



Key terms

Euler Angles

Directional stability

Center of mass

Angular velocity

Angular momentum

Control motor gyroscopes

Error

1a

My accelerometer zeros at $0 \frac{m}{s^2}$ for all directions. However, I do see a $1g$ force in the z direction. This ~~is~~ is because ~~it is being~~ gravity is acting on the phone in the z direction.

Bset 0 playing with accelerometer data

```
In[1]:= SetDirectory[NotebookDirectory[]];  
Import["../General.m"];
```

2b pushing phone on table

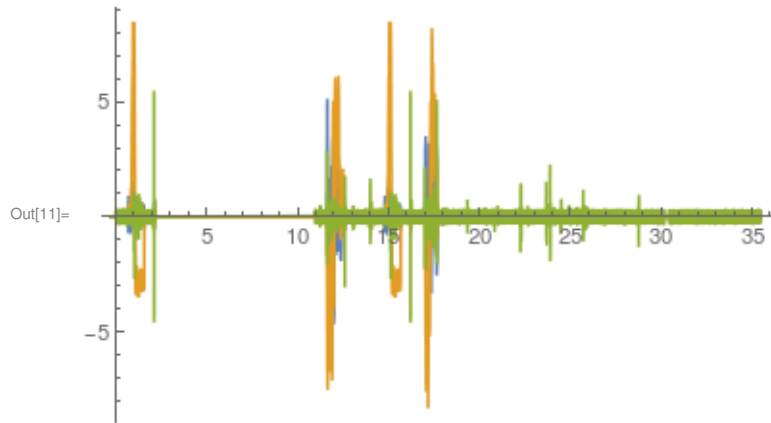
```
In[3]:= $2bRaw = Import["pushY.csv", "Data"];  
{"time", "x", "y", "z", "gforce"};  
  
In[5]:= $2bHeader = $2bRaw[[1]]  
$2bData = $2bRaw[[2 ;; Length[$2bRaw] - 2]];  
  
Out[5]= {time, x, y, z, gforce}
```

Data came with strange white space, so clean it up!

```
In[7]:= cleanData[x_] := Module[{}, If[Length[x] ≠ 4, {0, 0, 0, 0}, x]]  
  
In[8]:= $2bCleanData = Map[cleanData, $2bData];  
  
In[9]:= Dimensions[$2bData]  
Dimensions[$2bCleanData]  
  
Out[9]= {5290}  
  
Out[10]= {5290, 4}
```

Let's see what all three accelerations look like

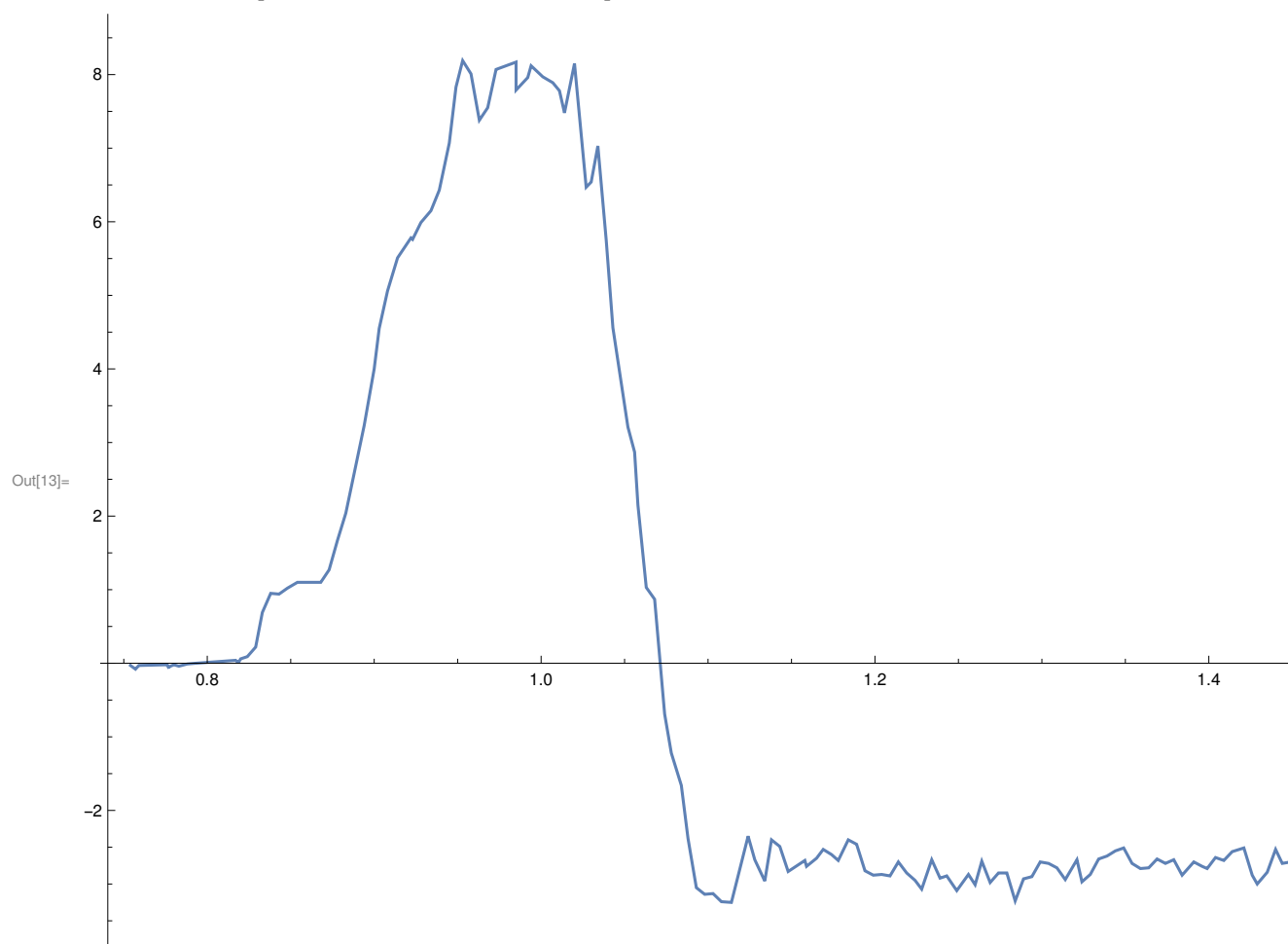
```
In[11]:= Rasterize@ListLinePlot[{$2bCleanData[[All, {1, 2}]],  
    $2bCleanData[[All, {1, 3}]], $2bCleanData[[All, {1, 4}]]}, PlotRange -> All]
```



