Individual Course Project (ICP)

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Purpose of Repository

The purpose of this repository is to provide further insight and explanation into the methods I used to complete my Individual Course Project. In my repository, I have provided the source codes I studied to further my knowledge and understanding of the shoot-a-way shooting machine. This source code helped me to better understand the Machine Learning technique implemented in the shooting gun's processor as well as provide better insight into the troubleshooting issues I have seen FIT athletes endure when partaking in usage of the FIT athletics shooting machine. My repository will be providing data I have collected from actual FIT athletes, replication procedures for if necessary, as well as a further explanation of my project and its intention of use.

The proposal I have decided on for my individual course project, is to evaluate and furthermore assess the accuracy and credibility of the FIT shooting machine. The FIT shooting machine is run off of a complex computer algorithm that allows for documentation and evaluation of an individual's shot in order to further improve the athlete's shot through methodical repetition of the shot by the athlete.The device's then tries it's best to match the "game-like" conditions an athlete would be exposed to in the real game however allow for practice of the shot in order to improve the athlete's confidence and overall performance in the specifically trained area. The machine's requirements are as follows; the machine shall keep a running time for which the athlete's shot shall be tracked at all regions of the floor, classified as either a free throw, two-point shot, or three-point shot. The shooting machine should keep track of all the athlete's shot attempts and keep a running percentage for all regions the athlete shoots from. The shooting machine shall offer different methods of collections (Normal, Made Shots, Made in a Row…). The shooting machine shall offer a full range of motion extending to at least 40 feet of the basketball court with an adjustable timer for safety conservation and so on... The modeling technique I will be using for said project will be classification to extend to a decision tree. The maker of the Shoot-A-Way shooting machine decided on a decision tree method of classification as this gives the mechanism a way to break down the immense variety of shots it is bound to experience since there are so many different ways and types of shots in basketball. He also imposed a mean and median filter method to allow for proper image processing of the shot when the data is first collected. The technique the Shoot-A-Way machine uses takes a ball going through the net as a "success" and a ball not going through the net as a “failure”. When the ball passes through the net of any form, the shooting machine is then trained to recognize said action as a “success” and logs this into the computer system as 1. At this point the shooting machine however, is not able to tell the difference in locations, shot type, and type of makes considering the typical athlete does not limit themselves normally to one type of shot during a training session. So, we then request the athlete to select specific locations, amount of shots they would like to attempt, how they would like the machine to record these makes, and lastly how much time between each shot’s output. Lastly, the athlete then manually will adjust the passing device for their comfortability. As the machine trains itself to learn where specific locations register to specific shots, suppose an athlete shoots one shot from the opposite side of the registered location, the device will not register this shot in that region but in the region the device is selected to output at.

This brings me to the problem I will be assessing in my project, the accuracy of the results the new shooting gun is producing. This will help me to assess how well the computer's image processor is able to classify successes and failures based on the image the computer captures and how well it matches the computer's definition of a successful shot. Since the shooting machine is built with intention for 97-100% retention, it was my job to investigate why athlete’s, myself included, are not receiving these results due to miscounts the gun will experience from varying internal and external factors. The external factors I was able to assess; the time the shot was taken, location(the right and left corner proved to be very difficult in documenting successes), multiple balls being shot at once, and the type of shot success, a soft, hard, complicated, or simple make. This also allowed me to look at the other internal factors of the shooting machine like the computer inaccuracy, delays, softer makes, and more. The internal factors dive into the lack of problem-solving the makers are not able to honestly control. Suppose an athlete chooses to use the gun strictly as a “rebounder”. The athlete will select a 1-count timer and one location at the farthest length possible. Now, suppose the athlete actually takes anywhere between 5-7 seconds to actually attempt the shot and now when the system registers “net” it runs into a dilemma as it no longer counts this shot everytime a supposed success is completed with the shot attempt based on the system settings already set into place. Also suppose the athlete’s shot success is softer than the trained “success” the system knows, it then fails to count this shot as a success and instead registers this shot as a failure.

