Number 111

Professorial
Inaugural Lecture Series

UTM
UNIVERSITI TEKNOLOGI MALAYSIA

The Journey of DNA Splicing System - from Biology, to Computer Science, to Mathematics

Professor Dr. Nor Haniza Sarmin

24th August 2022 (Wednesday) | 2.30 pm

Dewan Senat Ainuddin Wahid

facebook LIVE https://www.facebook.com/FakultiSainsUTM/

All are invited

The Journey of DNA Splicing System – from Biology, to Computer, to Mathematics

PROFESSIONAL INAUGURAL LECTURE SERIES NUMBER 111

24th August 2022

Organized by
Universiti Teknologi Malaysia

PROF. DR. NOR HANIZA SARMIN
Department of Mathematical Sciences, Faculty of Science,
Universiti Teknologi Malaysia
nhs@utm.my

innovative • entrepreneurial • global

ABSTRACT

The mathematical modelling of DNA splicing system has first been introduced in 1987 which is simulated by the technique of recombinant DNA molecules that relies on restriction enzymes in the study of formal language theory. In this lecture, the research in DNA Splicing System which involves multidisciplinary areas will be illustrated. This is done by sharing the journey of splicing systems in Malaysia, particularly in Universiti Teknologi Malaysia. Lastly, the modelling of the DNA splicing system using graph theory will be presented.

THE MAP OF MATHEMATICS

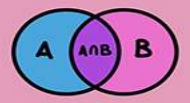
FOUNDATIONS

FUNDAMENTAL RULES

MATHEMATICAL LOGIC

$p \Rightarrow q$

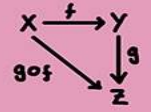
SET THEORY



CONSISTENT SET OF AXIOMS?

GÖDEL INCOMPLETENESS THEOREMS

NOPE



CATEGORY THEORY

THEORY OF COMPUTATION

$P \neq NP$?

COMPLEXITY THEORY

CARDINAL NUMBERS

$\aleph_0$ ALEPH NULL

OCTONION

$\{e_0, e_1, e_2, e_3, e_4, e_5, e_6, e_7\}$

QUATERNION

$a+bi+cj+dk$

PI

π

EXPONENTIAL

e

COMPLEX NUMBERS

$3,\ i,\ 4+3i,\ -4i$

PRIME NUMBERS

3, 11, 47, 907

INFINITY

∞

NUMBER THEORY

REAL NUMBERS

$-4\pi, \sqrt{2}^1, e$

RATIONAL NUMBERS

$-7, \frac{1}{2}, 2.32$

INTEGERS

...-2, -1, 0, 1, 2...

NATURAL NUMBERS

1, 2, 3, 4, 5...

ARITHMETIC

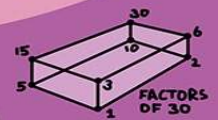
$+ - \times \div$

COMBINATORICS

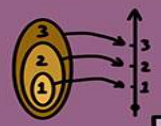
PARTITION THEORY

TREE

GRAPH THEORY



ORDER THEORY



MEASURE THEORY

GROUP THEORY

PERMUTATION GROUP

LINEAR ALGEBRA

$\begin{pmatrix} & \\ & \end{pmatrix} \cdot \begin{pmatrix} & \\ & \end{pmatrix} = \begin{pmatrix} & \\ & \end{pmatrix}$

MATRICES

$\begin{pmatrix} 6 & 7 \\ -3 & 2i \end{pmatrix}$

ALGEBRA

$x^2-4x-8=5x+28$

$x^2-9x-36=0$

$(x+3)(x-12)=0$

EQUATION

$y=mx+c$

VECTORS

$\vec{x}$

NUMBER SYSTEMS

STRUCTURES

PURE MATHEMATICS

SPACES

CHANGES

ORIGINS

PERSIA c.820

ALGEBRA

INDIA c.628

FIRST ZERO 0

c.1730 MATHEMATICAL NOTATION

$e^{i\pi}=-1$

COUNTING

NEGATIVE NUMBERS

$-8\ \pi$

CHINA 200 BCE

50,000 BCE

EGYPT FIRST EQUATION 3000 BCE

GREECE 600-300 BCE

MÖBIUS STRIP

TOPOLOGY

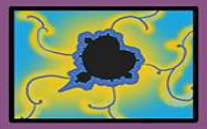
1 HOLE (GENUS 1)

DIFFERENTIAL GEOMETRY

COMPLEX ANALYSIS

FRACTAL GEOMETRY

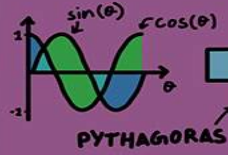
MANDELBROT SET



DYNAMICAL SYSTEMS

FLUID FLOW

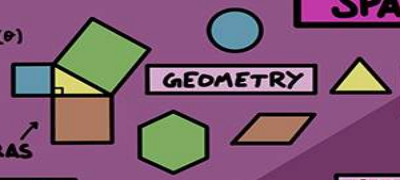
ECOSYSTEMS



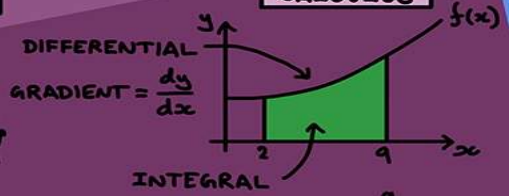
PYTHAGORAS

TRIGONOMETRY

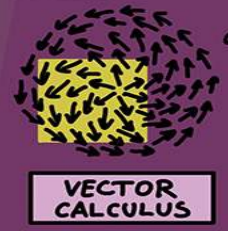
GEOMETRY



CALCULUS



DIFFERENTIAL EQUATIONS



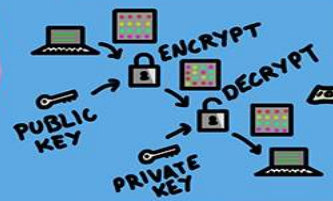
VECTOR CALCULUS

BUTTERFLY EFFECT

CHAOS THEORY

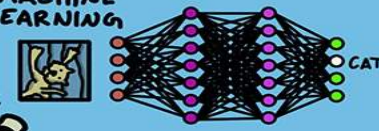
APPLIED MATHEMATICS

CRYPTOGRAPHY



COMPUTER SCIENCE

MACHINE LEARNING



PROBABILITY

BAYES' RULE

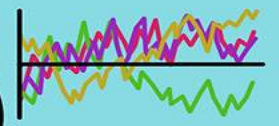
$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$

STATISTICS

```
while awake:
    do_science()
    if self.tired():
        awake = False
self.repair_brain()
```

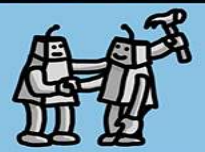
OPTIMIZATION

MATHEMATICAL FINANCE

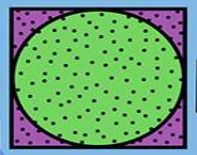


ECONOMICS

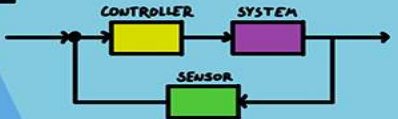
GAME THEORY



NUMERICAL ANALYSIS

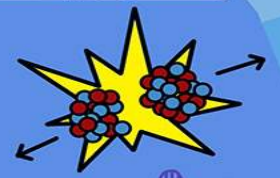


ENGINEERING



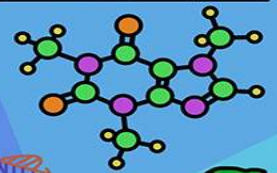
CONTROL THEORY

MATHEMATICAL PHYSICS

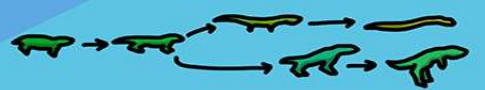


THEORETICAL PHYSICS

MATHEMATICAL CHEMISTRY



BIOMATHEMATICS



YOUTUBE: THE MAP OF MATHEMATICS

ARITHMETIC

× ÷

$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$

AR ALGEBRA

NUMBER SYSTEMS

PERSIA c.820

ALGEBRA

c.1730 MATHEMATICAL NOTATION

INDIA c.628

FIRST ZERO 0

$e^{i\pi} = -1$

COUNTING

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EQUATION

$y=mx+c$

NEGATIVE NUMBERS

-8 π

CHINA 200 BCE

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GAME THEORY

STRUCTURES

SPACES

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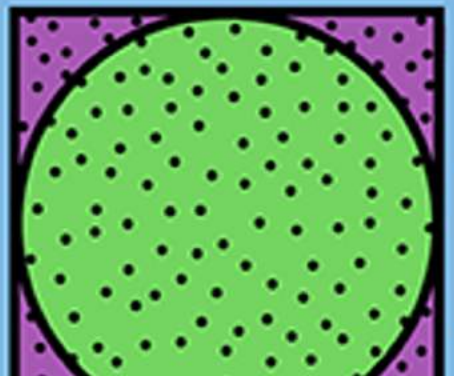
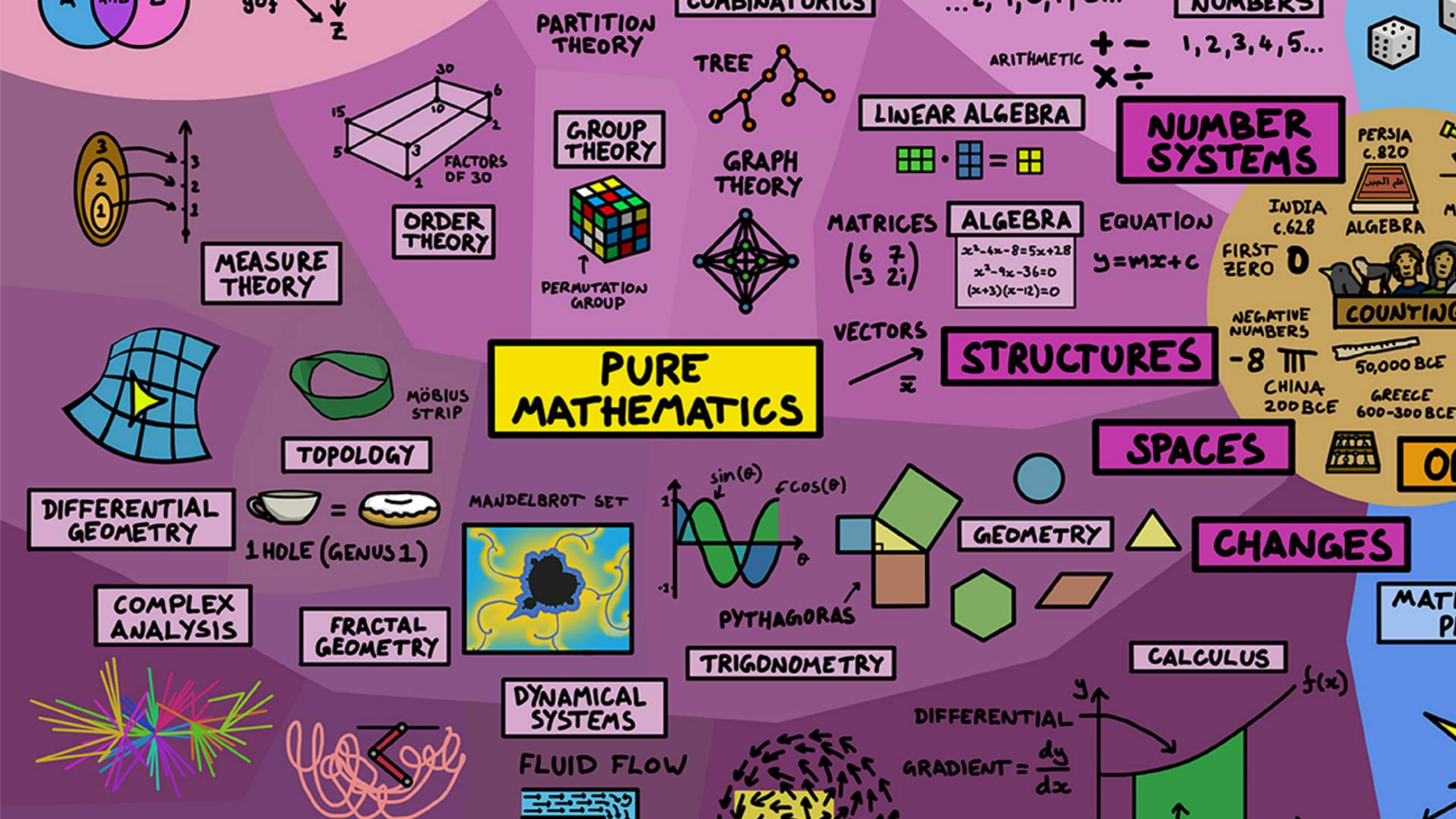
GEOMETRY

