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250 Final Project Report

As many students prepare to attend Allegheny College next fall, there is one question which they will for sure ask. That question is “where will I be living?” Allegheny College currently offers various forms of housing which also carry many restrictions. A student’s current living situation can be divided into three main categories: off campus housing, dormitories, or fraternity house. Unfortunately, the only way a student can live in an off campus house is if the school has ownership of the house. This means that housing is currently limited to property owned by the college.

The rules that the campus has about housing then brings up the problem which our group has come up with a solution for: “Who gets to live where?” This problem is surrounded by a question that can never really be fully answered for every individual: “What is a fair way to house everyone?” The problem with this is that there is no solution which can work for every individual. This is because some individuals prefer a certain dormitory over another. For instance, the dormitories which are currently offered are North Village 1, North Village 2, Allegheny Hall, College Court, Allegheny Commons, Walker Hall, Baldwin Hall, Ravine-Narvik Hall, Shultz Hall, Edwards Hall, Crawford Hall, and Brooks Hall. North Village 1 is currently one of the nicest places to live on campus. This means that many students want to live there. However, because not all individuals like the same things there are students who request to live in the lower quality dorms.

This is the reason why there is no perfect solution to the problem, because someone who wants to live in a lower level dorm may end up with the option to get into a better dorm, but never uses it because they are set on living in a lower level dorm. There are many reasons for this. One of the reasons is because the prices between singles, doubles, triples, quads, and pents all vary greatly. For instance it is cheaper to live in a double than it is to live in a single. Therefore someone trying to save money will chose the cheapest option of living.

For these reasons the solution cannot be perfect, but it can account for the majority of all students’ wishes. Our solution could then be deemed to be “fair” because it satisfies the majority of all students. It may seem unfair to not include every individual’s wishes; however our solution to the problem does in a way take all individuals into account. The way housing is currently set up is to generate a completely random pick number with each class level up taking priority over the one below it. This means juniors have priority over sophomores and sophomores have priority over freshman regardless of pick number. Seniors do not get a pick number because they are graduating and therefore will not need to live on campus housing. This fashion currently produces the result that the majority of students will go for the “best” housing first which means that regardless of pick number for “money saving” individuals, it is almost guaranteed that they can receive a double if they so choose. Our solution also allows this solution to occur because it is almost guaranteed that at any given time before the incoming freshman are housed that a double will be open.

This leads into the problem behind the current solution to housing and why our group chose to take action. Currently the pick numbers for housing are random. This in theory sounds completely fair because every just randomly gets assigned a number. It’s kind of like playing the lottery, there is no telling what you will get. However fair this may seem, what is stopping someone from getting over 400 every year they are at Allegheny? The answer is nothing stands between an individual and repeated bad pick numbers. This is no matter to be overlooked because it has happened to students on this campus. Furthermore what is to stop a student from getting in the top 100 every single year? In no way can this be justified as “fair” in our eyes. Therefore our group decided to take action on the subject.

It is important for us to solve this problem in order to provide all students on campus with a fair room draw number. This being said the entire group working on this project got into the best housing possible for next year. However, just because we benefited from the current system does not mean it is fair. In order to provide the campus with a valid solution to the problem at hand we had to look past our own wants and desires and start looking into what would benefit the campus as a whole. In order to do this our group started surveying students on what would be the fairest way to house everyone. The answers of course were mixed, but most agreed with our current solution. In fact all students which were asked to give input on our new algorithm agreed that the new algorithm was far superior to the current solution. If this new algorithm were to be implemented there would of course be individuals against it. However, the number would be far less than the number against the current algorithm. In order to determine priority of living we put out a survey asking students to rate the campus housing options from 1-19 (1 being the best). About 60 individuals answered the survey and we used this to determine weights each dorm should receive. In the future if this were to be implemented we would put out a campus wide survey in order to get a broader view on the subject.

The background for this small, as there has not been a lot of work done in order to solve this problem. There is one other group currently working on this problem. However, we believe that their solution is not at all fair. Their solution to the problem is to house students based on their GPA and campus actives. From our understanding of their solution, someone who is very active on campus with a great GPA would get close to the front choice of housing. In theory this sounds like a great idea. However, there are many things that this does not take into account. These are things such as: how can all majors be weighted the same? Some majors are more difficult to receive a great GPA. In this case why would someone with a much harder major who works much harder have a worse pick number? Also in regards to campus activities, some students work a part time job in order to pay for college which severely limits their time on campus. Since we came to see the other group’s algorithm as “unfair” we decided to go our own route regardless of the fact that a solution is being developed by another group.

This leads fairly well into how we decided to solve the problem. In order to solve the problem we brainstormed and asked opinions from many individuals around campus. The general consensus was that in order to generate a fair room draw number we had to take into account previous housing situations, previous room draw numbers, whether or not the students used their own room draw number, and keep some of the random variable so that students don’t get completely last or first based on these previous variables. There were different weights assigned to these values. For instance your previous housing should have more of a weight than your previous room draw number. This is because it does not matter if your previous room draw number was terrible if you got to live somewhere great. This leads into the variable of if you used your own room draw number. If you had a terrible pick number, a terrible place to live, and you used your own room draw number because you had no other option you deserve to have a much better option for the next year. In the other case if you had a great pick number, had a great place to live, and used or didn’t use your own pick number then you should be more towards the end to give others a chance for a good place to live. This is isn’t to punish someone for having a great place to live or having a great pick number. It is to allow everyone an equal opportunity to get good housing across the student body.

