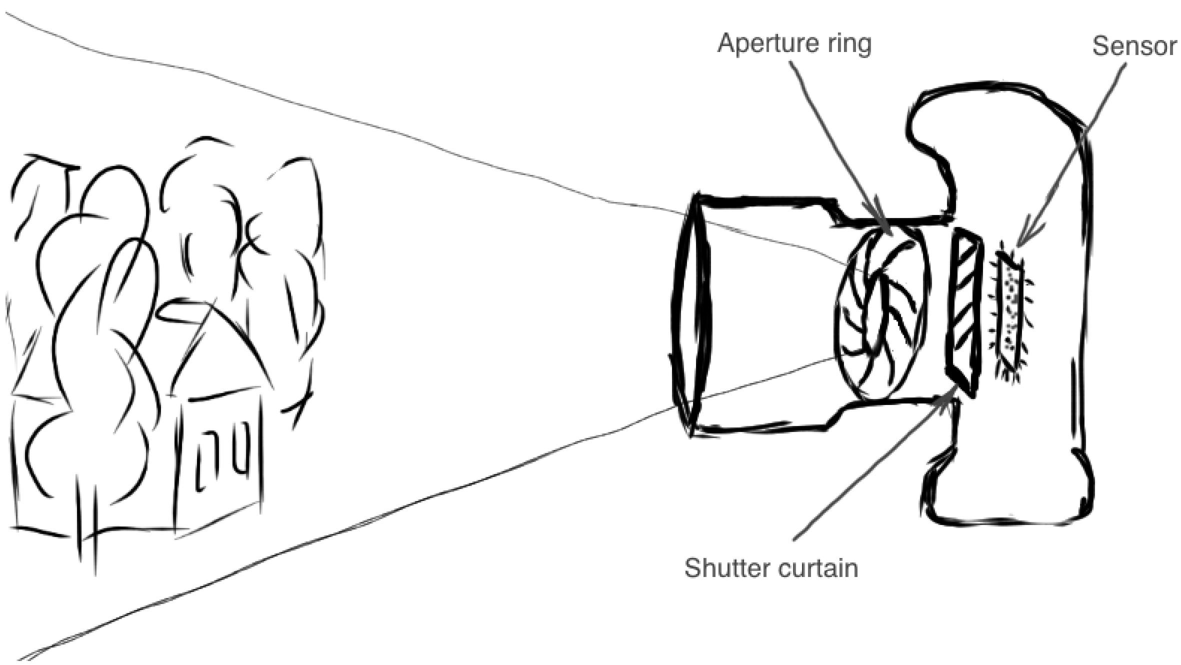
# LIGHT METER PROJECT

The light meter project seeks to address the issue of detecting the correct exposure settings while clicking a photograph from an SLR camera or any camera.

## Brief Description about Photography settings:

Photography is all about light. Photography is combination of science and art. It is all about the capturing what you see. In order to do that, you need to let the camera see what you wish. A camera is like a tool which helps you control how much light reaches the sensor. It does this by giving you access to aperture and shutter speed. To put it in simple words:

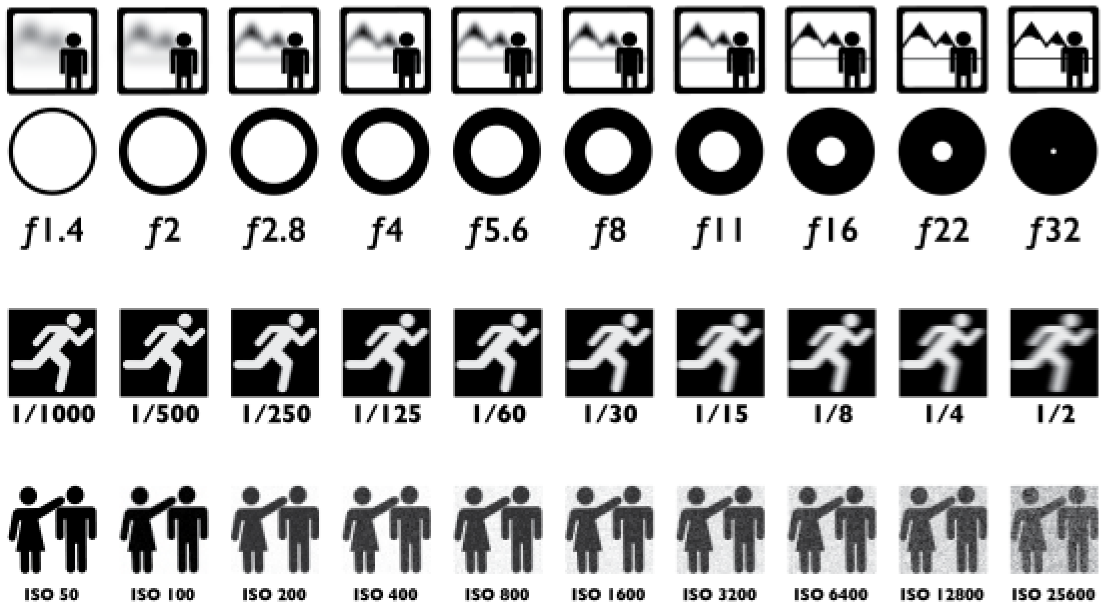
1) How large the hole is. The larger the hole, more you see – (Aperture a.k.a F-stop)
2) How long you look. The more you look the more details you notice (how fast/slow the shutter of sensor opens and closes thereby allowing the amount of light falling on the camera sensor)