Let's make a clear graph of just the push. We can see that the hand pushes the phone from .8 seconds to 1.07 seconds. After that, it decelerates at a constant rate

```
In[12]:= $2bPush = $2bCleanData[[All, {1, 3}]] [[150 ;; 325]];
```

In[13]:= **ListLinePlot**[\$2bPush, PlotRange -> Full]



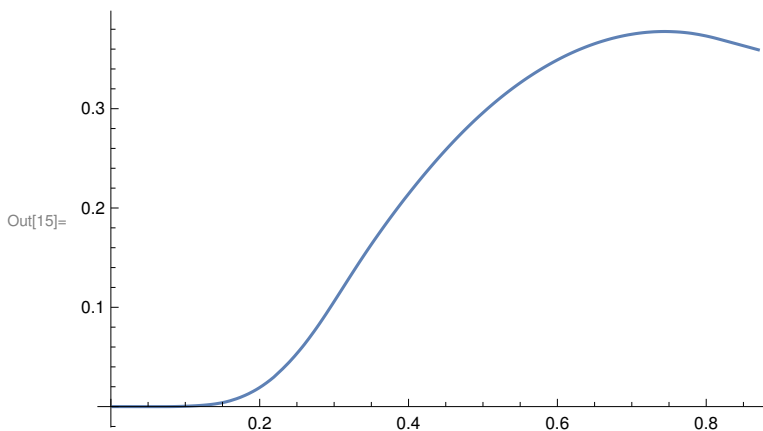
Now, we using our data, we can calculate the velocity at any point in time using the previous velocity, the acceleration, and the time step.

Position takes in a list containing tuples of times and accelerations. It returns a list of tuples containing times and positions. It should probably be separated into smaller functions at some point.

```
In[14]:= position[data_] := Module[{n, timesteps, deltaVelocity, velocityAtIndex,
    lengthTimesteps, deltaDistances, timeAtIndex, distanceAtIndex},
    n = Length[data];
    timesteps = data[[2 ;; n, 1]] - data[[1 ;; n - 1, 1]];
    deltaVelocity = data[[2 ;; n, 2]] * timesteps;
    lengthTimesteps = Length[timesteps];
    velocityAtIndex = Table[Total@deltaVelocity[[1 ;; i]], {i, lengthTimesteps}];
    deltaDistances = velocityAtIndex * timesteps;
    timeAtIndex = Table[Total@timesteps[[1 ;; i]], {i, lengthTimesteps}];
    distanceAtIndex = Table[Total@deltaDistances[[1 ;; i]], {i, lengthTimesteps}];
    Return[Transpose[{timeAtIndex, distanceAtIndex}]]
]
```

