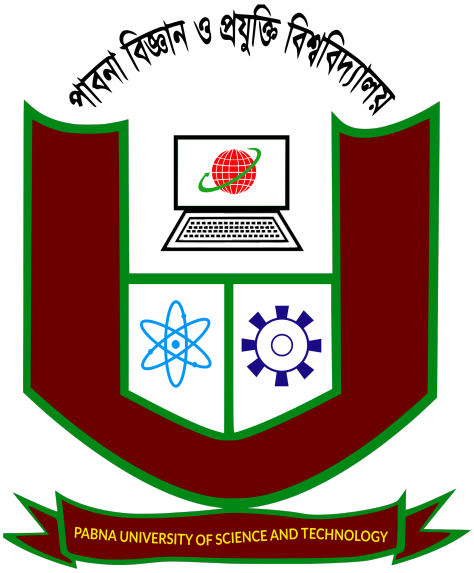
Improvement of Vicsek Model And Related Terms

Masters of Science

in

Pure Mathematics



By

Md. Abde Mannaf

Roll No.140358

Session 2017-18

June 2, 2022

Department of Mathematics

Pabna University Of Science and Technology

Pabna, Bangladesh

Improvement of Vicsek Model And Related Terms

A thesis submitted for the award of degree of

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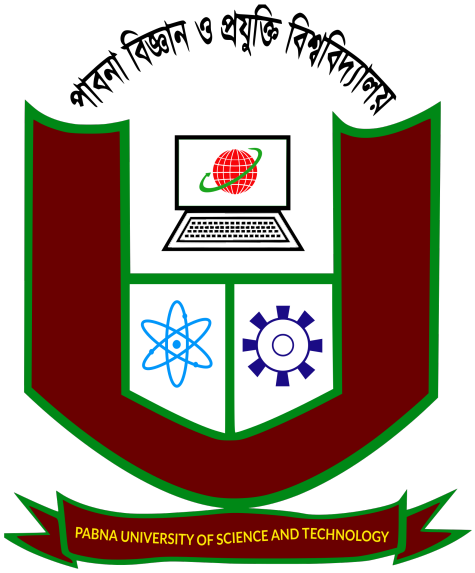

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Certificate

This is to certify that the work embodied in this thesis entitled **"Improvement of Vicsek Model And Related Terms"** has been carried out by **Md. Abde Mannaf S/O. Nur Mohammad, Roll No.(140358), Session 2017-2018** at Department of Mathematics, Pabna University of Science And Technology, Rajapur, Pabna, Bangladesh, under my supervision in partial fulfillment of the requirement for the award of the degree of Master of Science (M.S.) in Pure Mathematics.

The matter embodied in this thesis is original and has not been submitted for the award of any other degree.

Research Supervisor	Director
Supervisor Name	Director Name
Dr. Udoy Sankar Basak	**Dr. Udoy Sankar Basak**
	Prof. Sulimon Sattari

Dedication

This thesis is dedicated to

Abstract

Start from here....

Acknowledgment

In the Name of Allah, the Beneficent, the Merciful

Start from here....

May Allah bless you all!

Md. Abde Mannaf

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1.2 Joint Entropy and Conditional Entropy

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1.2.1 Write Here Your Second Subsection Heading

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1.3 Relative Entropy and Mutual Information

To add any Equation in document following environment needed.

$$\textbf{Lattice Constant} = \frac{\lambda}{2\sin\theta}\sqrt{h^2+k^2+l^2} \tag{1.1}$$

We can label any equation or figure using the command of

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\label{eq 1.1}
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Similarly, we can refer any equation, figure, and figure using the command of

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\ref{eq 1.1}
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1.4 Inserting Image

To insert any image in the document follow the following environment.

Figure 1.1: Punjab University Logo

1.5 Table Formation

Table 1.1: Caption of the Table

First Entry	Second Entry	Third Entry
item 11	item 12	item 13
item 21	item 22	item 23

1.6 Relationship Between Entropy and Mutual Information

1.7 Relationship Between Entropy and Mutual Information

1.8 Citation Example

Here some references are cited in APA style. Vellacheri et al., 2014 and Asaithambi et al., 2021

Chapter 2

Basic information theory

Information theory is an area of mathematics that has applications in biology, medicine, sociology, and psychology, medical science, etc.Using the probability and statistics we can measure the information flow.

2.1 Entropy

Now we want to introduce the concept of Shannon entropy or simply say that entropy, which is a measure of the uncertainty of a random variable. Let X be a random variable

Definition 2.1.1 (Entropy)**.** The entropy $H(X)$ of a discrete random variable X is defined b

Higher entropy →Higher Uncertainty
Higher Entropy → More Amount of information
Measure information in Terms of Uncertainty
Uniform Distribution Entropy Will be maximum

2.1.1 Write Here Your First Subsection Heading

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Chapter 3

Write Your Third Chapter's Name

Chapter summary

3.1 Entropy

Description about Entropy

3.1.1 Definition

Entropy measure the uncertainty .....

