



Ignite

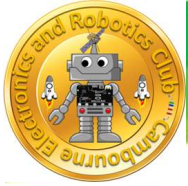
CERC Newsletter

JANUARY 2021

Shrobona
Founder

Sujit Bhattacharya
Mentor

Maya & Sreenidhi
Editors



Message from Mentor



At the onset, let me wish that the New Year 2021 bring a new dawn of hope, reassurance, cheer, compassion and prosperity to all of us. Happy New Year to you all.

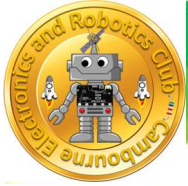
My personal commitment for the New Year remains to develop many problem and project based learning courses and workshops for the students in all age categories.

We have been pursuing the Project Based Learning (PBL) in all the activities and courses that we have initiated. PBL aims to develop independent learning and vocationally valuable skills along with deeper learning of curriculum content. Our major emphasis is on instructional techniques to move students progressively toward stronger understanding and ultimately greater independence in the learning process. I am confident that this Mentor-Led Self-Learning (MLSL) teaching pedagogy that I strongly advocate will benefit large number of students globally.

Motivated by the Maths for Python course, I wrote a program in Python with equations of circle, line, parabola, etc. to generate the following Christmas Greetings for the Young Scientist Challenge

Wishing Deeper Self-Learning for 2021.





Message from Editors

Happy New Year everyone!

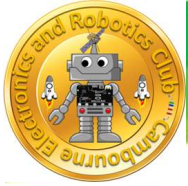
We would like to thank Sujit and Shrobona for giving us a chance to be editors and all the Young Scientists who contributed to this month's edition. We really enjoyed compiling this edition of the CERC magazine.

We would also like to encourage other children to take up the responsibility of being editors as it is really fun and a great opportunity for community service.

This edition includes a variety of articles based on STEM related topics.

Happy reading!





Message from Editorial board by Venkat Kommi



Nice to see different topics from 2nd edition of Ignite. Looking forward to see readers response like first edition of magazine.

Some of parents suggested once in a month Kids online quiz would welcome if more parents are interested.

One idea I would suggest and this could help more than their studies is online cooking channel by kids once in a month

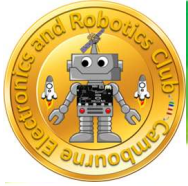
Readers please feel free to comment or suggest for the kids on their articles.

Ignite magazine is community based volunteered magazine, where a group of professionals, academics and young children are working together.

The articles are written by the children and are edited by their parents.

The editorial team is in charge of the publication of the magazine.

If you have any questions, suggestions, or concerns, please address them to vkommi@gmail.com



Use of Matrices in the real world by Vivek Kommi (12 years, Caxton, Uk)



Have you ever wondered how/where we use matrices in the real and digital world? In school, we learn about matrix addition and subtraction, but in real life, matrices are more important than we may think. Matrices open up wide areas of computing, maths, and many other subjects. Matrices are the building blocks for Quantum Computing, Image Processing/Manipulation, Forensic science, Machine Learning, and much more important and exponentially growing applications.

Matrices and vectors can predict the outcome of pandemics with the help of percentages and Markov Matrices. One great example of applications with Matrices is Google PageRank Algorithm. It ranks websites by checking their web-link and then gets a rough estimate of how good the website is, this also uses Markov Matrices.

Here are some relationships between matrices and vectors:

When you multiply a matrix by a vector you get a new vector out

M V Working Out V

$$\begin{pmatrix} 3 & -2 \\ -1 & 4 \end{pmatrix} \times \begin{pmatrix} 1 \\ 1 \end{pmatrix} = \begin{pmatrix} 3 + (-2) \\ -1 + 4 \end{pmatrix} = \begin{pmatrix} 1 \\ 3 \end{pmatrix}$$

M = Matrix
V = Vector

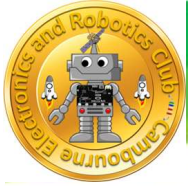
Let's represent this geometrically:

$$\begin{pmatrix} 3 & -2 \\ -1 & 4 \end{pmatrix} \times \begin{pmatrix} 1 \\ 1 \end{pmatrix} = \begin{pmatrix} 3 + (-2) \\ -1 + 4 \end{pmatrix} = \begin{pmatrix} 1 \\ 3 \end{pmatrix}$$