Plot of my position over time in a single direction. At the end, it looks like the phone has moved backwards. There could be a couple reasons for this. I think the phone was sensing accelerations in different directions as it slightly rotated. However, overall, the graph looks pretty good.

```
In[15]:= ListLinePlot[position[$2bPush]]
```



1a

```
In[16]:= $1aRaw = Import["walking.csv", "Data"];
{"time", "x", "y", "z", "gforce"};
```

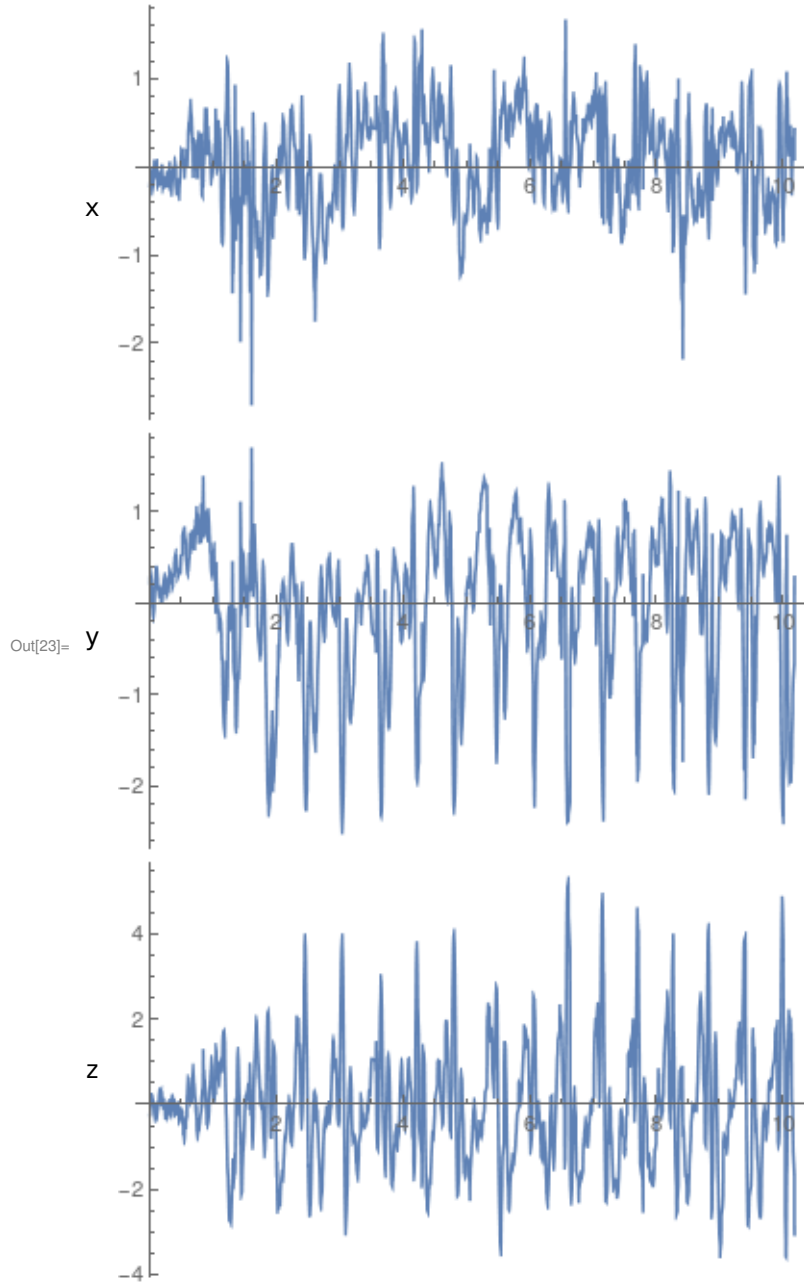
```
In[18]:= $1aHeader = $1aRaw[[1]]  
         $1aData = $1aRaw[[2 ;; Length[$1aRaw] - 2]];  
Out[18]= {time, x, y, z}
```

Data came with strange white space, so clean it up!

```
In[20]:= $1aCleanData = Map[cleanData, $1aData];  
  
In[21]:= Dimensions[$1aData]  
         Dimensions[$1aCleanData]  
Out[21]= {2030, 4}  
Out[22]= {2030, 4}
```


