The Oblique Throw

2022-03-20

What is the project about?

When we throw a ball (ignoreing wind resistance) when the ball leaves our hand we know the only accselaration acting upon the ball is the gravatational constant.

The simulations

For the simulations i used the following equations to get the distance that the ball travelled

Using this I wrote the following python code to simulate the throws

```
import math
import sympy

def calc_dist(v, a, h = 10):
    """
    Take in an velocety, angle and a height and calculate the distance it will travel
    """
    g = 9.82 # Gravatational constant
    x = sympy.Symbol('x')

    # Left side of the equatoin
    c1 = -1 * h

    # Right side of the equation
    c2 = v * math.sin(math.radians(a)) * x - 1/2 * g * x**2

    # Solve it, we can discard the negative solution
    t = max(sympy.solve(sympy.Eq(c1, c2), (x,)))
    s = v * math.cos(math.radians(a)) * t

    return s
```

Here is an example

```
print(calc_dist(15, 10), # Velocety: 15 m/s, angle: 10 degree
      calc_dist(20, 15), # Velocety: 20 m/s, angle: 15 degree
      calc_dist(5, 25)) # Velocety: 5 m/s, angle: 25 degree
```

```
## 25.3608136859927 39.5736277406020 7.51523973272992
```

I wrote a script to run this 22860 times but i wont go over that in this document, its linked as `main.py`

Visualising the data

Lets first take at what type of data we are working with here

```
summary(data)
```

```
##       vel             ang              dist
##  Min.   : 0.2   Min.   : 0.0   Min.   :  0.00505
##  1st Qu.:12.8   1st Qu.:22.0   1st Qu.: 15.00609
##  Median :25.5   Median :44.5   Median : 46.72623
##  Mean   :25.5   Mean   :44.5   Mean   : 66.86415
##  3rd Qu.:38.2   3rd Qu.:67.0   3rd Qu.:101.62410
##  Max.   :50.8   Max.   :89.0   Max.   :272.61055
```

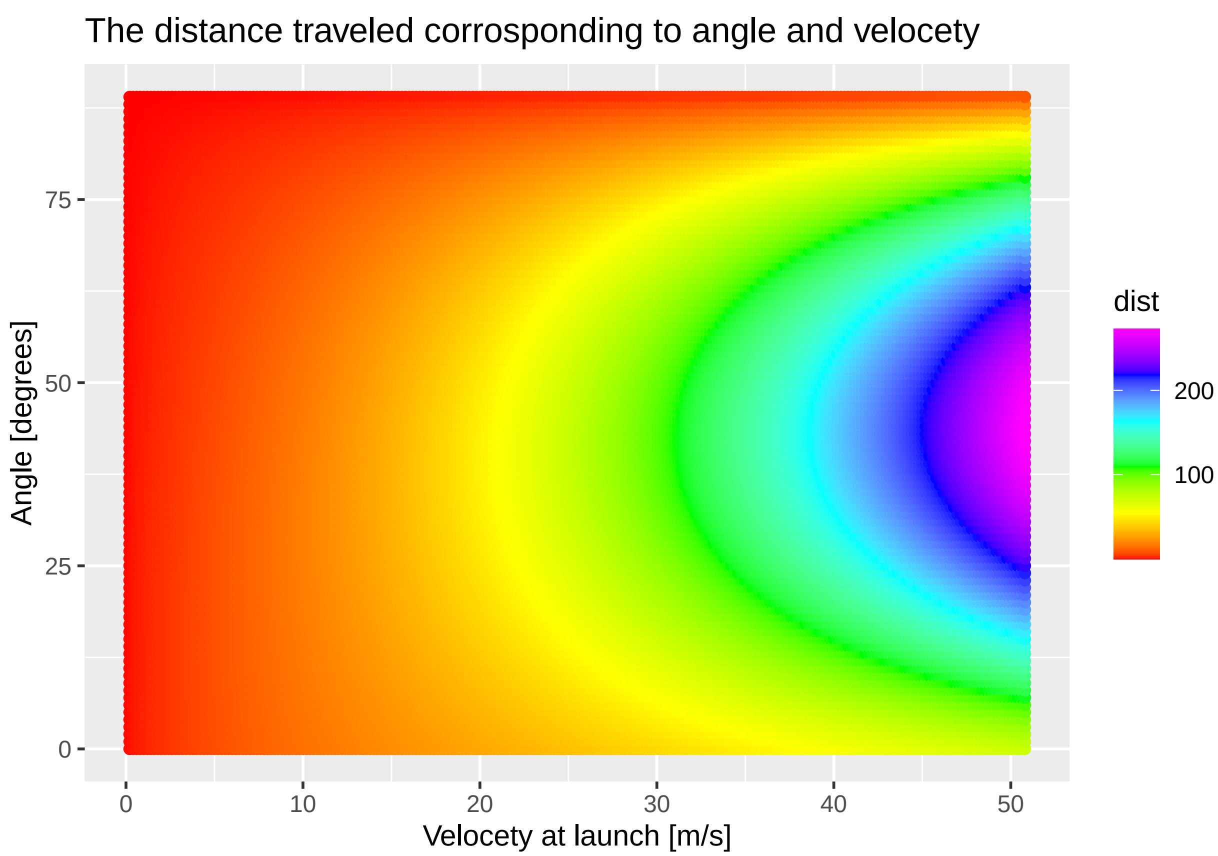
From taking a look at the summary we can see that the higest distance we reached was 272 meters with an avrige of 66

```
str(data)
```

```
## spec_tbl_df [22,860 x 3] (S3: spec_tbl_df/tbl_df/tbl/data.frame)
##  $ vel : num [1:22860] 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 ...
##  $ ang : num [1:22860] 0 1 2 3 4 5 6 7 8 9 ...
##  $ dist: num [1:22860] 0.285 0.285 0.285 0.285 0.285 ...
##  - attr(*, "spec")=
##   .. cols(
##   ..   vel = col_double(),
##   ..   ang = col_double(),
##   ..   dist = col_double()
##   .. )
##  - attr(*, "problems")=<externalptr>
```