Now, it was my job to test how accurately the shooting machine is able to reproduce game-like situations tailored to the athlete’s preference and furthermore produce accurate results of the athlete’s success in these game-like shots. If eight FIT athletes take five shots each from nine separate locations across the key at two different distances from the basket, then the shooting gun will produce between 80-85% accuracy of the player's shot. Since I will be evaluating things like blind spots on the camera itself and other factors I have collected from personal experience with the gun, I can confirm that the accuracy will not be at 100% due to some small mishaps in the gun's hardware and makeup. I do hope to exploit more of its faults as well as promote it's benefits and advantages. The code I will be using for this project does actually require my use of a third-party software, the Florida Tech Athletics Shooting machine. Not only will the machine's camera be a great example and implementation of classification and recognizers, we can also use the machine to classify the type of shot and region/location. I will be conducting thorough research into the code and how said machine is made to document the different types of successes from different regions and how the classification of all this is done. My hope is to use this knowledge to further assess the shortcomings of the shooting machine to further aid the progression of the machine and help our FIT athletes obtain better, more accurate results when using the FIT athletics shooting machine.

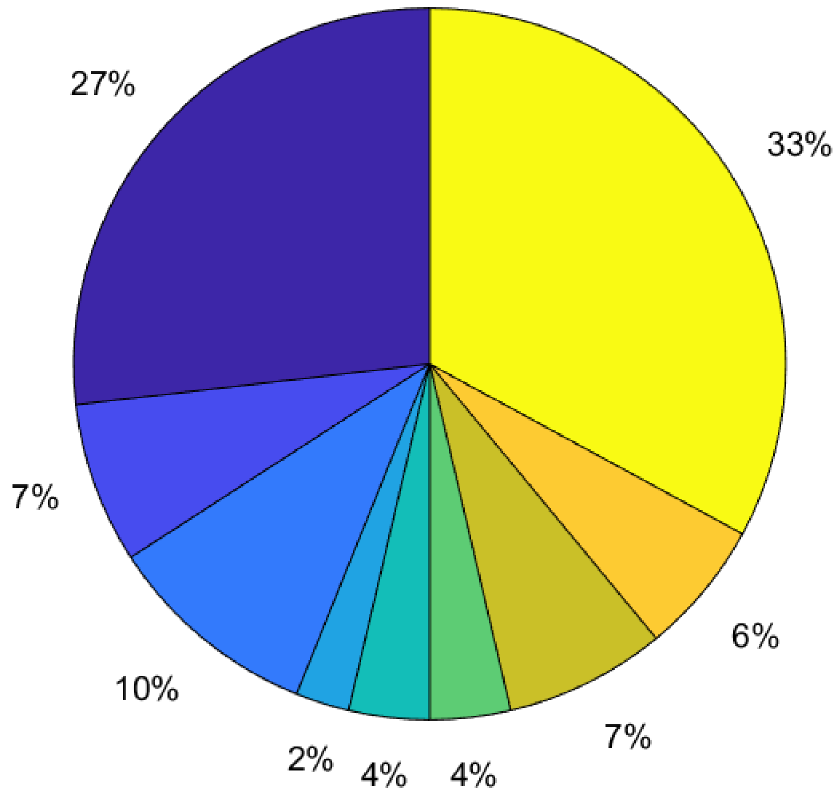
After conducting my research, I can attest first to the following benefits of the FIT shooting machine. FIT athletes are able to get constant and pure repetition of their shot with device usage. Athletes said to have felt more comfortable with their shots by the middle region and felt their shots overall improve from usage of the gun. The FIT shooting gun is also very consistent with results and lack of miscounts in the regions more consistent with the middle of the basketball court. This I believe is due to the way and direction the ball enters into the net where the machine then follows the decision tree to determine a success or failure.

```
>> x = ShootingMachineError2pt

x =

  10×10 table
```

Shot_Location	RC	RW	RE	RS	T	LS	LE	LW	LC
"Shot_Location"	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
""	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
"Player 1"	4	0	1	0	0	0	1	1	3
"Player 2"	3	1	0	0	2	0	0	0	4
"Player 3"	1	1	1	0	0	1	0	1	5
"Player 4"	3	2	0	0	1	0	0	0	4
"Player 5 "	2	1	0	1	0	0	0	1	2
"Player 6 "	3	1	2	0	1	0	2	2	2
"Player 7"	1	0	2	1	0	1	1	0	4
"Player 8"	5	0	2	0	0	1	2	0	3

```
>> x = 3:10;
>> labels = {'RC','RW','RE','RS','T','LS','LE','LW','LC'};
>> pie(x,labels)
```

Loaded data of Errors and miscounts during mid-range, two-point shot attempts, by shoot-a-way machine during athletes shot attempts. Shots were not miscounted in consecutive order.