Below is an image which gives the implications of F-stop and shutter speed.

ISO setting dictates the granularity of the image. For our project we assume ISO 100 for all values. Even in real life we don't change ISO settings as much we change the F-stop and shutter speed values.

# PHOTOGRAPHY SIMPLIFIED




**Shutter Speed**

8000
4000
2000
1000
500
250
125
60
30
15
8
4
2
1”
2”
4”
8”
15”
30”

**Aperture**

22
16
11
8
5.6
4.0

**ISO**

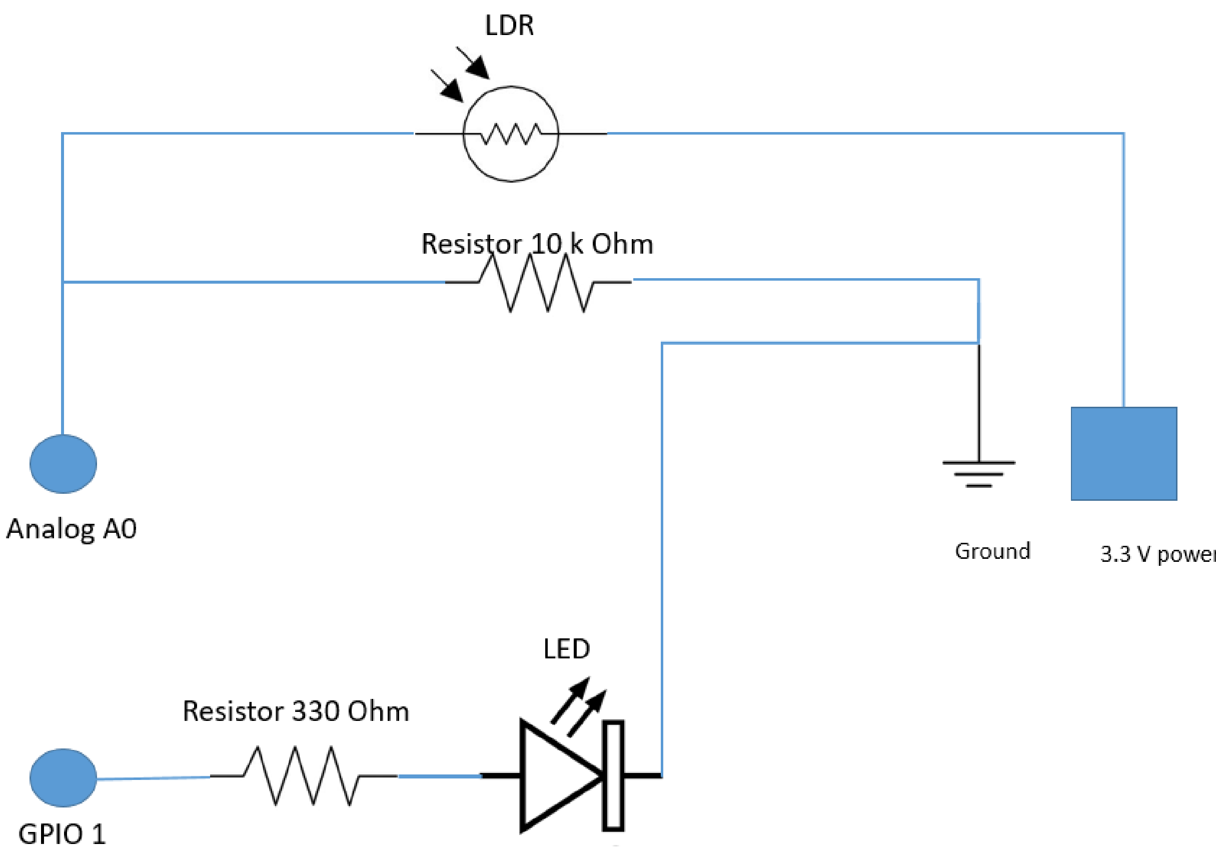
100
200
400
800
1600
3200
6400

**Freeze motion**

Components used:

- 1 BOLT IoT Module
- 1 LDR
- 1 LED
- 1 10k Ohm Resistor (for LDR)
- 1 330 ohm Resistor (for LED)
- 1 Power source – (power bank conventionally used for charging mobile phones)
- Connecting cable – Power bank to Bolt IoT device

Circuit Diagram:




There are 2 parts in this project:-

1) Controlling/Accessing the LDR through mobile phone
2) A machine learning model to predict the most preferred or suitable exposure settings

## Part 1: Accessing the LDR through mobile phone:

This involves a simple Javascript which is programmed to read the inputs from LDR sensor from Analog pin A0. This gives us the lux value.

We know from the equation Luminance $L = 2^{EV-3}$ ...........................Equation 1

Solving for EV (Exposure value) we get $EV = \log_2 L - 3$..................Equation 2

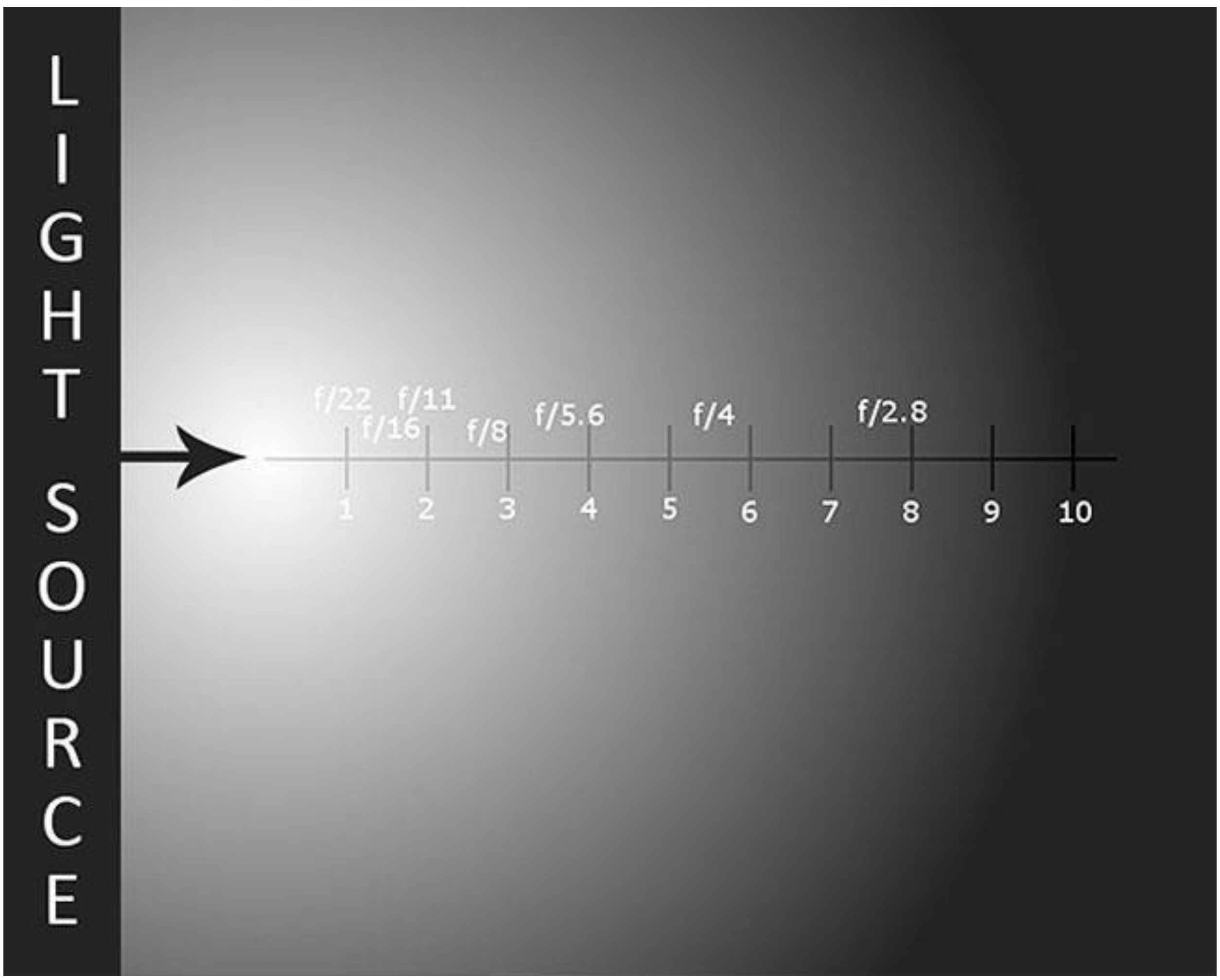
We also know that $\mathrm{EV} = \log_2(N^2 \div T)$.................................................Equation 3