CHANGES



NUMER ANALY


PARTITION THEORY
COMBINATORICS
NUMBERS
1, 2, 3, 4, 5...
ARITHMETIC
TREE
GRAPH THEORY
GROUP THEORY
PERMUTATION GROUP
LINEAR ALGEBRA
NUMBER SYSTEMS
FACTORS OF 30
ORDER THEORY
MEASURE THEORY
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CALCULUS
DYNAMICAL SYSTEMS
FLUID FLOW
DIFFERENTIAL
GRADIENT = dy/dx

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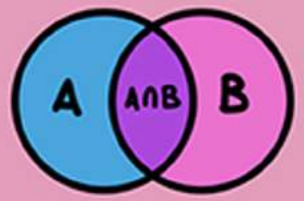

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P≠NP?

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INFINITY
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CARDINAL NUMBERS
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π

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INTEGERS
$\ldots -2, -1, 0, 1, 2 \ldots$

NATURAL NUMBERS
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ARITHMETIC
$+ - \times \div$

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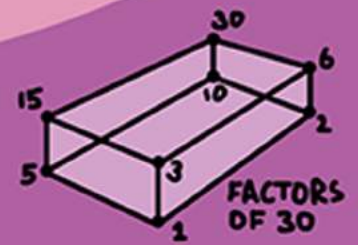

ORDER THEORY

MEASURE THEORY

GROUP THEORY

PERMUTATION GROUP

MATRICES
$\begin{pmatrix} 6 & 7 \\ -3 & 2i \end{pmatrix}$

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INDIA
C.628

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MEASURE THEORY

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PERMUTATION GROUP

MATRICES $\begin{pmatrix} 6 & 7 \\ -3 & 21 \end{pmatrix}$

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$\sin(\theta)$ $\cos(\theta)$

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COMPLEX ANALYSIS

FRACTAL GEOMETRY

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FLUID FLOW

CALCULUS

DIFFERENTIAL

GRADIENT $= \frac{dy}{dx}$

INTEGRAL

AREA $= \int_2^9 f(x)\,dx$

DIFFERENTIAL EQUATIONS

BUTTERFLY EFFECT

CHAOS THEORY

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VECTOR CALCULUS

P(B)

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UATION

MX+C

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NUMERICAL ANALYSIS

ENGINEERING

CONTROLLER

SYSTEM

SENSOR

MATHEMATICAL PHYSICS

CALCULUS

f(x)

MATHEMATICAL CHEMISTRY

CONTROL

ERNION
+cj+dk

MPLEX
MBERS

+3i ,-4i

AL
RS

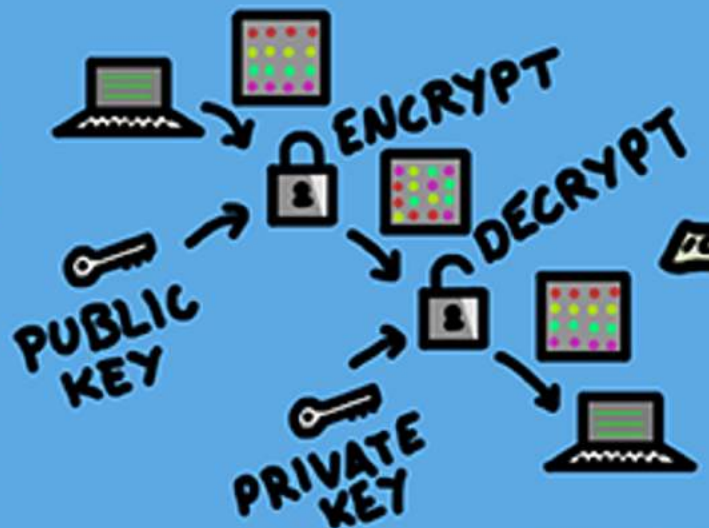
2.32

AL
ERS

,5...

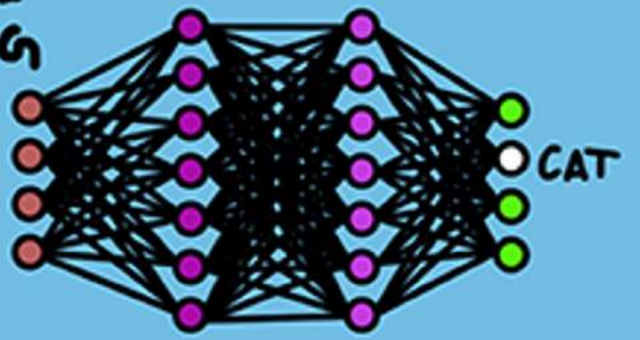
ER
MS

CRYPTOGRAPHY



COMPUTER SCIENCE

MACHINE LEARNING

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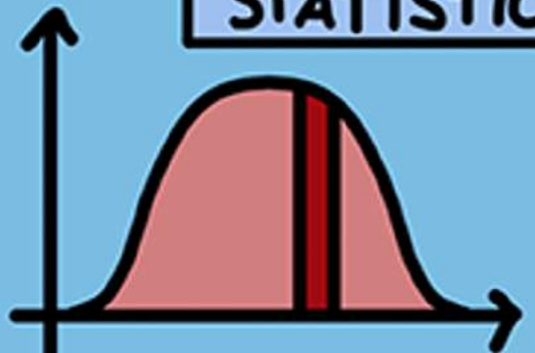
OPTIMIZATION

PROBABILITY

BAYES' RULE

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

STATISTICS



MATHEMATICAL FINANCE

ORIGINS

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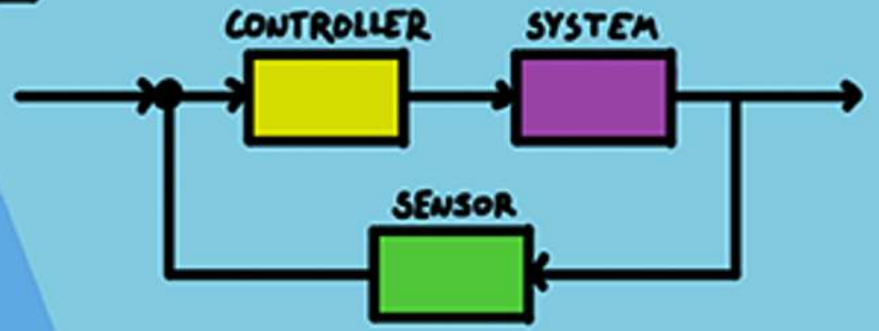
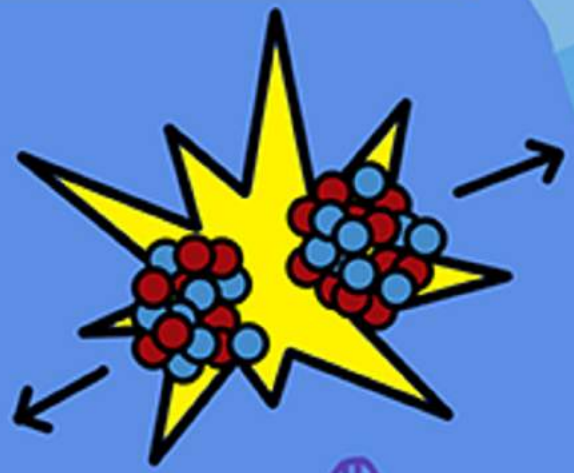


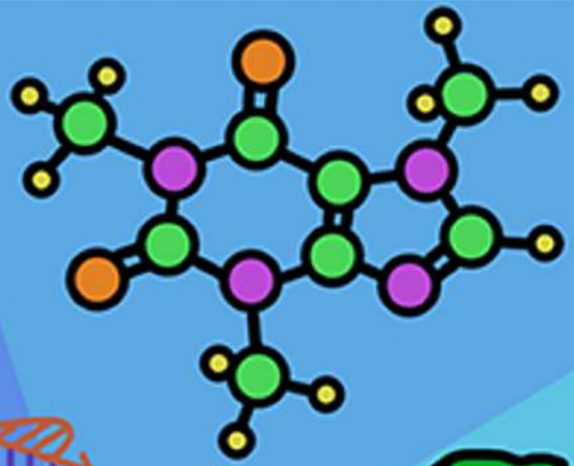
CONTROL THEORY

MATHEMATICAL PHYSICS



THEORETICAL PHYSICS

MATHEMATICAL CHEMISTRY



BIOMATHEMATICS

BY DOMINIC WALLIMAN © 2017

YOUTUBE: THE MAP OF MATHEMATICS

WHAT IS PURE MATHEMATICS?

Pure mathematics is the study of the basic concepts and structures that underlie mathematics. Its purpose is **to search for a deeper understanding and an expanded knowledge of mathematics itself**.