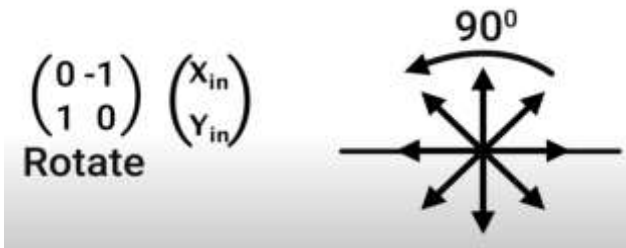
in out



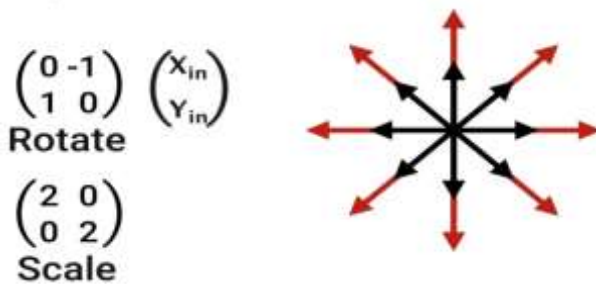
As you can see, this vector, when multiplied by a matrix, gets scaled and rotated.



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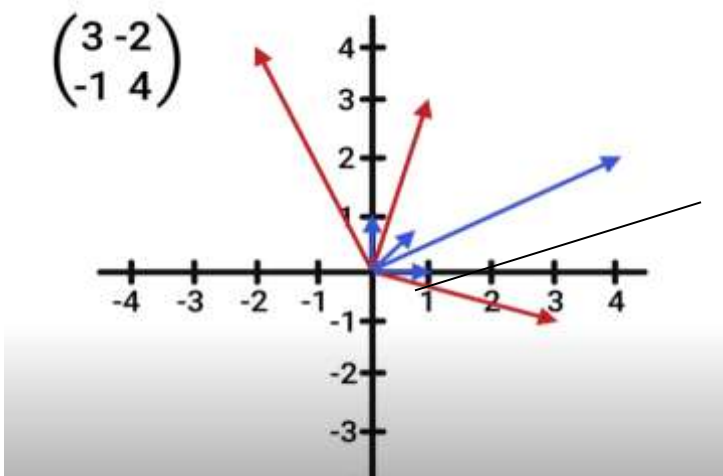


Another example is this matrix, this matrix only rotates the vector 90 degrees.



This one scales it to twice its length.

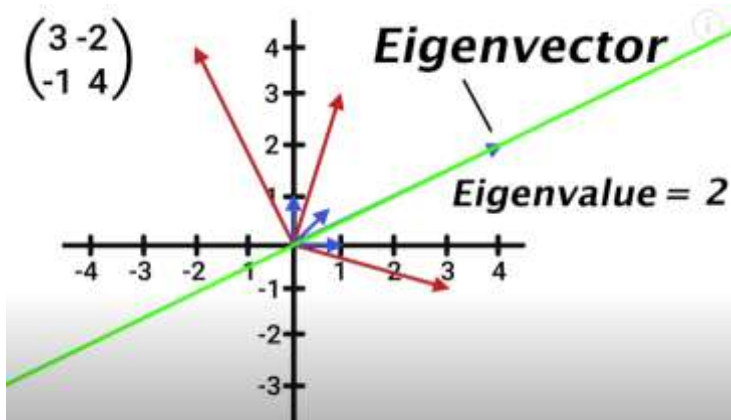
When applied to this matrix some of the vectors get scaled and rotated.



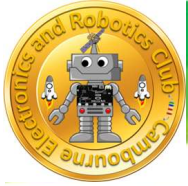
Red = vector x matrix

Blue = original vector

Take a look at this vector though, it only scales.



Any vector on this green line is called an eigenvector, the amount it scaled by is called the eigenvalue, in this case, the eigenvalue is 2.



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One Important rule is: If eigenvalues or eigenvectors are imaginary/complex, then any (non-zero) input vector will be rotated some amount

The inner product is an important operation on two vectors. It can be used to find the angle between two vectors.