From the str function we get a preview of our data and we find that we have 22860 datapoints

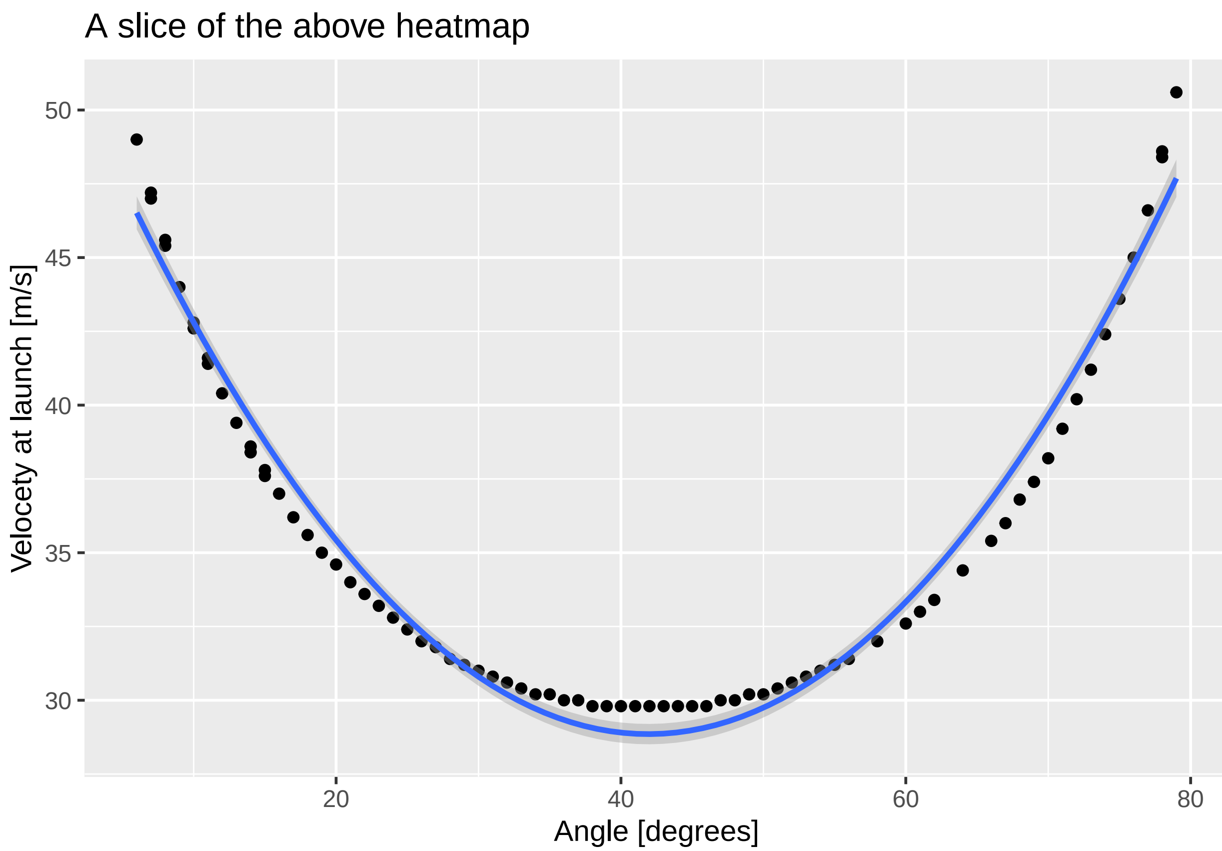
Why not try and plot it?



Now what can we do with this data?

Lets try to isolate a range of distances and with this range we can also try to use a regression

Here i got all the datapoints with a dist value between 99 and 100m



From that parabalae we find the fomula to be `f(x) = 0.01369*x²-1.14801*x+52.91235` with a r^2 value of 0.975, so quite a nice fit

My theroy is that we can calculate the top of the parabulae and find the optimal angle for all velocties when the height is 10

```
a <- 0.01369 # To get the point we are looking for we only need the a and b constants
b <- -1.14801

print((-1*b)/(2*a)) # -b/2a
```

```
## [1] 41.92878
```

So the optimal angle for the oblique throw when the height is 10m would be 41.93 degree