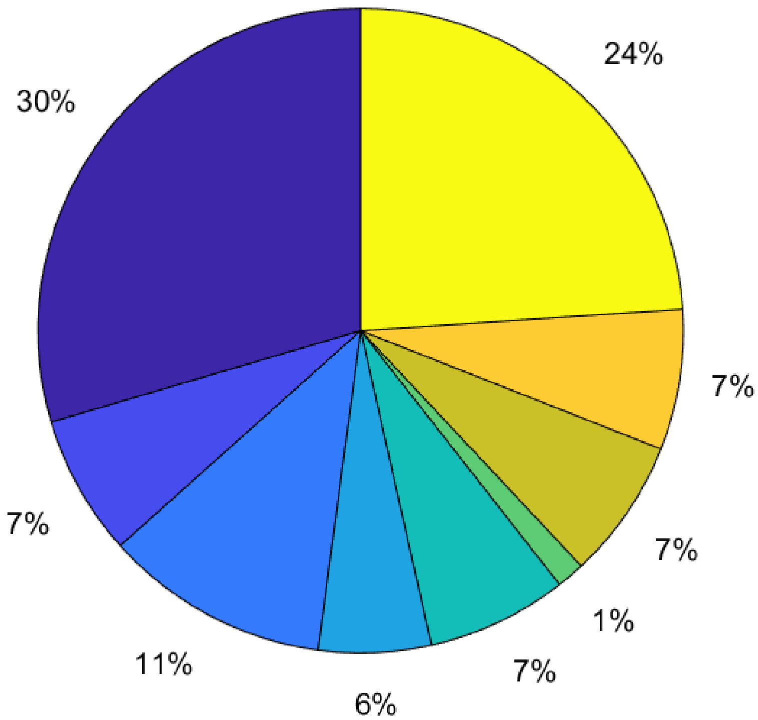
Mid-range shot attempt miscounts, classified by region from going Counter clockwise. Note, the small percentages for the RS, T, LS.

```
>> X = ShootingMachineError3pt

X =

  10×10 table
```

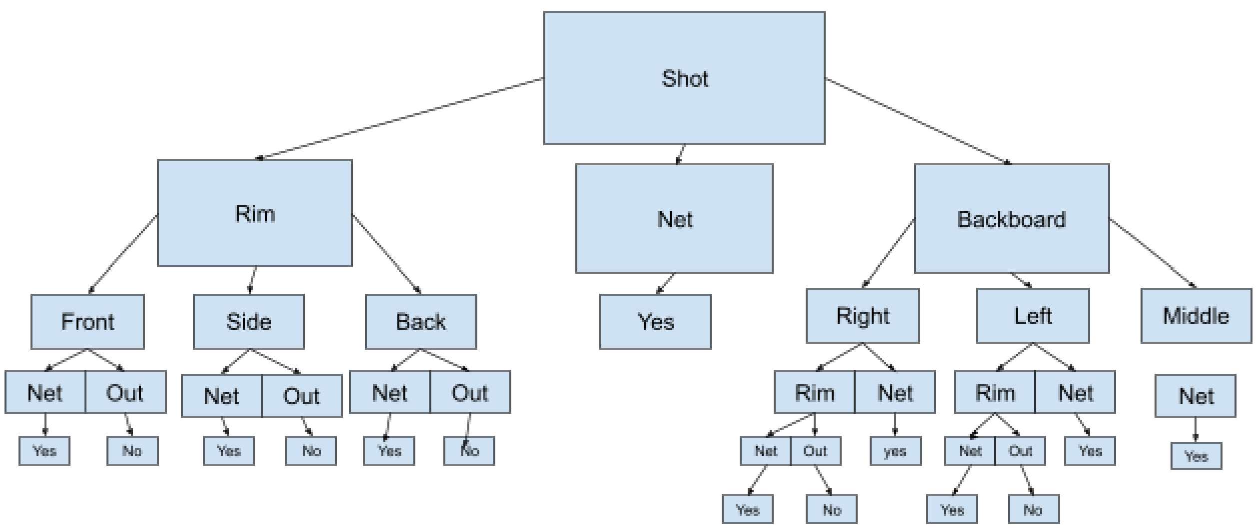
Shot_Location	RC	RW	RE	RS	T	LS	LE	LW	LC
"Shot_Location"	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
""	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
"Player 1"	3	2	0	0	1	0	0	0	3
"Player 2"	1	1	1	0	0	1	0	1	1
"Player 3"	4	0	2	1	0	0	2	1	3
"Player 4"	3	1	0	0	2	0	0	0	2
"Player 5 "	3	0	1	0	0	0	0	1	2
"Player 6 "	2	1	0	1	0	0	0	1	2
"Player 7"	1	0	2	1	2	0	1	0	1
"Player 8"	4	0	2	1	0	0	2	1	3

```
>> labels = {'RC','RW','RE','RS','T','LS','LE','LW','LC'};
>> pie(X,labels)
```

Loaded data of Errors and miscounts during perimeter, three-point shot attempts, by shoot-a-way machine during athletes shot attempts. Shots were not miscounted in consecutive order.