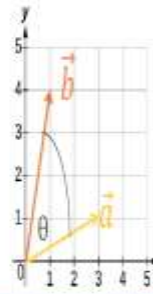
$$\langle \vec{v}, \vec{w} \rangle = \vec{v}^T \vec{w} = v_1 w_1 + \dots + v_n w_n = \sum_{i=1}^n v_i w_i$$

$$\vec{a} = \begin{pmatrix} 3 \\ 1 \end{pmatrix} \quad \vec{b} = \begin{pmatrix} 1 \\ 4 \end{pmatrix} \quad \langle \vec{a}, \vec{b} \rangle = \vec{a}^T \vec{b} = 3 * 1 + 1 * 4 = 12$$

$$\langle \vec{x}, \vec{y} \rangle = \|\vec{x}\| \|\vec{y}\| \cos(\theta)$$

$$\theta = \cos^{-1} \left(\frac{\langle \vec{x}, \vec{y} \rangle}{\|\vec{x}\| \|\vec{y}\|} \right)$$

$$\theta = \cos^{-1} \left(\frac{12}{\sqrt{10} \sqrt{17}} \right) = 0.402 \text{ radians}$$



You probably have heard of the Fibonacci sequence (A repetitive pattern when you add the previous two terms)

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233....

832 040 *next term?*

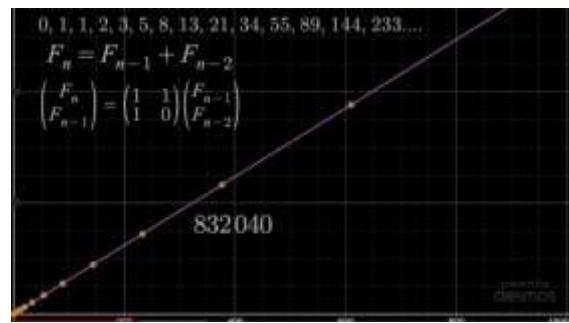
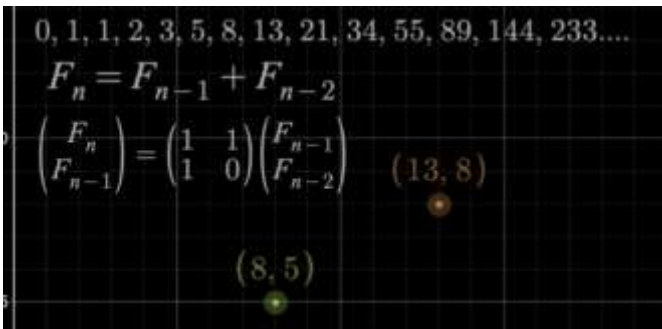
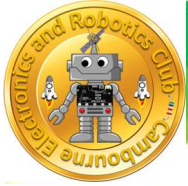
So if I asked you 'What is the next number in the sequence after this number' you would take a long time working this out. But there is a nice visual way of calculating this.

This is the inner product for the Fibonacci sequence.

$$F_n = F_{n-1} + F_{n-2}$$

$$\begin{pmatrix} F_n \\ F_{n-1} \end{pmatrix} = \begin{pmatrix} 1 & 1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} F_{n-1} \\ F_{n-2} \end{pmatrix}$$

As you can see below the vector (8, 5) multiply with the matrix (1 1/1 0) result vector (13, 8) is next in the Fibonacci sequence. This will happen for any point on the main line where eigenvectors sit.



All these are the Eigen vectors for the said transformation matrix

Eigenvectors and eigenvalues are the fundamentals of Quantum Computing and Machine Learning.

Matrices in the Pixelated world:

Digital images can be manipulated using matrices when broken into the smallest bits of information (pixels). The image below demonstrates binary pixel art, in which each box is being represented in the correlating matrix with either a "1" or a "0". A zero means the box contains nothing (would normally appear transparent or white), while a one indicates that the box is filled (in this case it is filled with black).

Notice that the ones form a heart as shown pixelated to the left.

Kernels are matrices that when you apply them to an image it can blur, sharpen, emboss, outline, or find edges.