Let's see what all three accelerations look like

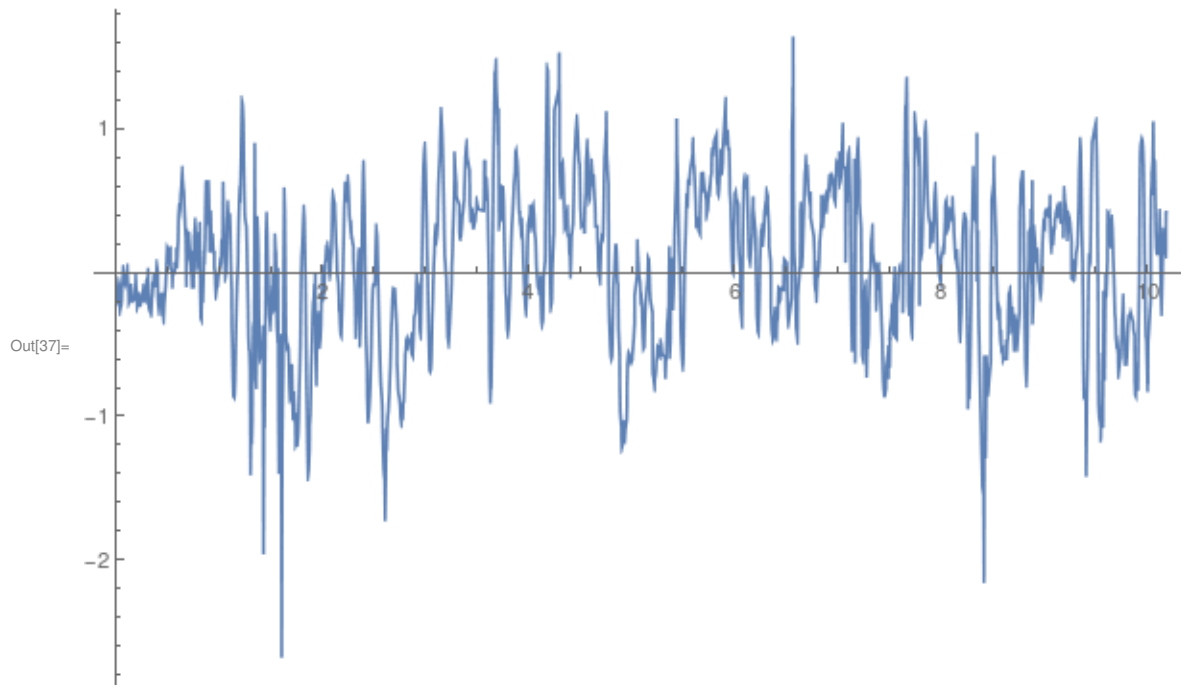
```
In[23]:= Grid[Transpose[{"x", "y", "z"}, Table[Rasterize@
  ListLinePlot[$1aCleanData[[All, {1, n}]], PlotRange -> All], {n, {2, 3, 4}}]]
```



Let's make a clear graph of the walk. We can see that the walk ends around 10 seconds. After that, it was corrupted from doing other commands on the phone.

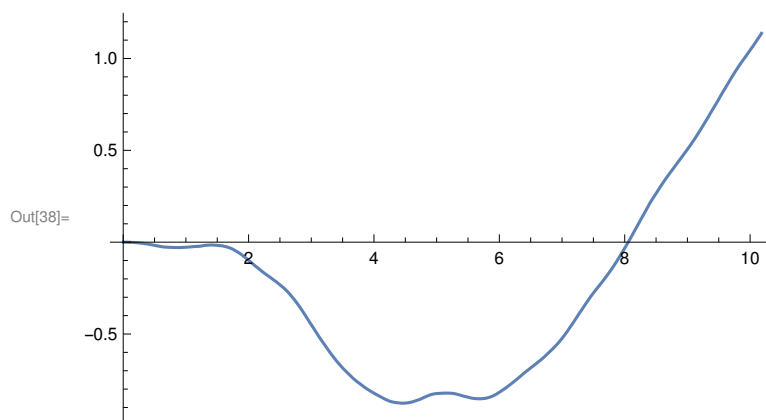
```
In[36]:= $1aWalk = $1aCleanData[[All, {1, 2}]];
```

```
In[37]:= Rasterize@ListLinePlot[$1aWalk, PlotRange -> Full, ImageSize -> Large]
```



Given that I walked about 10 meters, I think my calculations might be a bit off somewhere.

```
In[38]:= ListLinePlot@position[$1aWalk]
```



This bset was fun and interesting. I'm still not sure whether or not my

distance calculations were wrong because I wasn't understanding my data correctly, or if my phone wasn't giving out great data. It definitely seemed that my method of calculating position worked much better over a short period than a long period. I probably needed to use a high pass filter.

```
In[75]:= exportNotebookPDF [ ]
```