Where N -> Aperture (F-Stop)

And T -> Shutter speed(in seconds)

From this relation we know for every value of EV we get a wide range of N and T. N depends on lens and the range is limited by the type of lens we use. Typically N will be in the range F 45 – F 1.

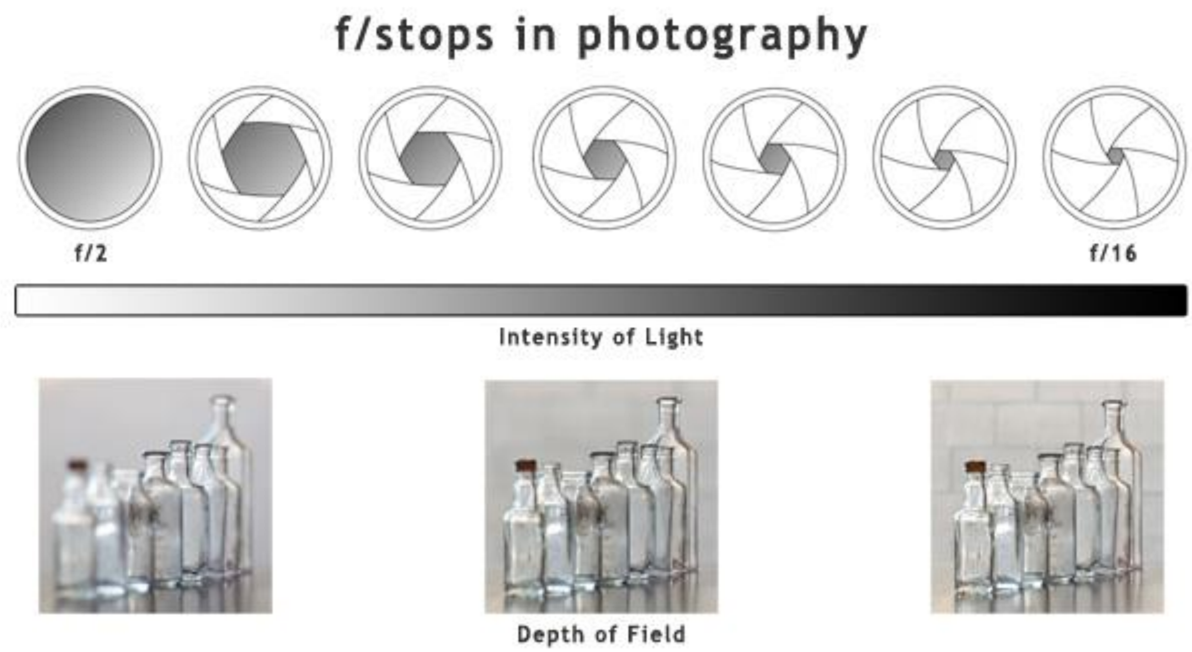
T depends on the camera speed to release the shutter. Typical speeds are 1/8000 of a second to 8 seconds.



