass another group in position on the course. While this sometimes can happen depending on the tournament, there aren't many times where something like this would be allowed. Thankfully, within this simulation these kinds of discrepancies only occur a couple of times per run and overall do not widely affect the performance of the run itself.

3. Simulation Run Summary

Overview of Runs: The three main scenarios that are tested here are the number of times the marshal gets sent out to the course, the amount of time that it takes a group to finish their round from starting time stamp to finish, and how frequently a group falls behind pace, ahead of pace and within pace on the course.

You will find a direct correlation between two separate runs where the times taken to complete a round and the stress on the marshal, being the number of times they are sent out, are directly affected by the occurrences of groups falling behind or ahead of pace.

4. Data Collection and Storage

4.1 Data Collection Methodology

For the collection of data I took 10 runs of the program and saved the outputs to 10 text files where I then used the re import to gather data based on keywords within each of the files. Such keywords were as follows: "Marshal sent", "ahead of pace", "behind pace", "stayed". The count of occurrences of these specific keywords defined the overall numbers within the data.

4.2 Data Formats and Storage

The data was stored as console output in a .txt file 10 times for 10 runs. This data was processed within excel in the graphs and charts below.

5. Data Analysis

5.1 Analysis Approach

The main methodology used to analyze this data was comparison of numbers in time totals to the number of occurrences of certain events like when a group fell behind, ahead, within pace and the number of times a marshal is needed to correct a groups pace when they are 5 mins over pace.

5.2 Results

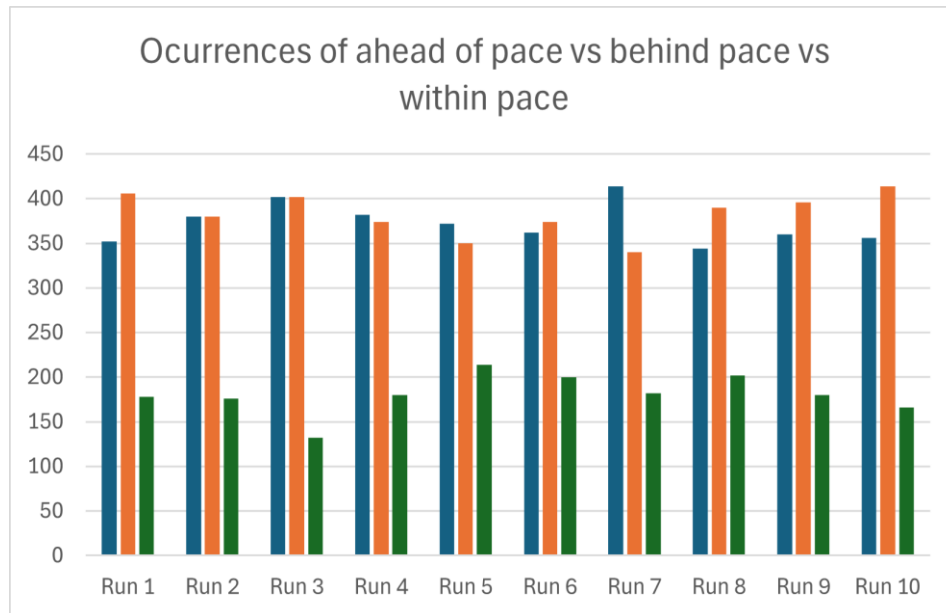
Below you can find a table that displays the results of data scenarios:

Groups	Time to complete round based on run one
Group 1	4:08:00
Group 2	4:32:00
Group 3	4:18:00
Group 4	4:15:00
Group 5	4:14:00
Group 6	4:27:00
Group 7	4:37:00
Group 8	4:08:00
Group 9	4:21:00
Group 10	4:31:00
Group 11	4:29:00
Group 12	4:08:00
Group 13	4:23:00
Group 14	4:21:00
Group 15	4:32:00
Group 16	4:30:00
Group 17	4:28:00
Group 18	4:21:00
Group 19	4:19:00
Group 20	4:27:00
Group 21	4:15:00
Group 22	4:20:00
Group 23	4:18:00
Group 24	4:15:00
Group 25	4:31:00
Group 26	4:10:00