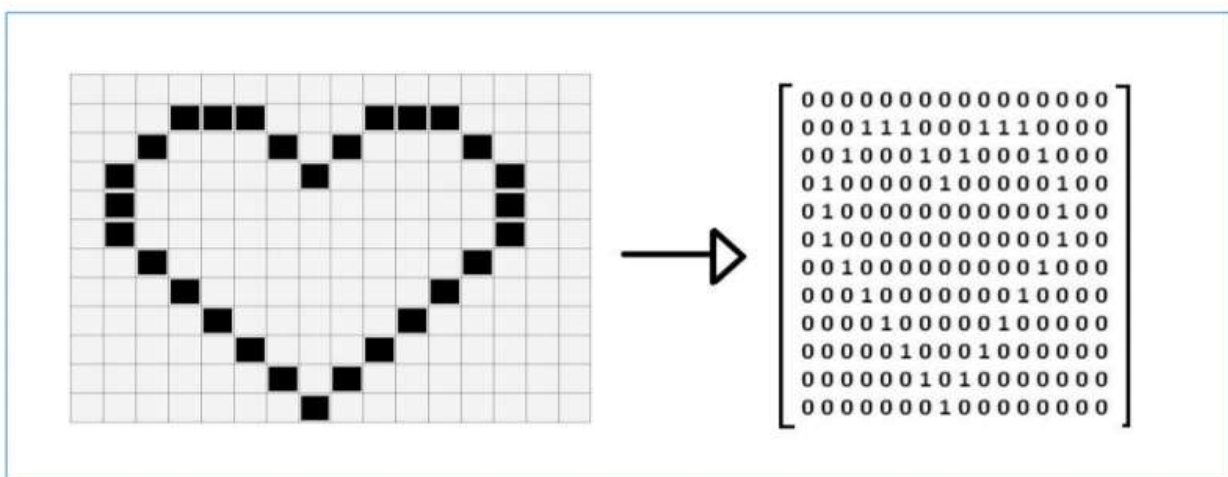
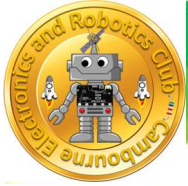


Figure 1: Binary pixel art

You can use python programming to test these kernels out on any images.



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I hope this article on Matrices has given some information about applications and uses of matrices in the real and pixelated world.

Many popular image processing effects are a result of kernel convolution. Here are some more examples of possible kernels:

ORIGINAL



SHARPEN



KERNEL:

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

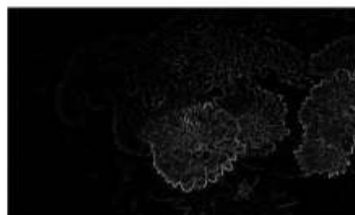
EMBOSS



KERNEL:

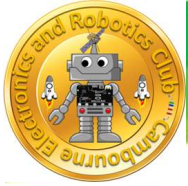
$$\begin{bmatrix} -2 & -1 & 0 \\ -1 & 1 & 1 \\ 0 & 1 & 2 \end{bmatrix}$$

OUTLINE



KERNEL:

$$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$



Influence of climate change on bird migration by *Rishika N Srivastava* (13 years Gandhinagar, India)



Climate change is happening at fast pace¹. Many things are being noticed. For example, global warming (Figure 1), pollution (Figure 2), over construction of buildings (Figure 3) etc. Many bird species are not able to accommodate these climatic shifts. This may result in decline or extinction of some bird species.



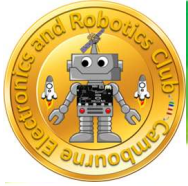
Figure

1 Global warming causes migration of Penguin²

Figure 2 Pollution affect birds³



Figure 3 Collision of birds with buildings and other urban structures⁴



Effect on stop-overs

There are certain areas used by birds as stop-overs. They depend on these areas for food and nesting. Here, they take rest also. For instance, birds use coastal wet land areas (Figure 4). It is like refueling for long distance. Without such places, it would be difficult for birds to reach to their destinations. Many of such stop-overs are about to disappear due to climate change. Climate change has caused desertification (Figure 5), flooding and temperature change in many areas. Over the years, sea-level has risen¹. This has resulted in flooding of many stop-overs. Decrease in rainfall has caused desertification and land degradation. Now, deserts are expanding. Example is Sahara Desert. Air dryness has increased. Birds cannot take rest in such areas. These areas may behave as ecological barrier. Birds may get perished due to expansion of such areas¹.



Figure 4 Shrinking wetlands affect migratory birds

Figure 5 Desert expansion influences bird migration⁶

Change in migration route

Due to climate change birds are forced to change their path. In many cases, journeys do not happen at all. In some regions, like North Africa, France and Spain, during winter season, some bird species are not seen now. Now, they can be seen in England. They breed there. Earlier, Cranes used to go to Portugal and Spain. But now, they stay in Germany. Along with them, Starlings may also be seen. During harsh winter, many birds may survive due to cold. In some cases, at these stop-overs, food used by migratory birds is consumed by local birds. Breeding spaces are also occupied by local birds. So, due to changed climatic condition, competition for resources and space has increased. In some regions, due to increase in temperature, there is early spring. This result in early insect hatching and blooming of vegetation. This happens before the hatching of young birds. Due to this, food provided to offspring is not sufficient. Migration route of ducks in Europe is shown in Figure 6