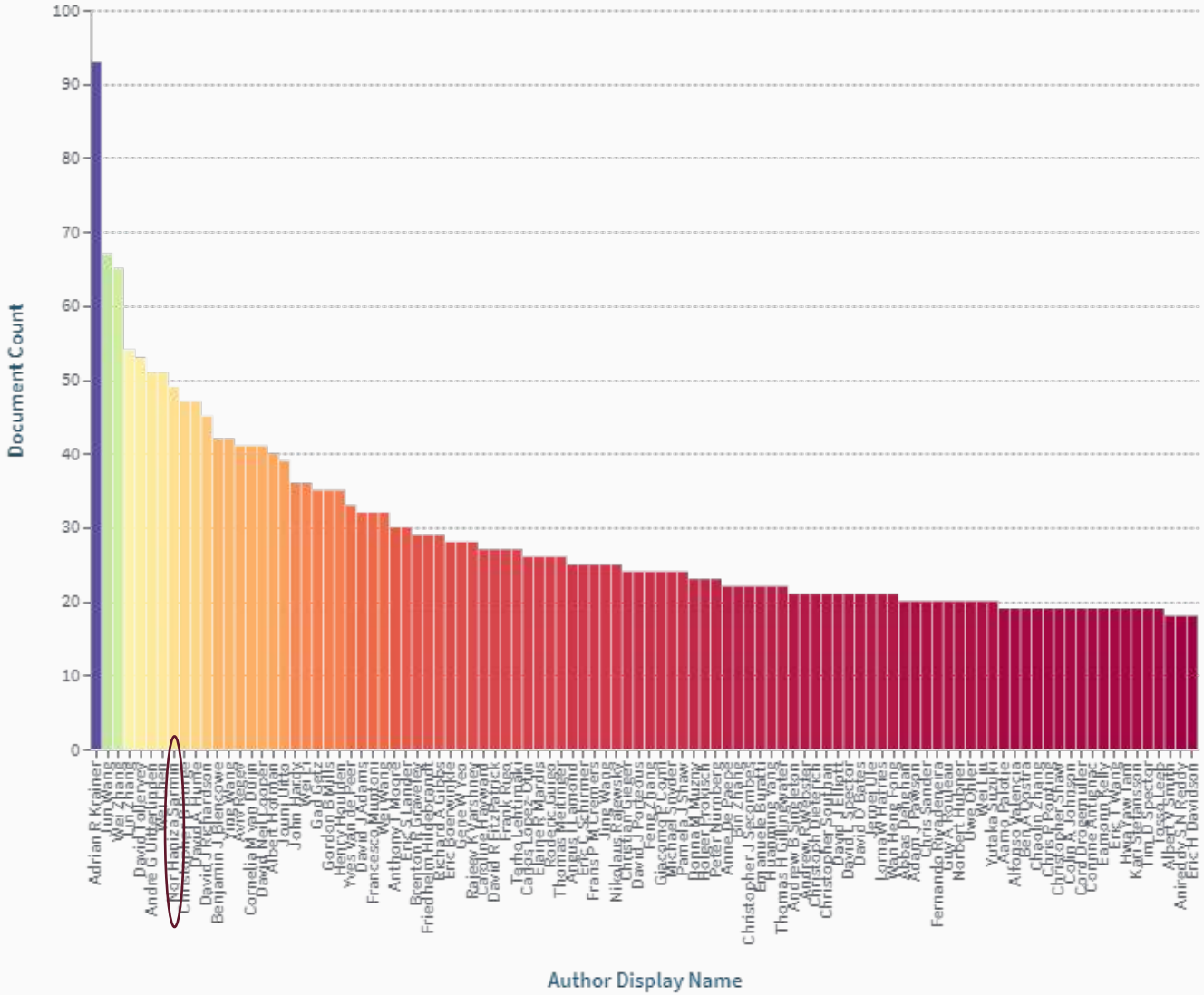
WHY STUDY PURE MATHEMATICS?

One of the reasons is because they **appreciate the beauty** of the particular types of abstract patterns involved in their own research, and **enjoy discovering non-obvious aspects** of these complex patterns.

DNA SPLICING SYSTEM

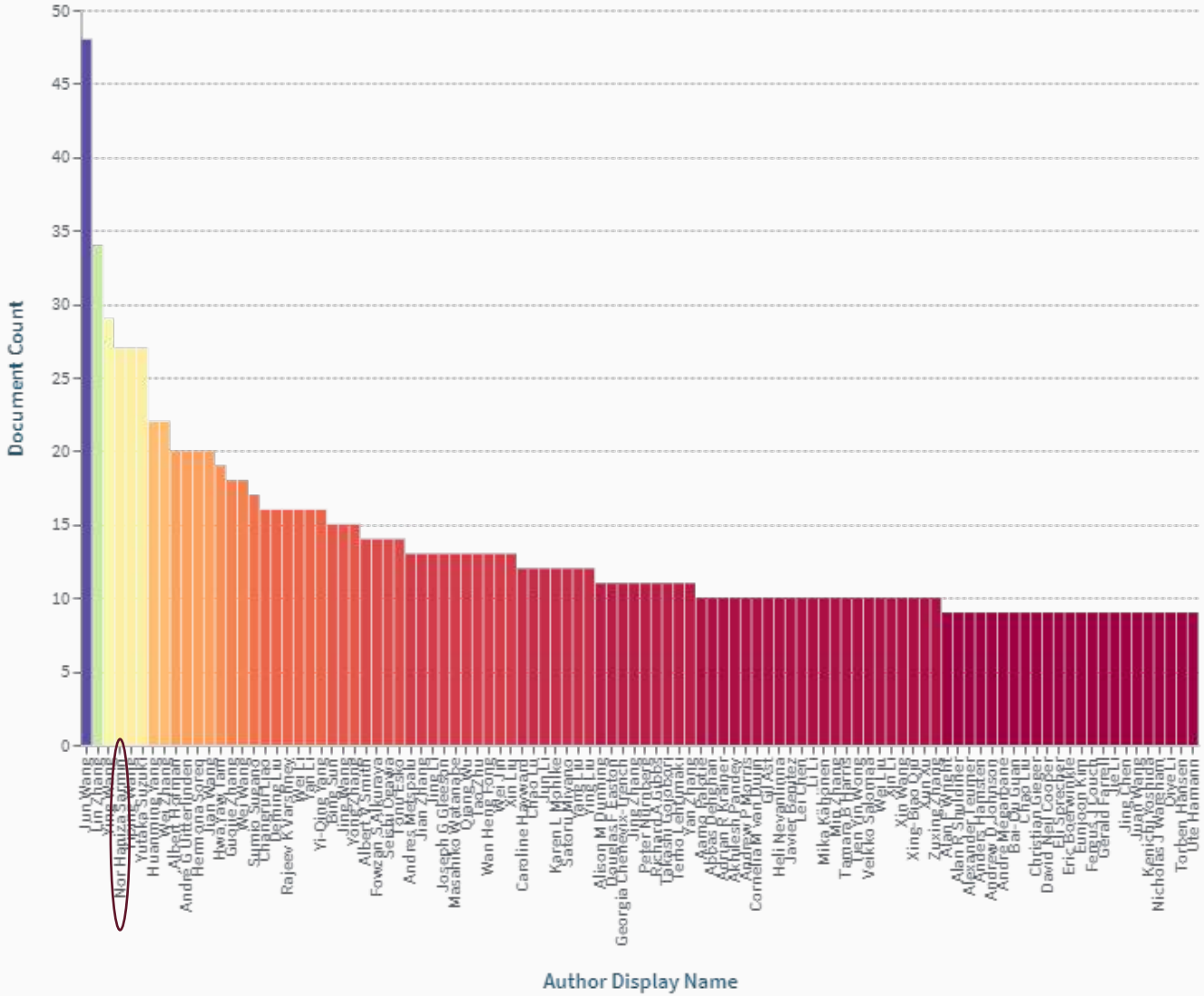
Ranking in Splicing Systems (Lens.org)

World



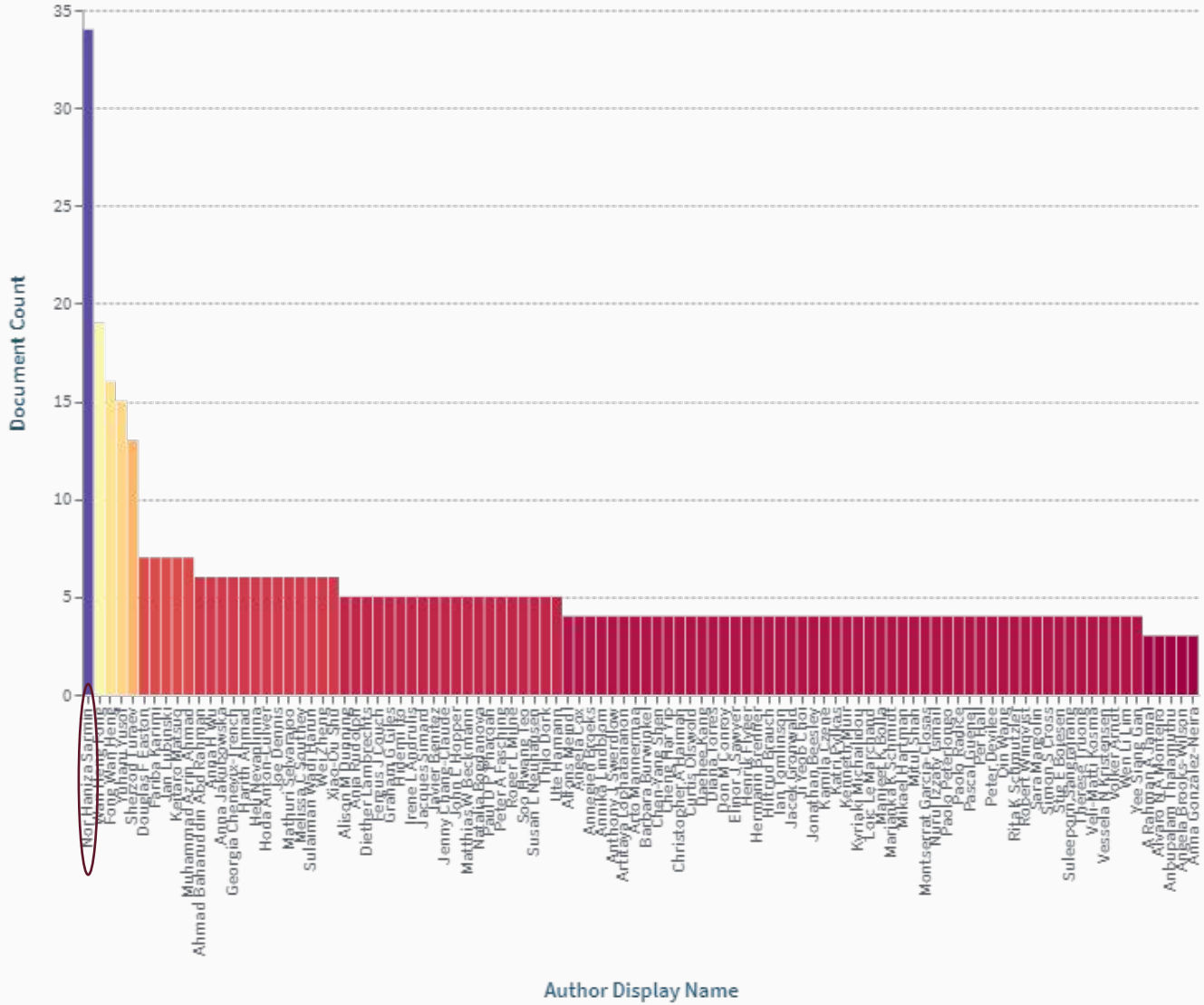
Ranking in Splicing Systems (Lens.org)