From the image above we can infer that a high light intensity requires a higher F-stop number and low light intensity requires a lower F-stop number. So in the first part I am manually setting the F-stop values based on the intensity values. So with Lux value form senor(L) and mapping it to the F-stop values in the table we calculate the Shutter speed(T) We use equation 2 to first get the EV value and then use Equation 3 solving for T to get shutter speed(T)

## Part2: A machine learning model to predict the most preferred or suitable exposure settings

Light intensity alone does not define the F-stop value. F-stop is a far more critical value. By adjusting the F-stop we can capture the depth of the field. This is where the artistic nature of photography comes into play. In part 2 we intend to deploy a machine learning algorithm to be able to predict the right settings (Fstop, shutter speed and EV) from the light intensity values we read from the LDR sensor. Below image is as a reference to understand how depth/light intensity varies with Fstop:




### Algorithm Steps:

**Step 1** - create a dataset with probabilities assigned to each row which consists of values(Fstop, shutter speed and EV) (refer excel sheet “GuidedLightMeter.csv” to see the initial values). Here for the initial set I have assigned value of 1 to few settings which I feel is right for correct exposure.

**Step 2** – Identify the dependent and independent variables. Dependent variable is the probability which we seek to predict (Match column). Independent variables are F-stop and Shutter speed. EV is not considered in our independent variable as we can calculate it given F-stop and shutter speed and we want to avoid unnecessary bias from being introduced into the model

**Step 3** – We split the data set into training and test data set.

**Step 4** – We normalize or scale the values as F-stop and Shutter speed are measure in different units. For example a Shutter speed value of 1/125(0.008) will not impact the model significantly if taken as is as it is very low when compared to corresponding Fstop value of say 11(F-11)

**Step 5** – We use ***Random Forest classification*** algorithm to train the data set

**Step 6** – Confusion matrix to view the accuracy of the model:

Train dataset:

| | Predicted 0 | Predicted 1 |
|---|---|---|
| Actual 0 | 350 | 7 |
| Actual 1 | 13 | 42 |

Test dataset:

| | Predicted 0 | Predicted 1 |
|---|---|---|
| Actual 0 | 44 | 0 |
| Actual 1 | 1 | 1 |

Accuracy = (350 + 42)/(350 + 7 + 13 + 42) = 95%

**Step 7** – We now read a lux value from the sensor and using Equation 3 prepare a dataset of all possible values of F-stop(N) and Shutter speed(T) values. We can limit the F-stop values between F-22 – F-1 and Shutter speeds between 8 seconds – 0.004 seconds(1/250). Alternatively we can have this in a table prepared before hand (LightMeter.csv) and select the range based on EV values which in turn is calculated using Equation 2

**Step 8** – Using the dataset created from Step 7 we run the model to give the probability prediction and display those rows with the highest values which is our possible settings output.

```
Exposure Value =  6.0
luminence =  624.0

Possible settings are
    Fstop  ShutterSpeed  Exposure Compensation  Flash     Match
10    1.0      0.008000                   -0.6   -0.6  0.283333
21    1.4      0.016667                   -0.6   -0.6  0.000000
31    2.0      0.033333                   -0.6   -0.6  0.000000
47    4.0      0.250000                   -0.6   -0.6  0.217857
49    4.0      0.200000                   -0.6   -0.6  0.000000
55    5.6      0.250000                   -0.6   -0.6  0.461667
61    8.0      1.000000                   -0.6   -0.6  0.633333
66   11.0      1.000000                   -0.6   -0.6  0.006250
69   16.0      4.000000                   -0.6   -0.6  0.000000
72   22.0      4.000000                   -0.6   -0.6  0.000000
```

**Step 9** – From the probabilities given in the Match column we select the rows with the maximum probabilities.

```
Recomended settings is
    Fstop  ShutterSpeed  EV     Match  Exposure Compensation  Flash
61    8.0           1.0   6  0.633333                   -0.6   -0.6
```

Here we have got only a single row but there are cases where we get 2 to 3 rows as recommended settings output.

**Step 10** – The photographer is encouraged to feed in the recommended settings in the camera and click the picture. If the photographer feels there is a different setting which he has used to get the a better picture he can give the feedback and it will be saved in our dataset so that the next time the model is trained we can arrive at a better approximation of the camera settings. The row selected by the photographer is marked as 1(under the Match column) to remember the settings at the corresponding EV value. Other rows are marked as 0 which is like a punishment to the machine learning algorithm so that it will know better next time. ☺

```
Which one did you like : 47

 Thankyou for your feedback, we will save it for future reference

    Fstop  ShutterSpeed  EV  Match
10    1.0      0.008000   6      0
21    1.4      0.016667   6      0
31    2.0      0.033333   6      0
47    4.0      0.250000   6      1
49    4.0      0.200000   6      0
55    5.6      0.250000   6      0
61    8.0      1.000000   6      0
66   11.0      1.000000   6      0
69   16.0      4.000000   6      0
72   22.0      4.000000   6      0
```