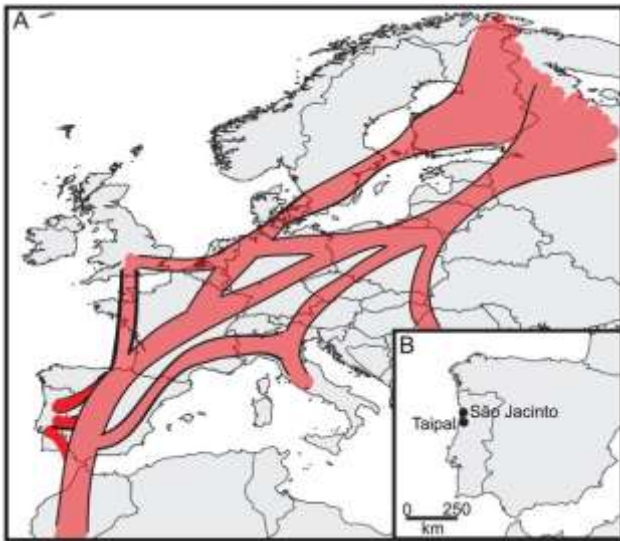
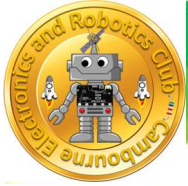


Figure 6 Migration route of ducks in Europe⁷

Climate change, Earth's magnetic field and bird's navigation

Attempts have been made to correlate magnetic variation with climate change⁸. For bird migration, earth's magnetic field is very useful. Birds are able to see the magnetic field of earth. It facilitates their navigation through various regions. There is a protein in a bird's eye. This protein is cry4. Blue light can be sensed by this protein. Magnetic field may also be detected by this protein. This ability is termed as magnetoreception⁹.

References

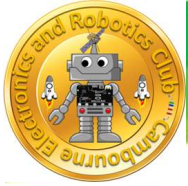
<https://tinyurl.com/yawyzwut>

<https://www.vecteezy.com/vector-art/1349330>

<https://www.allaboutbirds.org/news/the-sky-above-its-not-just-air-its-habitat/>

<https://urbanmigrators.wordpress.com/2014/07/04/loss-of-wetlands/>

<https://www.sciencedirect.com/science/article/abs/pii/S0012821X06007667>



Rocket Adventure *by Leo (9 years, Cambourne)*



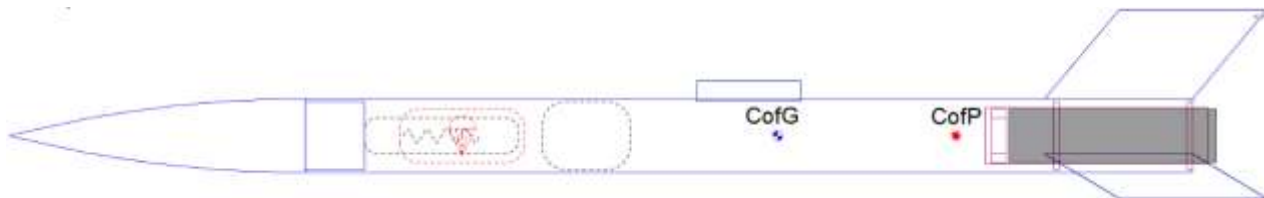
I've been learning all about NASA's Artemis project and the SLS spacecraft with the moon gateway. Also simulating rocket designs and launching them into space (virtually - you can find it on Google Play for free: 'Spaceflight Simulator'). Astronauts of the future will use the Orion rocket to visit other planets such as Mars.

Here is some information on Artemis and SLS:

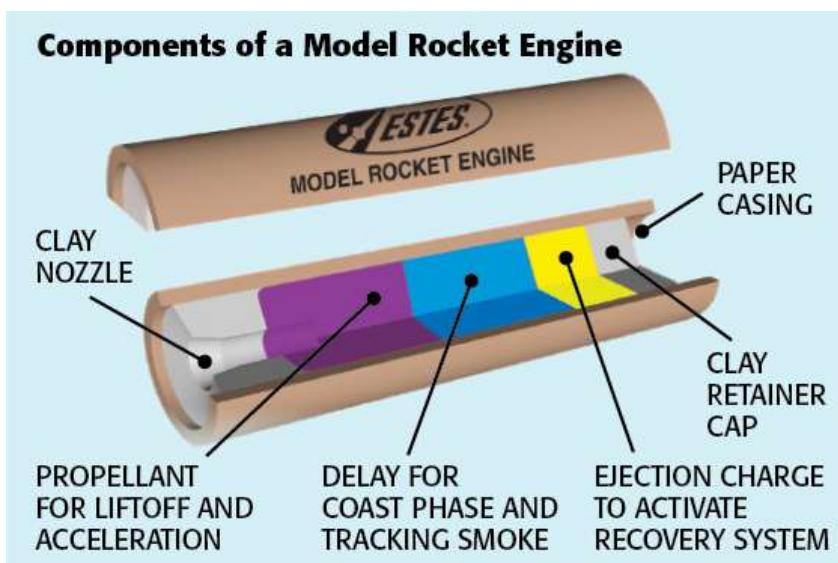
<https://youtu.be/T8cn2j13-4>

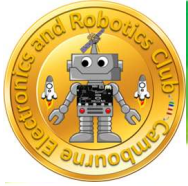
I got more interested in rockets and how they work. I built a model rocket with dad, which is powered by solid fuel engines.

For a rocket to fly properly, it must be balanced correctly. The Centre of Gravity (the balance point) must be in front of the Centre of Pressure (the point on the rocket where the area looking at the side of the rocket is the same, both sides of it). This makes sure the rocket flies correctly, because the fins at the back catch the airflow and keep it stable, like a dart. If the Centre of Pressure is in front of the Centre of Gravity, the rocket is unstable and will crash.



The engine is very similar to a firework, it contains solid rocket fuel.





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With a model rocket you start the motor with an electric 'fuse' which is pushed up into the motor. A battery is connected to make a thin piece of wire very hot and it burns like a fuse, so that it lights the engine. When the engine is lit, it burns quickly, and a lot of thrust is produced through the clay nozzle which launches the rocket into the sky!

When the rocket has reached the top of its flight (the apogee), a parachute is released by popping the nose cone off with the engine ejection charge (the parachute is protected from the heat by 'wadding'). Then the rocket floats safely to the ground with the parachute.



Ready to launch

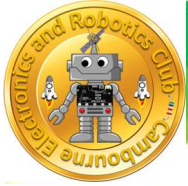


Lift Off!

The rocket is about 41 cm long

You can see a video of the actual launch here, by clicking on the YouTube link below:

<https://youtu.be/r8Qmo4xzmGE>



Rover down the line *by Manan Kakkar(9 Years , Cambridge UK)*



I received a Kitronik Rover for Christmas. I wrote several programs using it like making it a police car, sensing the obstructions and avoiding collision and line tracking which I found to be most challenging. The rover has a left sensor and a right sensor. When the colour of the two sensors are different, that means you are going off the line. Then switch one side of the motor off so that the rover turns back in the correct direction. It took me 3 trials to get the program working. When the sensor difference was 10, it didn't detect the line so I had to reduce it to 5.

Outcome

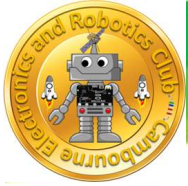
The program worked as you can see in the video. One of the challenges was that the line on the carpet was changing in width. So when the rover was turning on a wide section, it was sometimes becoming perpendicular to the line and then the program did not work. I could not find a way to control how much the rover turns.

You can watch in action from below link

https://drive.google.com/file/d/1bkyluilUcL-EK_hl1EuslyE079mcBN8X/view

My Introduction

When I joined CERC 1 year ago I knew nothing about micro bits and also found it a bit boring, but when I moved into the intermediate batch it started getting fun. I learned about extensions and that I could clap and turn the light off with pins and the if function. I also did programs with my kitronik rover. My favourite one was my line tracker. I also made a police car that did not follow people but whenever it came to a wall it turned so it did not crash. It had sirens but they were so quiet you could not hear them while the motor was running and the wheels kept falling off.



Message from Founder



Happy New Year to everyone.

Children have experienced an unprecedented year in 2020 which is still going on.

I strongly believe that we do have a community duty for education and other areas too.

We, adults can keep our children motivated, informed, and educated as we are passing through a global pandemic.

We must keep the children creative and joyful by various activities that we can. Parents, teachers, community all have equal role to play for the development.

Not every child is backed up by scientific or academic motivation at

home, we are ready to help through various platforms that we have created since CERC days

Announcement:

Please submit your articles for February magazine using this template before 31st January

CERC Ignite Team is looking Young volunteers with Knowledge of Editing/Presentation Skills, HTML, Web Authoring tools