Asia



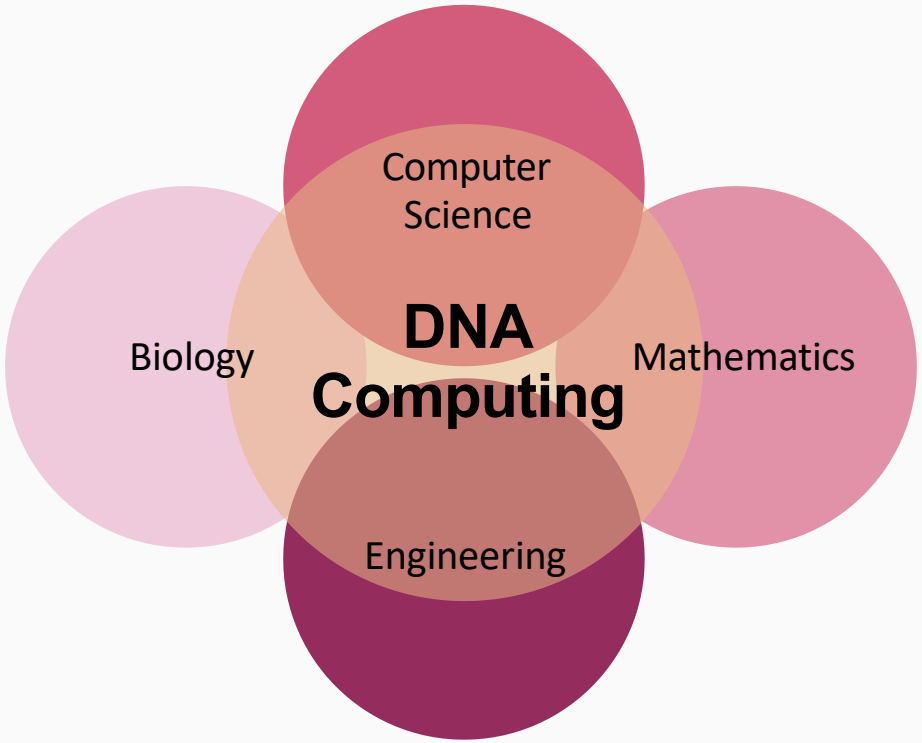
Ranking in Splicing Systems (Lens.org)

Malaysia



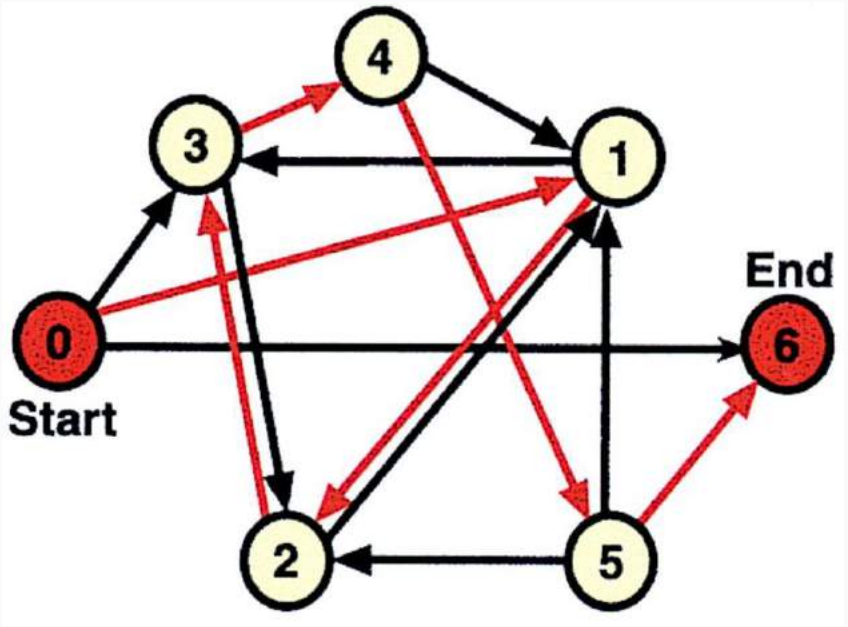
DNA Computing

- DNA computing has emerged in the last twenty years as an exciting new research field at the intersection of Biology, Computer Science, Mathematics and Engineering.



DNA Computing (Cont.)

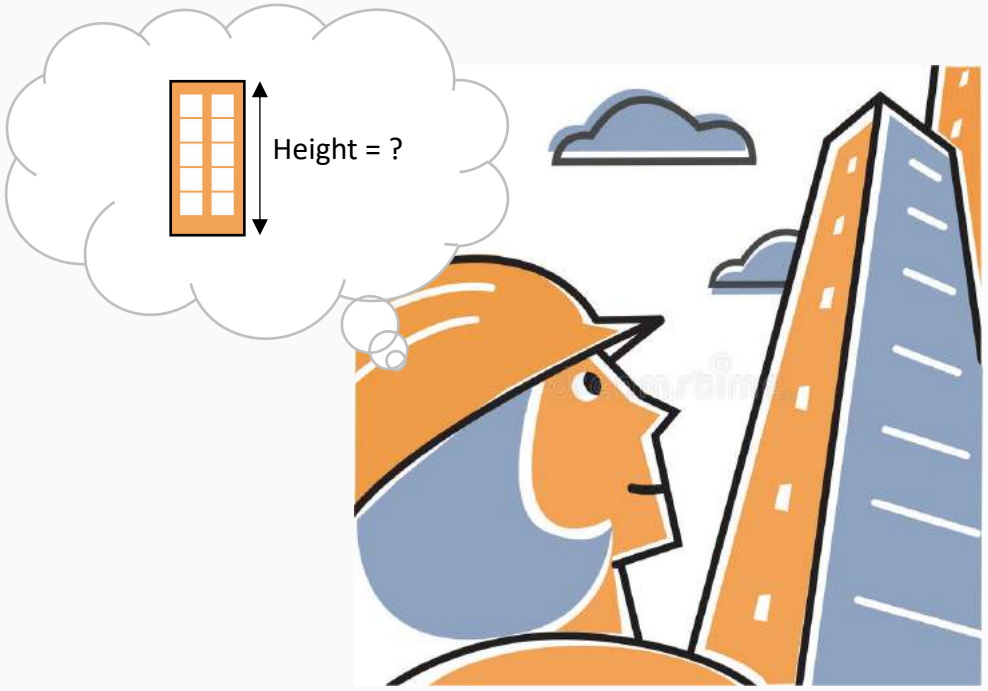
- Although anticipated by Feynman from the 1950s, the notion of performing computations at the molecular level was only realized in 1994, with Adleman's experiment on solving the Hamiltonian Path Problem using DNA.



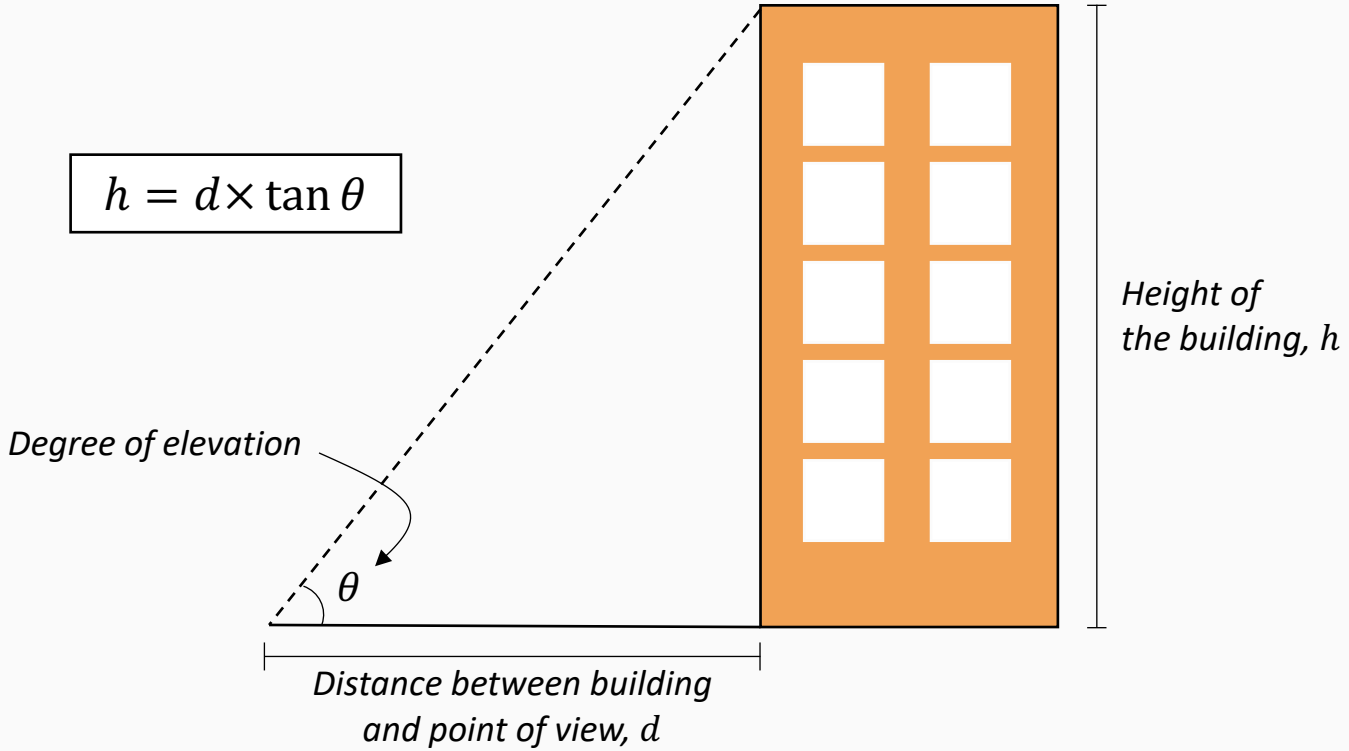
Adleman, L. M. (1994). Molecular Computation of Solutions to Combinatorial Problems. *Science*, 265(5187), 1021-1024.