Perimeter shot miscounts, classified by region from going Counter clockwise. Note, the small percentages for the RS, T, LS, especially highlighting the 1% for the Left Slot.



Ideal Decision Tree model, shooting machine will follow however with real percentages set by the shoot-a-way maker (these were not accessible to the public)

As you can see above, my findings are consistent with what I hypothesized. However, some things I did find a little inconsistent or odd you could say, the accuracy I described being much more consistent in the more middle based regions of the court are not as so with three point shots as although this number is low compared to the corner I see a consistent percentage aside from the left slot. While this did surprise me as I believed the direction the ball hits into the image processor was the only factor influencing the determination of a success or failure I realized, if the shot success is too soft or too hard for the system to recognize as a success it automatically registers the shot as not falling in line of the basket, an outlier, and registers this shot as a miss. This was very surprising for me to see as I did not expect the accuracy to go down the further away since the shot is still entering the basket “anonymously”. However, after seeing this and also one more inconsistency, I realized the type of make is very important to how the shot recognizes a success or failure as well. When the athletes would shoot from the corners although not by much decrease in the right corner, the left corner saw almost 10 less shots miscounted. Which leads me to believe an athlete will shoot the shot either softer, or with more focus in this spot from the three point spot as this is the last shot in the experiment. We can contribute this misleading data to human error as these athletes are competitive by nature, they are attuned to attempt the experiment as well as possible on their last attempts although they were kept blind to the experiment I was conducting. Another error I believe is the lack of shots I had each athlete take at the individual spot. I believe if I required each athlete to conduct ten shot attempts instead of five this would have given more accurate results of the shoot-a-way machine as well as allowed the machine more time to recognize the location and make specific adjustments to the specific location to better process successes and failures. However, I cannot attest if this would have been an actual feature of the machine as I did not conduct said research and cannot attest to either confirmation or rejection based on my own personal experiences and knowledge of the shoot-a-way machine.

This takes us into the acknowledgements and furthermore instructions of replications of these works, as one could repeat this test multiple times to give an even further analysis into the shooting machine's benefits and faults to help improve our FIT athletes. First acknowledgements go to the FIT athletes who allowed me to study and evaluate their practice time as this does add a bit of pressure to the developing athlete. Secondly, I would like to acknowledge the difficulty and complexity the shooting machine's code invokes as the variety of shot attempts in basketball will lead to all kinds of mishaps if an image processor is not carefully constructed. For example, a few miscounts can be contributed to the net around the rim used to catch the remaining balls for reproduction through the machine. Since this net is large with elastic material, some shots when shot hard or depending on placement against the backboard, would bounce against the outer net and into the hoop then causing the system to register the shot as a success even though the athlete actually did not make the shot. This also made for a pretty comedic moment during experimentation conduction. To repeat said process, the student should first gather eight to ten FIT men and women basketball players (the gender should be relatively evenly-split however this is not strict). After they have gathered their athletes, have each athlete on their own time conduct 5 mid range shot makes and record the amount of makes out of total shot attempts as well as the amount of times the FIT shooting gun did count a success as a failure or vice versa. Repeat this process with three point shots. Conclude the results, summarize these results into data sets and visuals as this will further help to assess and explain one’s findings.

Although this project did require a lot of time and help on my part from my teammates and the men’s basketball team as well, I genuinely enjoyed and appreciated the task. This project taught me a lot about the breakdown and implementation of classification methods. I enjoyed having to understand the difference between the various types of classification methods and which one was best to implement into the FIT shooting machine. I believe my research has helped FIT athletes improve their overall moral about their skillset as well as improve their insights into what shot attempts they may want to focus on instilling more confidence in the results the FIT shooting machine produces. I look forward to watching or assisting the shooting machine in making improvements not only to feedback accuracy but allow for a method of computer passing length selection versus manual labor from the athlete to adjust the pulley.