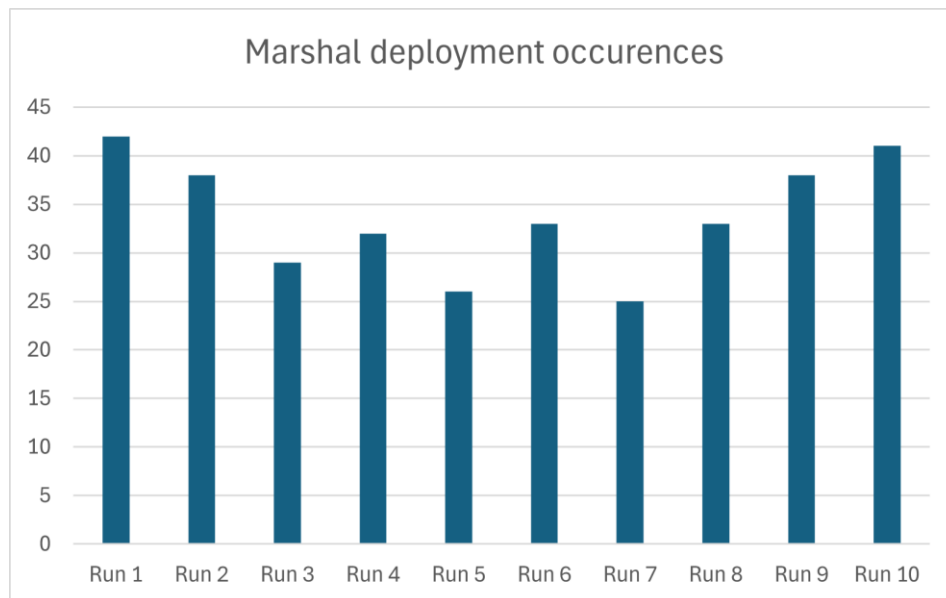
This is a result chart detailing the times taken to complete a round per group per the first run.

Groups	Time to complete round based on run one
Group 1	4:26:00
Group 2	4:22:00
Group 3	4:26:00
Group 4	4:21:00
Group 5	4:26:00
Group 6	4:17:00
Group 7	4:11:00
Group 8	4:13:00
Group 9	4:12:00
Group 10	4:15:00
Group 11	4:19:00
Group 12	4:16:00
Group 13	4:19:00
Group 14	4:17:00
Group 15	4:13:00
Group 16	4:18:00
Group 17	4:14:00
Group 18	4:16:00
Group 19	4:14:00
Group 20	4:21:00
Group 21	4:13:00
Group 22	4:05:00
Group 23	4:21:00
Group 24	4:21:00
Group 25	4:15:00
Group 26	4:13:00

This is a result chart detailing the times taken to complete a round per group per the seventh run.



This is a result bar graph that displays the comparison per 10 runs of the number of times that a group got ahead of pace, behind pace, and within pace.



This graph shows the number of times per run that a marshal had to correct a group's slow play of 5 minutes over pace.

5.3 Discussion

This chart and two graphs are very significant to the data due to the way that they directly correlate with one another and show the relationship between time taken to complete a full round per group and how often they fall ahead of/ behind / within pace. As you can see for run one in the time chart above groups like group 1, group 8, and group 26 contribute to the overall decrease in number of times the marshal is deployed, however there are many data points within this run where groups finished

much later and took much longer to complete a round therefore, there will be a result like in run 1 on the marshal deployment occurrences graph shown above. This also explains why in run 1 of the ahead/behind/within graph there is a much larger time discrepancy between the number of times groups got ahead of pace vs behind pace. Groups in this run after the run finished were observationally much slower than they were quick or on pace.

If you take a look at run 7 and the time to complete the rounds within that run, you can correlate the much larger discrepancy between a much larger number of ahead of pace counts vs a lower number of behind pace counts. It is also noticeable that the number of times all the groups within that run fall within pace is larger than the average amongst all 10 runs.

These results that are shown amongst the two charts and the graphs provided are a direct result of how the number of times a marshal on average is sent out for a group being 5 minutes over pace is directly related to how long on average it takes for a round in a run to finish.

6. Conclusion

Throughout the gathering of data within this milestone the runs provide observations on the frequency of need for marshal involvement when managing players pace, the length of time taken for groups to complete a round from the time they tee off to the time they return the carts, and the frequency of groups falling behind, within or ahead of pace. All in all, the runs that have been provided and the different parameters that have been studied within these runs provide a unique insight into how the time structure of a golf course works when dealing with the pace of play on a golf course.