Mathematical Modelling

- Mathematical modelling is an abstract, simplified, mathematical construct related to part of reality and created for particular purpose.



$$h = d \times \tan\theta$$



Edward A. Bender, *An Introduction to Mathematical Modelling*, (John Wiley & Sons, New York), 1978

Mathematics and DNA Splicing System

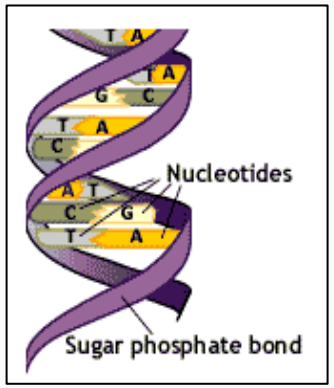
- The mathematical modelling of splicing system was first defined by Tom Head in 1987.
- It was introduced as a mathematical model of the generative capacity of a biological system containing DNA molecules in the presence of appropriate enzymes.

Structure of DNA

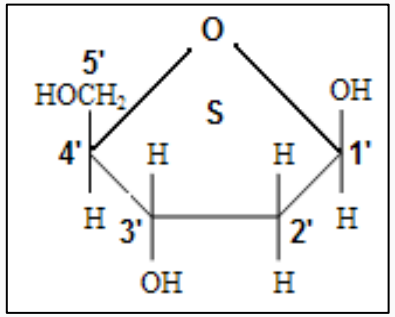
DNA – Deoxyribonucleic Acid

made up of

Nucleotides



Phosphate group



Base

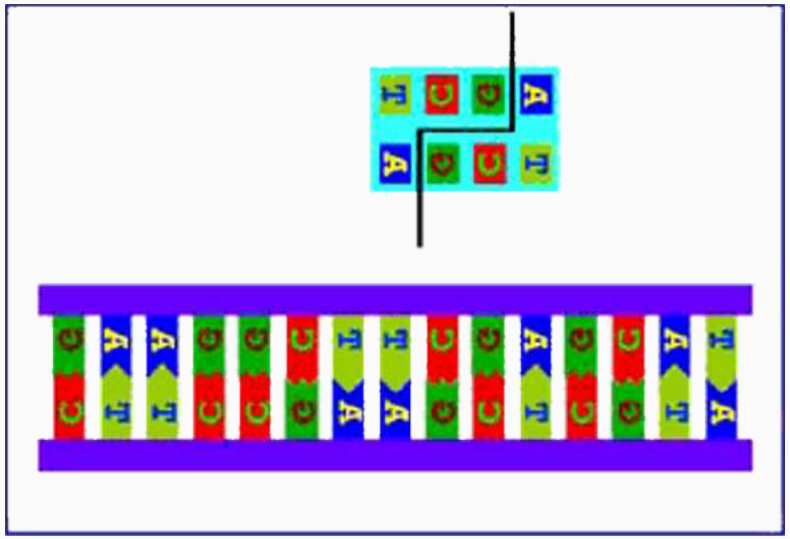
Adenine (A)
Cytosine (C)
Guanine (G)
Thymine (T)

Pentose (a 5-carbon sugar)

Structure of DNA (Cont.)

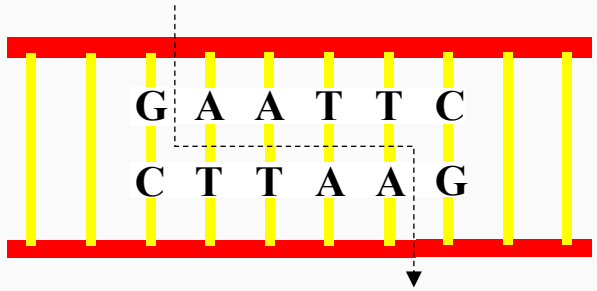
Restriction Enzymes

- A restriction enzyme is an enzyme that cuts double-stranded or single stranded DNA at specific recognized nucleotide sequences, known as restriction sites.

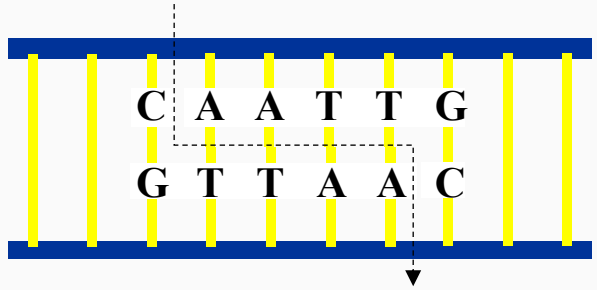


Restriction Enzymes (Cont.)

*EcoR*I: ([G/C],[A/T],[A/T],[T/A],[T/A],[C/G])



*Mfe*I: ([C/G],[A/T],[A/T],[T/A],[T/A],[G/C])

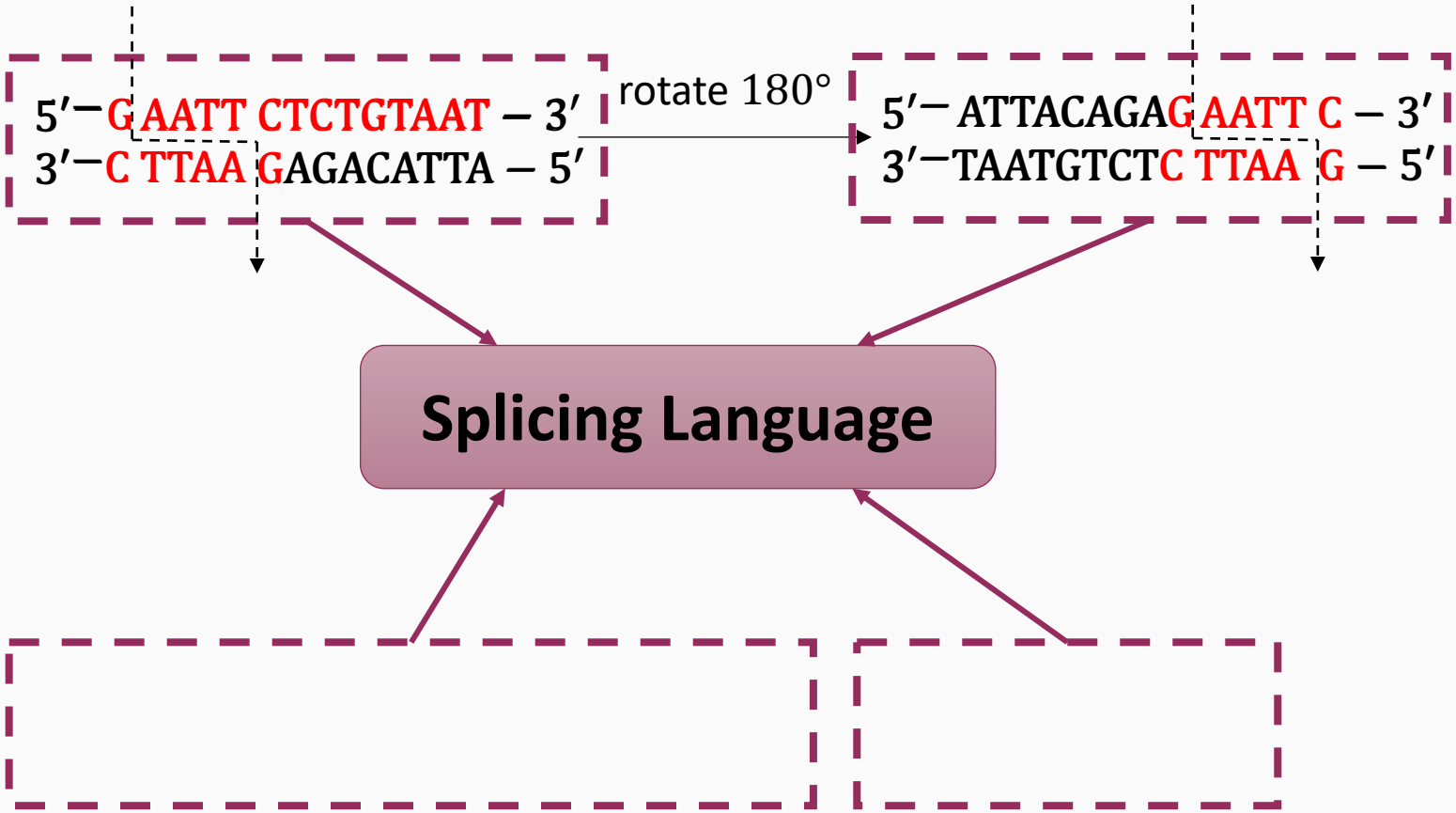


Mathematical Modelling of DNA Splicing System

How we model ؟.

Mathematics and Formal Language		DNA in Mathematical Model	
Alphabets	$h, n, i, z, a, s, m, r, o$	DNA bases	a, c, g, t
Strings	nor & $haniza$ & $sarmin$	DNA Sequence	$acgttgat$ & $gcgttga$
		DNA Splicing	$acgt-\ -tgat$ & $gcgt-\ -tga$
Grammar	$Nor + Haniza$ $Haniza + Sarmin$	Grammar	Watson-Crick
Language	$Nor\ Haniza$ $Haniza\ Sarmin$	Language	$acgttga$ & $gcgttgat$

Mathematical Modelling of DNA Splicing System (Cont.)



How it began?

PH **Tom**
To: nhs@m... & 1 more >

Starting the proposal file.

Dear Niza,

Just to indicate that I am getting started to work on the proposal, I have attached my edited outline copied from the earlier proposal that you sent me. I've done nothing of substance yet on it - but maybe you should look through it and see if you agree on the sections where I have suggested that they are completely for you to fill out.

Research Grant:

Mathematical Modelling of Recombination Capacity of Systems of Enzymes Acting on DNA

21 April 2004 – 21 April 2007

MOSTI (IRPA Vote No. 74259)

RM 150, 000.00

Nor Haniza Sarmin, Tom Head, Tahir Ahmad, Siti Mariyam Shamsuddin, Fahrul Zaman Huyop, Fong Wan Heng, Nur Idalisa Nordin, Deborah Lim Shin

Tom Head's visit to UTM, 2004

- **Title of research**:
  Formal Language Theory and DNA

- **MSc with Dissertation:**
  2004 - 2005

Assoc. Prof. Dr. Nor Muhainiah Mohd Ali

Department of Mathematical Sciences, Faculty of Science, UTM

- **Title of research**:
  Modelling of Splicing Systems Using Formal Language Theory

- **PhD in Mathematics:**
  2004 - 2007

Assoc. Prof. Dr. Fong Wan Heng

Department of Mathematical Sciences, Faculty of Science, UTM

Research Grants:

Mathematical Modelling of Splicing Systems on DNA Molecules
1 December 2006 – 30 November 2008
MOSTI eScienceFund 02-01-06-SF0013 (Vote No 79081)
RM 209 998.00
Nor Haniza Sarmin, Tom Head, Nor'aini Aris, Noor Aini Abdul Rashid, Fong Wan Heng, Loh Ser Lee

Automation of DNA Computing Readout Based On "in vitro-in-silico" Processing of Real-Time Polymerase Chain Reaction
1 December 2006 – 31 May 2008
MOSTI eScienceFund 01-01-06-SF0176
RM 270, 116.00
Zuwairie Ibrahim, **Nor Haniza Sarmin**

DNA Sequence Design for DNA Computation Applications with Length and Taqman Constraints
1 December 2006 – 30 November 2008
MOSTI eScienceFund 02-01-06-SF0069
RM 199, 997.00
Zuwairie Ibrahim, **Nor Haniza Sarmin**, Marzuki Khalid

Visit to SUNY Binghamton, New York, USA, 2007

Visit and Research Seminar at SUNY Binghamton, New York, USA, 2007

Theoretical vs Lab Results

Wet Splicing System involving *Cvi*QI and *Aci*I

- An initial DNA molecule *I* used in this splicing model is a small segment taken from bacteriophage lambda between 42958 and 43117 with the length of 160 base pairs (bp).
- The initial molecule contains one cutting site each of the restriction enzymes *Cvi*QI and *Aci*I where the genome locations for the cutting sites are found at 42992-42995 and 43036-43039 respectively.
- Five sticky ends of molecules α, β, γ, $\alpha - \beta$ and $\beta - \gamma$ are produced by the restriction enzymes when cutting the initial molecule. The lengths of fragments for the sticky ends are given in the following.