Different weights were places on these variables. For instance if an individual did use their own room draw number then previous housing is 50% of their next pick, previous room draw is 40%, and then there is a 10% random to ensure that the algorithm doesn’t automatically shoot someone to the back or front. On the other hand if the individual used someone else’s pick number then previous housing is 70% of their next pick, previous room draw is 20%, and then the random remains the same to keep individuals from floating immediately to the top or bottom of the list. The random variable also helps individuals with a middle pick number and a middle quality of housing float around in the list to provide some variance in their pick number so they aren’t always placed near the middle. It also helps individuals with great previous living get a chance at the middle of the list.

Attached is both some pseudo code for how this algorithm and also its running output for the first 100 students in each class. The program generates a number for all students, however that is a lot of output to include in this report. In our code we used Insertion Sort (Sedgewick, Wayne) for sorting the students based on the new number we gave them and putting them into a list. Since we use Insertion Sort O(n^2), calculate a new value for the students O(n) , and give a unique random O(n^2), our runtime comes out to O(n^2 + n + n^2). This runtime seems bad. However, with any amount of students that could possibly be housed on this campus this runtime is acceptable. For example we only have around 2000 students currently and it takes less than a second to do the calculation. Therefore this runtime complexity is obviously acceptable.

Our results of this algorithm were very close to the results we wanted. For example: for an individual that had a previous pick number of 400, lived in a walker double, and used their own pick number received a new pick number of 160 which is very reasonable. All of the results in the attached output follow this pattern. Our group was pleased with the results of our testing as they were fair based on the weights and priorities of living filled when we put out the survey. As mentioned earlier these weights could be adjusted if a campus wide survey was to be put out. Here is some sample output that can be broken down to show the fairness of the new algorithm.

Junior208 485 ED 86.80526315789473 8

Junior385 412 RD 86.60000000000001 9

Junior131 477 BD 85.67368421052632 10

Junior198 418 ED 85.54526315789474 11

Junior172 488 BD 84.79368421052632 12

Junior 208 shows that he/she lived in an Edwards double their sophomore year with a pick number of 485 which is very low on the priority of living chart and they had very bad room draw number. The new algorithm dictated that he/she should be placed very high in the list (8). This is a fair analysis based on their previous conditions. The other numbers show a similar trend with the bad doubles from other dorms and bad pick numbers. You can see from the outputs that the weights are close in value: “86.805” and “86.6”. This is where we used insertion sort. The higher the number you received the higher up you were in the list. This means that the number “86.805” has one higher pick number than “86.6”. This pretty much concludes our results. To sum it up briefly; everyone was housed in a manner that was fair based on their previous living, room draw number, and a small random percentage. If this algorithm were to go into use then rigorous “fairness” testing would take place to ensure that no flaws arise for specific individuals.

This brings us to the problems our group faced during the project. Our first and foremost problem was actually deciding what would be a fair way to house students. We spent a lot of time on this as a group. In order to solve this problem, as stated earlier in the paper, we verbally prompted individuals around campus for their proposed solution to the problem. After that we asked individuals if our algorithm was fair in their eyes. The answer was almost always “yes”. For those who said “no” to our algorithm it seemed more as if the “no” stemmed from problems understanding the new solution rather than problems with the new solution. Another problem we had was giving students previous housing data. In order to do this we worked with Res Life on campus in order to obtain data about all the housing structures and their capacity. This proved necessary because certain dorms are reserved for freshman and certain dorms are reserved for upperclassmen. This means we had to make a list of all possible places a freshman, sophomore, junior, and senior could live. This would have been impossible without the capacity of each building because technically every student on campus could live in NV1 if there was no capacity to the building.

There were other small problems we had while implementing the project. These were things like determining the weight for each of the variables. In order to come up with a pleasing solution we played with the weights until the program was outputting numbers which seemed fair. In order to determine fairness we gave examples to students of their previous data and what number they would receive for the upcoming year. Of those asked, all students said the new pick number is fair.

Our biggest take away from this assignment was the fact that we came up with a solution that satisfied more people than the current solution. This was also our biggest learning takeaway. We learned that tons of steps have to be taken in order to find the “fairest” way of doing something. Overall it was something that greatly benefited our learning experience. We also learned how to take our knowledge we learned in 250 and apply it to a real world problem which is something we will end up doing in the job field. Therefore this assignment was not only extremely rewarding, it was necessary.

In the end we were able to generate a fair room draw number for every student on campus. Our group was very satisfied with the results and we plan to do future work on the algorithm. In the future we hope to get more data about student living and possibly take our algorithm in front of Allegheny Student Government in order to get feedback on how this would work for our campus. Overall the project was a great success.