These runs, while displaying a random nature in time in the modeled groups that play on the course, directly show how on any given day the way that individual golfers and groups playing slow directly affect the stress upon marshal need and the total time for a tournament to fully complete. Ideally a course would love to have a tournament finished as fast as possible so on days like run 1 where the marshal frequents groups on the course, the timing is the least ideal. On the contrary on days like run 7, the marshal is less stressed so it can be directly assumed that that day overall took a lot less time to complete the tournament overall.

7. Documentation Updates

7.1 Model Changes

The main model change that has occurred before the simulation model runs to observe data is the change in the conditions of the model in that instead of the model being comprised of groups on a normal but busy day on a golf course, this sim model takes all of the fundamental aspects of the early conception of the project but instead applies to the scenario of a tournament of 26 groups with 2 carts each totaling 52 carts. This tournament takes place all within a time constraint of 600 minutes or 10 hours and golfers are expected to have been done with the course and have carts returned by that time mark whereas before once carts were returned their carts would be recycled for new groups who wanted to play the course in a non-tournament setting.

7.2 Tools and Libraries

The re library was a newly included library within this project to document the data found within the simulation. I used re specifically for the collection of data regarding measuring the number of times that the marshal was sent to the golf course for the slow play threshold being broken and how many times specifically the groups on the course fall behind or ahead of pace. As for how long it takes the groups to finish the round from start to finish, I gathered this data into an excel file and separated the lines that detailed the start and end times into their own column where I gathered the data. The data points were retrieved using the re import by counting the number of times that a certain phrase occurred within the output of 10 different runs.

The datetime library was also included to display the number of hours and number of minutes it took for groups in the displayed runs to complete their individual rounds.

7.3 Simulation Plan Table Updates

There were no specific table updates.

8. Reflection and Next Steps

8.1 Challenges Faced

There were some issues with data extraction using pandas, I was doing a bit of research attempting to get some results to show based on the limited amount of code related to pandas that I had. Instead, I opted for the re import to gather data based on the console outputs written to txt files and the occurrences of keywords within those outputs.

8.2 Future Plans

The next step of development is the sensitivity analysis where I will study how input data changes the overall results of the runs of the project simulation.

9. References

W3schools.com. W3Schools Online Web Tutorials. (n.d.).
https://www.w3schools.com/python/python_regex.asp

A Simulation Run Table

Simulation Run Table						Instructions for Using the Table
Run ID	Objective	Parameters/Configurations	Expected Outcome	Actual Outcome	Notes/Comments	Run ID: Assign a unique identifier for each simulation run.
Run 1	Display the correlation of occurrences of marshal need vs total times taken for rounds in a run	This run was executed specifically with randomized parameters relating to time	Run complete at a leveled correlation between times where groups fall behind vs ahead of pace	Run show visible occurrence discrepancies	[Additional comments or observations]	Objective: Briefly explain what each run is testing.
Run 3	Display the correlation of occurrences of marshal need vs total times taken for rounds in a run	This run was executed specifically with randomized parameters relating to time	Run requires more stress on marshal to be deployed	Run requires an average amount of marshal interference	[Additional comments or observations]	Parameters/Configurations: List any parameters or configurations that are used for this run.
Run 5	Display the correlation of occurrences of marshal need vs total times taken for rounds in a run	This run was executed specifically with randomized parameters relating to time	Run requires less stress on marshal to be deployed	Round requires second to least amount of marshal interference	[Additional comments or observations]	Expected Outcome: State what you predict will happen based on the settings.
Run 7	Display the correlation of occurrences of marshal need vs total times taken for rounds in a run	This run was executed specifically with randomized parameters relating to time	Run shows a lower rate of occurrences of groups falling within pace	Runs show higher rate of groups falling within pace	[Additional comments or observations]	Actual Outcome: Record the results of the run.
Run 9	Display the correlation of occurrences of marshal need vs total times taken for rounds in a run	This run was executed specifically with randomized parameters relating to time	Run shows a higher rate of occurrences of groups falling within pace	Runs show higher rate of groups falling within pace	...	Notes/Comments: Include any additional observations or issues that arose during the simulation.

Table 1: Simulation Run Table