Fragment: $\alpha \underline{\textit{Cvi}\text{QI site}}\ \beta \underline{\textit{Aci}\text{I site}}\ \gamma$

$|\alpha|$ = 35 bp

$|\beta|$ = 44 bp

$|\gamma|$ = 81 bp

$|\alpha - \beta|$ = 79 bp

$|\beta - \gamma|$ = 125 bp

Theoretical vs Lab Results (Cont.)

Wet Splicing System involving *Cvi*QI and *Aci*I

- Initial Molecule (42958 and 43117 from bacteriophage lambda)

ggactatcgaagagtgcaaggcgatcaaggcagagtaccaacagaaactcaaagacctgcgaaatag cagaagtgaggccgcatgacgttctcagtaaaaaccattccagacatgctcgttgaaacatacggaaat cagacagaagtagcacgcagactg (160 bp)

- Enzyme *Cvi*QI (palindromic)

5’…G▼TAC…3’

3’…CAT▲G…5’

- Enzyme *Aci*I (non-palindromic)

5’…C▼CGC…3’

3’…CGC▲C…5’

Theoretical vs Lab Results (Cont.)

Wet Splicing System involving *Cvi*QI and *Aci*I

The splicing language from this splicing system S invoving one cutting site each of palindromic restriction enzyme *Cvi*QI (*g*, *ta*, c) and non-palindromic restriction enzyme *Aci*I (*c*, *cg*, *c*) with different palindromic crossings is shown in the following:

$$L(S) = \{\alpha gtac(\beta ccgg\beta' gtac)^{n-1}(\alpha' + \beta ccgc\gamma)\}$$
$$+\{\gamma' gcg(g\beta' gtac\beta ccg)^{n-1}(c\gamma + g\beta' gtac\alpha')\}.$$

where $n \in \mathbb{Z}^+$. The fragments of DNA strings in the splicing language $L(S)$ are stated as follows:

$$\alpha \underline{gtac} \left(\beta \underline{ccgg} \beta' \underline{gtac}\right)^{n-1} \alpha',$$

$$\alpha \underline{gtac} \left(\beta \underline{ccgg} \beta' \underline{gtac}\right)^{n-1} \beta \underline{ccgc} \gamma,$$

$$\gamma' \underline{gcg} \left(\underline{g} \beta' \underline{gtac} \beta \underline{ccg}\right)^{n-1} \underline{c} \gamma \text{ and}$$

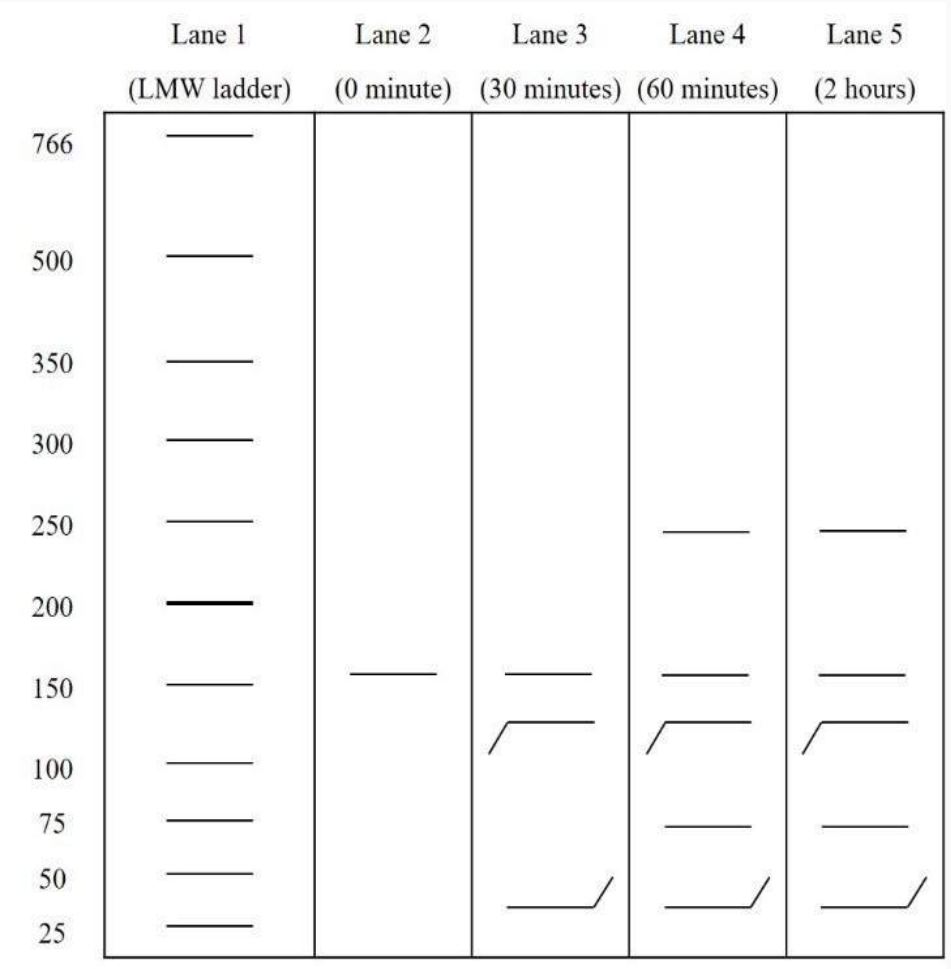
$$\gamma' \underline{gcg} \left(\underline{g} \beta' \underline{gtac} \beta \underline{ccg}\right)^{n-1} \underline{g} \beta' \underline{gtac} \alpha'$$

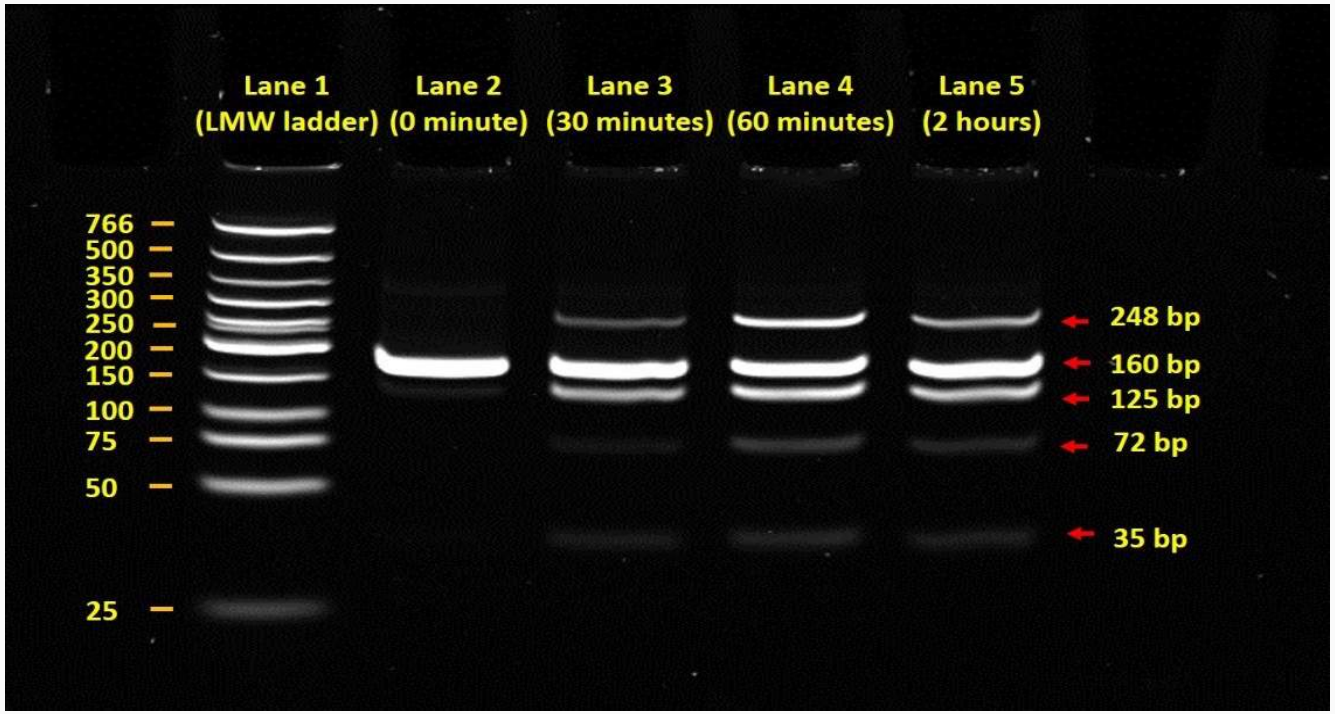
where $n \in \mathbb{Z}^+$ represents multiple copies of the specific strings.

Wet experiment on splicing system at Universiti Teknologi Malaysia, 2007

Theoretical vs Lab Results (Cont.)

