

Geddes Billiards

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I. Bringing Home the Bacon

Anyone at Olin knows Professor John Geddes is über cool, and it only helps that he's a pool shark. But can he use his sharp skills to win this game on a single shot?

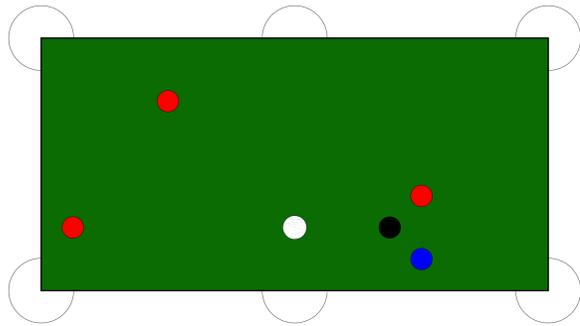


Figure 1: The starting pool conditions. John has to sink both the blue and black balls in order to win.

II. What Could Possibly Go Wrong?

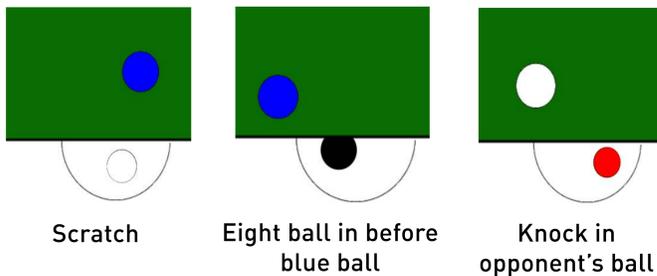


Figure 2: Failure cases

III. Modeling Bumps and Bashes

Our model took into account rolling resistance, collisions among balls, and deflections off walls. Ball collisions were treated as elastic, but a percentage of the kinetic energy was lost when bouncing off walls. Reflection was modeled as an instantaneous change in velocity and based on Figure 3.

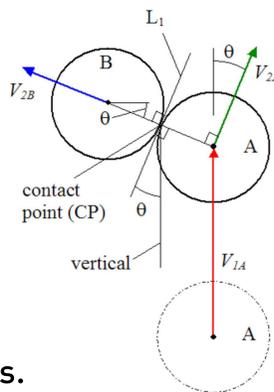


Figure 3: Momentum is transferred along the vector between the two ball centers. Source: "The Physics of Billiards." *Real World Physics Problems*. Web. 22 Nov. 2016

Collision physics based off of those by Gamasutra in "Pool Hall Lessons: Fast, Accurate Collision Detection Between Circles or Spheres." Web. 22 Nov. 2016

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ABSTRACT

Impressed by John Geddes' billiards skills, we decided to help him take his abilities to the next level by finding solutions to a difficult shot. We found that the particular shot we selected had multiple solutions and one had a relatively high margin for error. We therefore considered it to be a feasible shot for John Geddes to make. When comparing the effects of initial speed of the ball and angle the cue ball is hit at, we discovered that angle was more influential than speed.

IV. Limitations

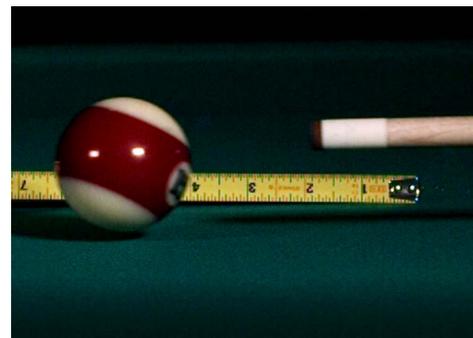
Spin

We neglected ball spin in our model, which could influence the response of the balls during collisions. It also meant we didn't take into account angular momentum that could be pulling the ball sideways.

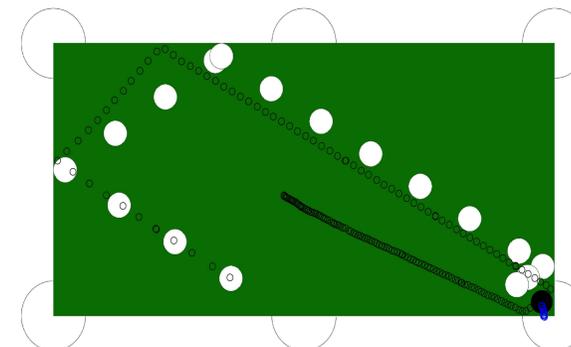
Pocket Entrances

Collisions with the wall around pockets were drastically simplified. Either the ball bounced directly off the wall as if there were no pocket or the ball fell into the pocket. There were no bounces off corners.

V. Can We Do Physics as Well as John?



To determine an upper bound for our initial speed, we captured John Geddes hitting a ball his hardest with a high-speed camera. We then analyzed the video to find the initial speed of the ball.



We analyzed another video to calibrate our energy loss in collisions with the walls. The black outlines are from the video and the white orbs are from our model. Our model isn't perfect, but it is good enough to give us an idea of if a shot is possible.

VI. The Key to Success

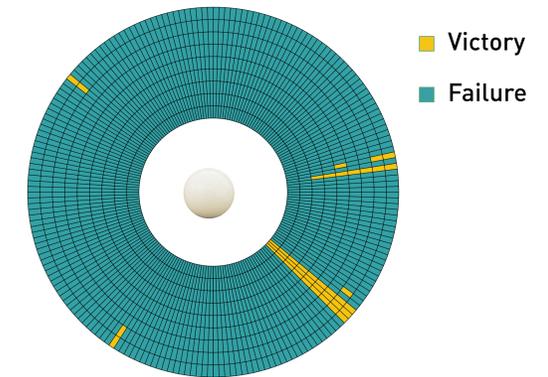


Figure 5: Winning cue ball angles and speeds. The distance from the center indicates the initial speed and the angle is the direction in which the cue took off. The orientation is the same as in Figure 1.

Looking at Figure 5, we can see that John has several opportunities to win the game. His best bet would be to shoot along one of the wide yellow swatches, where the margin for error is highest and thus he has the greatest chance of winning. Judging by the specks of yellow on the left side of the figure, it does seem to be possible to win by shooting the ball off the back wall, the probability of success is pretty low. It also appears that, overall, speed is less important than angle.

VII. Moving Forward

Give It Spin

A lot of factors go into spin which can greatly influence behaviors such as wall reflection and trajectory. This makes our predictions less reliable, especially when modeling shots involving high-speed collisions.

...and...

Help Geddes Win!

With a more realistic model, we can more accurately predict the outcomes of sophisticated shots and help John win in even more unlikely scenarios. We didn't think it was possible at the outset, but we are now convinced there is a way to make John Geddes even more awesome.