Problem 01

Let X and Y be to random variable. Then the time series of two random variable are:

$$X = [\ 1\ 2\ 1\ 0\ 1\ 0\ 0\ 1\ ]$$

$$Y = [\ 2\ 2\ 3\ 1\ 1\ 2\ 1\ 0\ ]$$

Find the Entropy, Join Entropy, Conditional Entropy, Mutual Information etc.

Solution

We know that,

$$H(X) = -\sum_{x \in X} p(X = x) log_2 p(X = x)$$
$$P_x(0) = \frac{3}{8} \qquad P_x(1) = \frac{3}{8} \qquad P_x(2) = \frac{3}{8}$$

we know that,

$$\begin{aligned} H(X) &= -\sum_{x \in X} p(X = x) log_2 p(X = x) \\ &= P(0) \cdot \log_2(P(0)) + P(1) \cdot \log_2(P(1)) + P(2) \cdot \log_2(P(2)) \\ &= \frac{3}{8} \cdot \log_2(\frac{3}{8}) + \frac{1}{2} \cdot \log_2(\frac{1}{2}) + \frac{1}{8} \cdot \log_2(\frac{1}{8}) \end{aligned}$$

Entropy for Y

$$Y = [\ 2\ 2\ 3\ 1\ 1\ 2\ 1\ 0\ ]$$
$$P(0) = \frac{1}{8} \qquad P(1) = \frac{1}{8}$$
$$P(2) = \frac{3}{8} \qquad P(3) = \frac{1}{8}$$

$$\begin{aligned} H(Y) &= -\sum_{y \in y} p(Y = y) log_2 p(Y = y) \\ &= P(0) \cdot \log_2(P(0)) + P(1) \cdot \log_2(P(1)) + P(2) \cdot \log_2(P(2)) + P(3) \cdot \log_2(P(3)) \\ &= \frac{1}{8} \cdot \log_2(\frac{1}{8}) + \frac{3}{8} \cdot \log_2(\frac{3}{8}) + \frac{3}{8} \cdot \log_2(\frac{3}{8}) + \frac{1}{8} \cdot \log_2(\frac{1}{8}) \end{aligned}$$

3.1.2 Write Here Your First Subsection Heading

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3.2 Joint Entropy

Description .....

3.2.1 Definition

Text in the

X \ Y	0	1	2	3
0	0	$\frac{1}{8}$	$\frac{1}{8}$	0
1	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$
2	0	0	$\frac{1}{8}$	0

Table 3.1: Join Entropy

$$H(X,Y) = -\sum_{x\in X, y\in Y} p(X=x, Y=y)\cdot log_2 p(X=x, Y=y)$$

$$P(0,0)=0, \quad P(0,1)=\frac{1}{8}, \quad P(0,2)=\frac{1}{8}, \quad P(0,3)=0$$
$$P(1,0)=\frac{1}{8}, \quad P(1,1)=\frac{1}{8}, \quad P(1,2)=\frac{1}{8}, \quad P(1,3)=\frac{1}{8}$$
$$P(2,0)=0, \quad P(2,1)=0, \quad P(2,2)=\frac{1}{8}, \quad P(2,3)=0$$

$$\begin{aligned} H(X,Y) &= -\sum_{x\in X, y\in Y} p(X=x, Y=y)\cdot log_2 p(X=x, Y=y) \\ &= p(0,0)log_2p(0,0) + p(0,1)log_2p(0,1) + p(0,2)log_2p(0,2) + p(0,3)log_2p(0,3) + \\ &\quad p(1,0)log_2p(1,0) + p(1,1)log_2p(1,1) + p(1,2)log_2p(1,2) + p(1,3)log_2p(1,3) + \\ &\quad p(2,0)log_2p(2,0) + p(2,1)log_2p(2,1) + p(2,2)log_2p(2,2) + p(2,3)log_2p(2,3) \\ &= 0 + \frac{2}{8} + \frac{1}{8} + 0 + \frac{1}{8} + \frac{1}{8} + \frac{1}{8} + \frac{1}{8} + 0 + 0 + \frac{1}{8} + +0 \\ &= \end{aligned}$$

Chapter 4

Write Your Fourth Chapter's Name

4.1 Write Here Your First Section Heading

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4.2.1 Write Here Your Second Subsection Heading

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Chapter 5

Write Your Fifth Chapter's Name

5.1 Write Here Your First Section Heading

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5.2.1 Write Here Your Second Subsection Heading

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References

Asaithambi, S., Sakthivel, P., Karuppaiah, M., Balamurugan, K., Yuvakkumar, R., Thambidurai, M., & Ravi, G. (2021). "Synthesis And Characterization of Various Transition Metals Doped SnO_2@ MoS_2 Composites for Supercapacitor and Photocatalytic Applications". *Journal of Alloys and Compounds*, *853*, 157060.

Vellacheri, R., Al-Haddad, A., Zhao, H., Wang, W., Wang, C., & Lei, Y. (2014). "High Performance Supercapacitor for Efficient Energy Storage Under Extreme Environmental Temperature". *Nano Energy*, *8*, 231–237.

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