Wet Splicing System involving *Cvi*QI

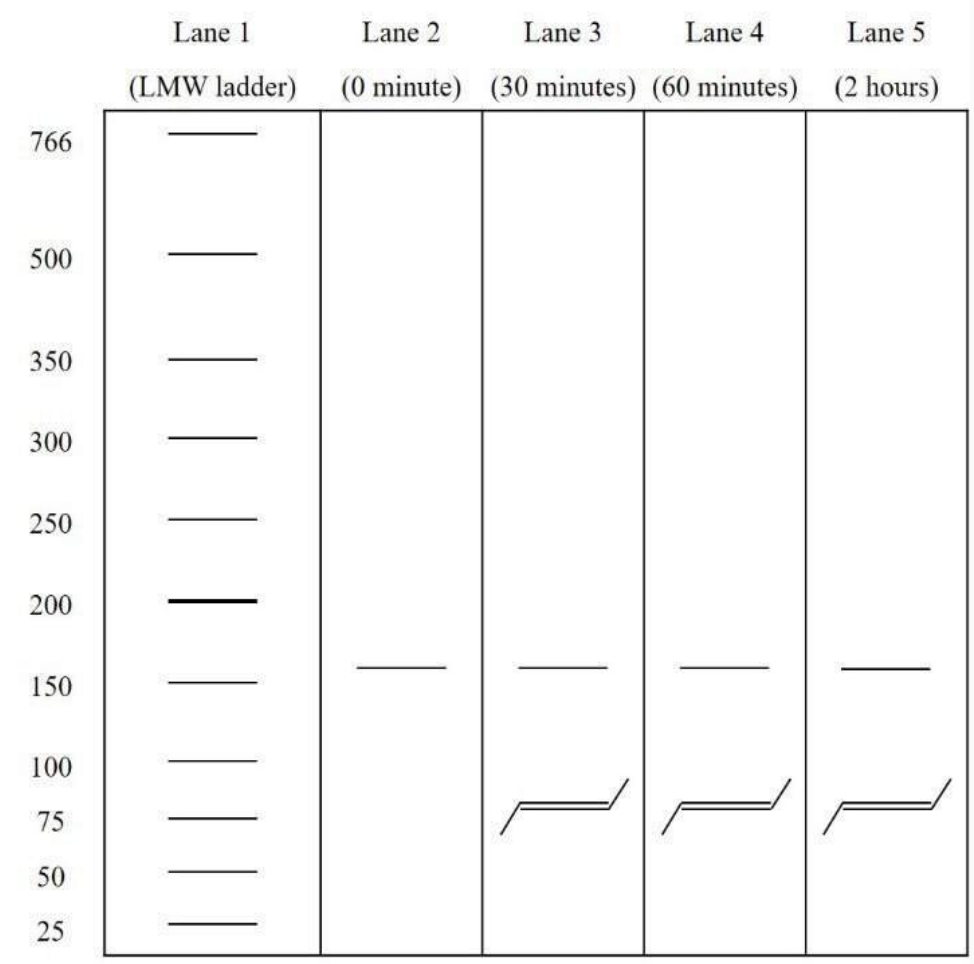


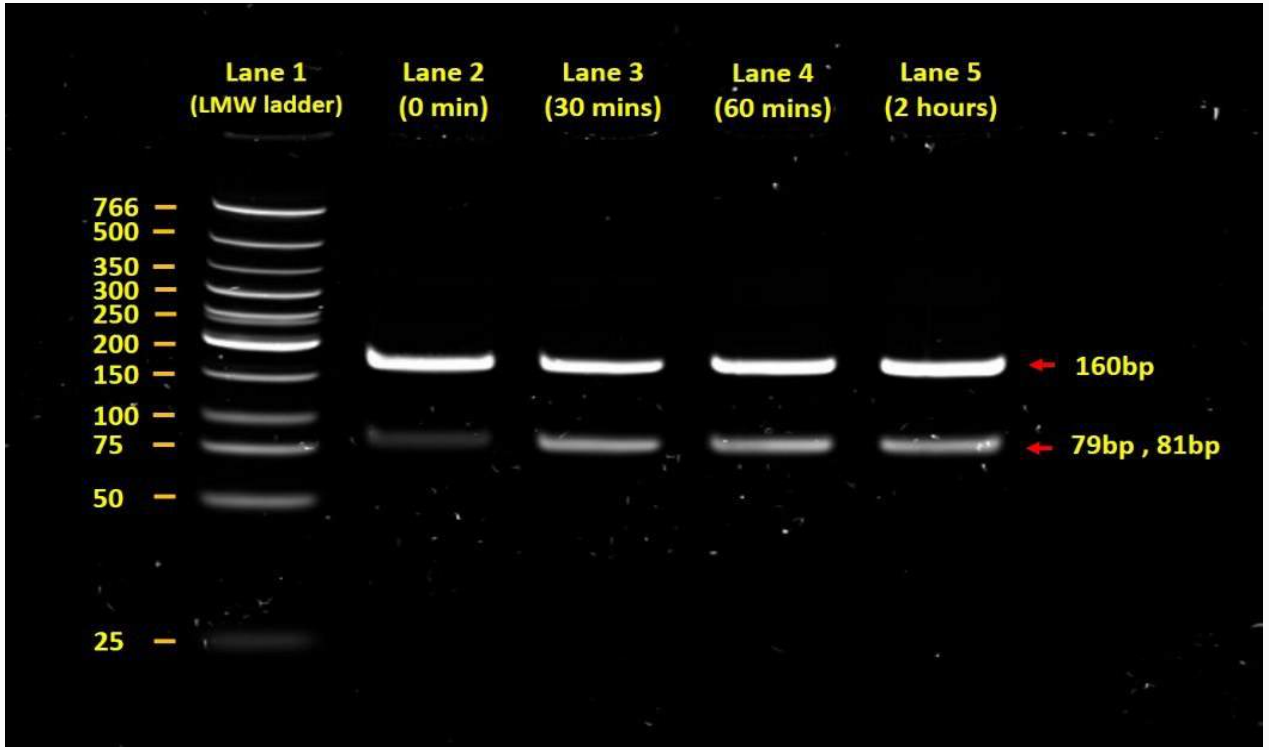


- Lane 1: LMW ladder
- Lane 2 (0 minute): 160 bp
- Lane 3 (30 minutes): 35 bp, 72 bp, 125 bp, 160 bp and 248 bp
- Lane 4 (60 minutes): 35 bp, 72 bp, 125 bp, 160 bp and 248 bp
- Lane 5 (2 hours): 35 bp, 72 bp, 125 bp, 160 bp and 248 bp

Theoretical vs Lab Results (Cont.)

Wet Splicing System involving *AciI*

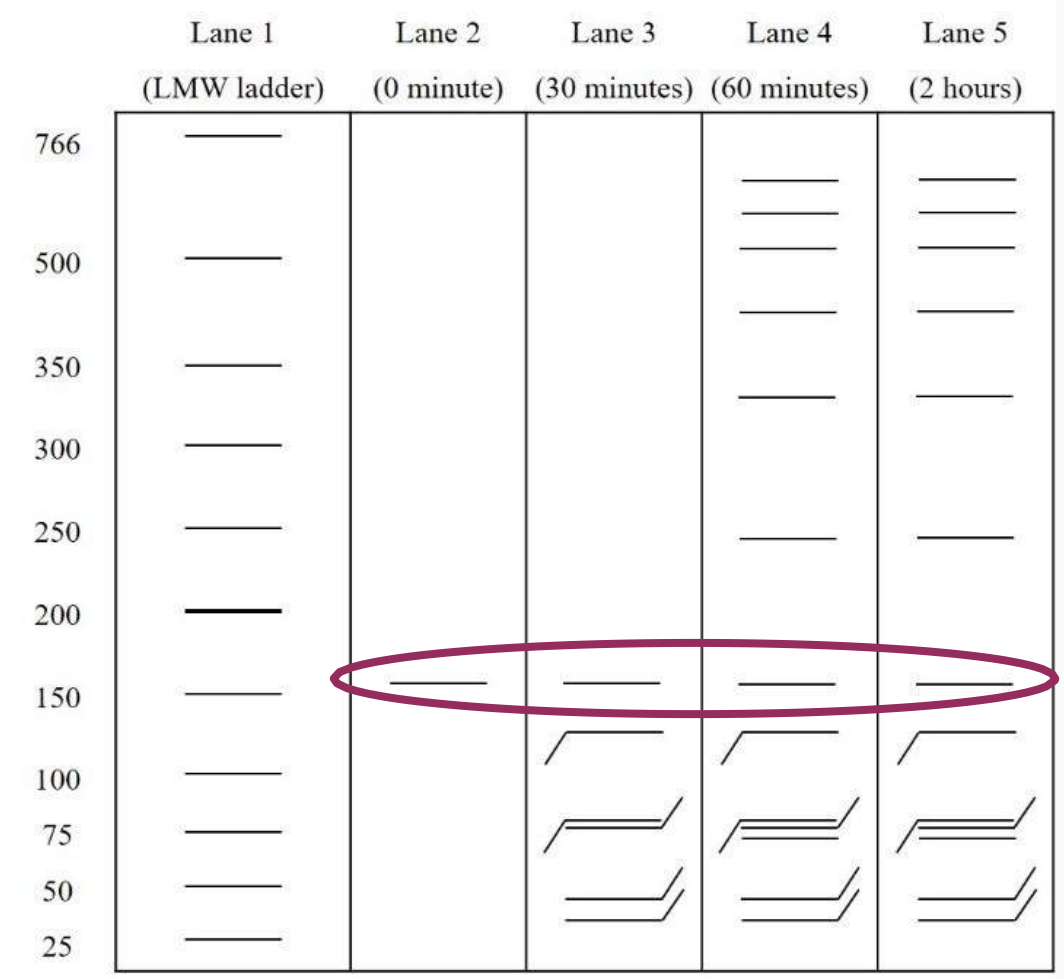


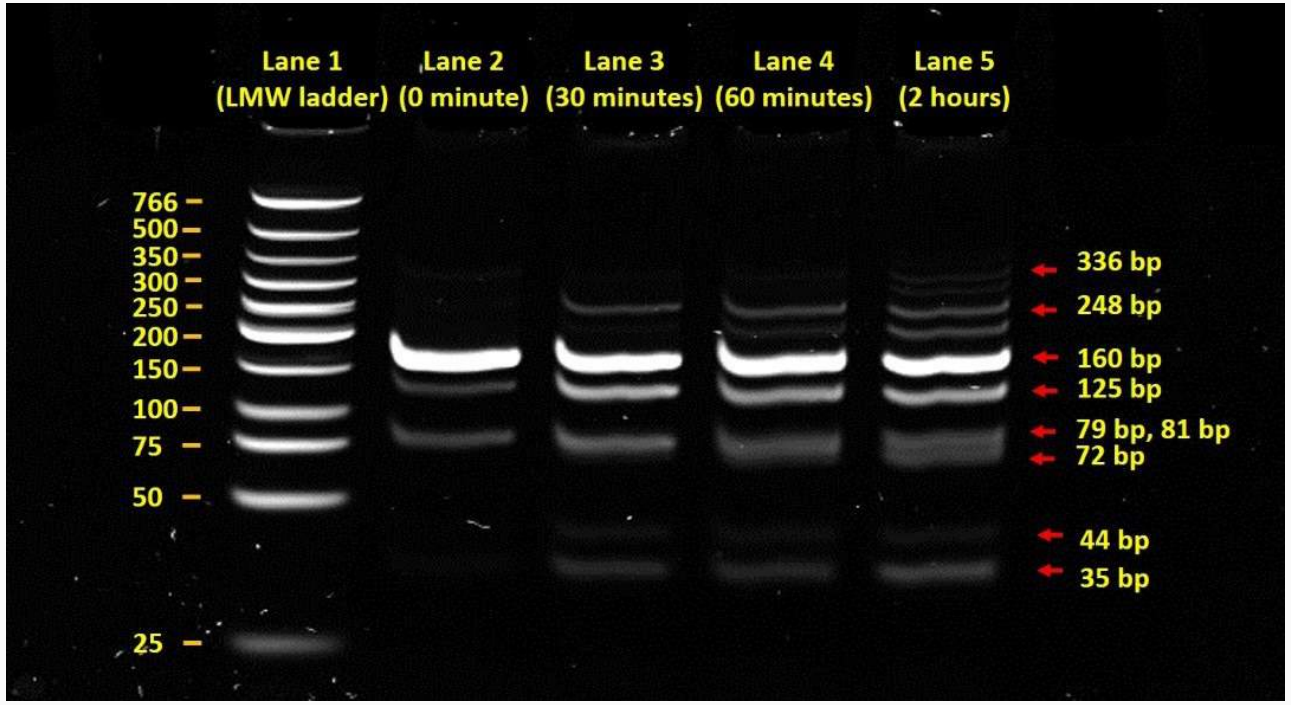


- Lane 1: LMW ladder
- Lane 2 (0 minute): 79 bp (or 81 bp) and 160 bp
- Lane 3 (30 minutes): 79 bp, 81 bp and 160 bp
- Lane 4 (60 minutes): 79 bp, 81 bp and 160 bp
- Lane 5 (2 hours): 79 bp, 81 bp and 160 bp

Theoretical vs Lab Results (Cont.)

Wet Splicing System involving *Cvi*QI and *Aci*I



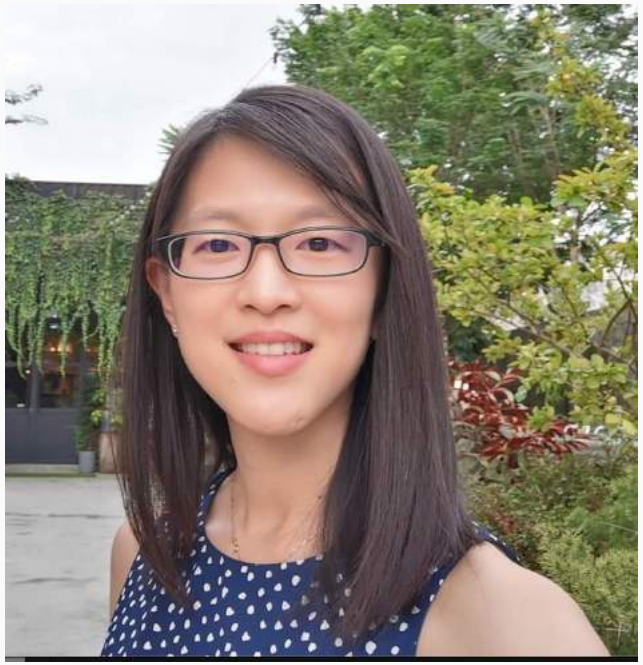


- Lane 1: LMW ladder
- Lane 2 (0 minute): 79 bp (or 81 bp), 125 bp and 160 bp
- Lane 3 (30 minutes): 35 bp, 44 bp, 79 bp, 81 bp, 125 bp, 160 bp, 248 bp
- Lane 4 (60 minutes): 35 bp, 44 bp, 79 bp, 81 bp, 125 bp, 160 bp, 248 bp
- Lane 5 (2 hours): 35 bp, 44 bp, 72 bp, 79 bp, 81 bp, 125 bp, 160 bp, 248 bp, 336 bp

Publications:

1. **Nor Haniza Sarmin** & Fong Wan Heng, **Isomorphisms of Groups of Order 8 with Certain Point Groups**, Menemui Matematik, 27 (2005), 13-22
2. **Nor Haniza Sarmin** & Fong Wan Heng, **Irreducible Representations of Groups of Order 8**, Matematika, 22 No 1 (2006) 1-16.
3. Fong Wan Heng, **Nor Haniza Sarmin** & Zuwairie Ibrahim, **Recognition of Simple Splicing Systems Using SH-Automaton**, Journal of Fundamental Sciences, Vol. 4, No. 2, 2008, pp. 337-342.

Dr. Fong Wan Heng, my first PhD student during her convocation on 16 August 2008.



- **Title of research:**
  Splicing Systems and Languages
- **MSc with Dissertation:**
  2006 – 2007

Deborah Lim Shin Fei

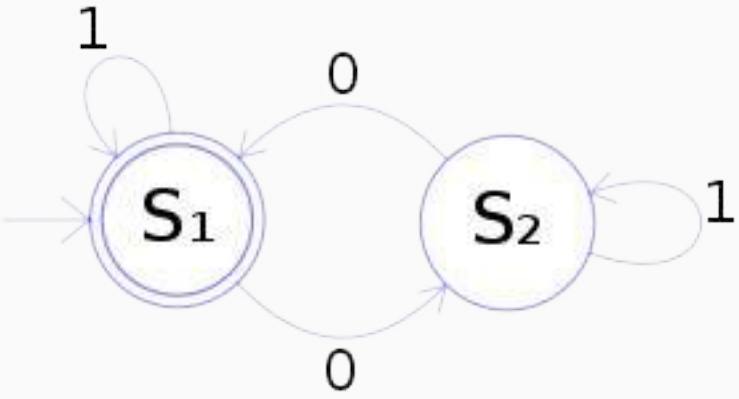
Assistant Manager, Panasonic System Networks Malaysia Sdn Bhd

Publications

1. Deborah Lim Shin Fei & Nor Haniza Sarmin, "**Watson-Crick Automata**", International Conference on Research and Education in Mathematics (ICREM 2), 27-29 May, 2006, Residence Hotel at UNITEN, Bangi, Selangor, Malaysia, pp 436-443.
2. Deborah Lim Shin Fei & Nor Haniza Sarmin, "**Watson-Crick Automata: Theoretical Computation Models in DNA Computing**", Menemui Matematik (Discovering Mathematics), Vol. 27, No. 2 (2006): 1-8.
3. Deborah Lim Shin Fei, Nor Haniza Sarmin & Wan Heng Fong, "**Three Variants of Splicing Systems – Head, Paun and Pixton**", Technical Report of Department of Mathematics, Faculty of Science, UTM 1. 2007, LT/M BIL.04/2007.
4. Deborah Lim Shin Fei, Nor Haniza Sarmin & Wan Heng Fong, "**Adult and Limit Languages in Splicing Systems**", 2007, LT/M BIL.03/2007.

Automata

Automata theory is the study of abstract machines, as well as the computational problems that can be solved using them. It is a theory in theoretical computer science.



Conference on Biomathematical Computing: Past, Present and Prospects, SUNY Binghamton, New York, USA, 2008

DNA Splicing Research Group (DSRG)
formed in 2008.

- **Title of research**:
  DNA Splicing System Inspired by Bio Molecular Operations

- **PhD in Mathematics:**
  2008 - 2011

Assoc. Prof. Dr. Yuhani Yusof

Faculty of Industrial Sciences & Technology, Universiti Malaysia Pahang

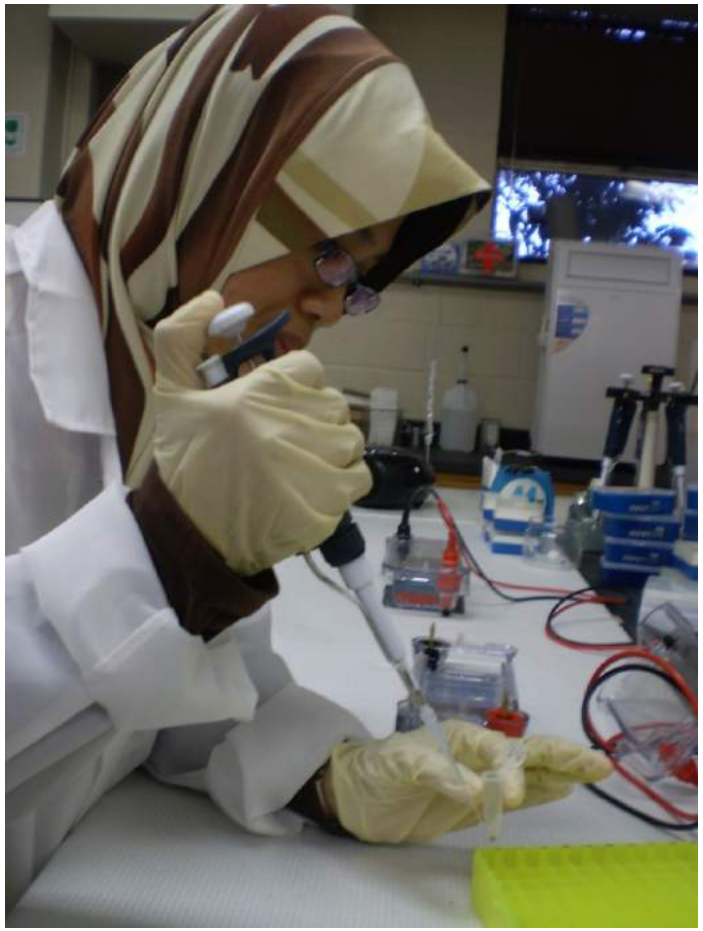
Research grants:

Solid Codes and Automata Diagrams in Splicing System
1 April 2009 – 31 March 2010
New Academic Staff with PhD Scheme Grant, UTM (Vote No 77924)
RM 10, 000.00
Fong Wan Heng, **Nor Haniza Sarmin**

Generalization of Rules in Splicing Languages
15 November 2009 – 14 November 2011
Fundamental Research Grant Scheme (FRGS), MOHE (Vote No 78482)
RM 32, 000.00
Fong Wan Heng, **Nor Haniza Sarmin**

Publications:

1. **Nor Haniza Sarmin**, Yuhani Yusof and Fong Wan Heng, **Some Characterizations in Splicing Systems**, *International Conference on Mathematical Sciences (ICMS 2010)*, Abant Ỳzzet Baysal Üniversitesi, Bolu, Turkey, 23 – 27 Nov 2010, American Institute of Physics (AIP) Conference Proceedings, Melville, New York, Vol 1309, pg. 411-418, (ISBN 978-0-7354-0863-0).
2. Fong Wan Heng, **Nor Haniza Sarmin** and Yuhani Yusof, **Some Analysis on Certain Types of Splicing Systems**, The Fifth IEEE International Conference on Bio-Inspired Computing: Theories and Applications (BIC-TA 2010), Liverpool Hope University, Liverpool, United Kingdom, 8-10 September 2010, pg. 1319-1321. (IEEE Catalog Number: CFP1001F-CDR, ISBN: 978-1-4244-6439-5).
3. Yuhani Yusof, **Nor Haniza Sarmin**, Fong Wan Heng, **The Concepts of Persistent and Permanent in Non Semi-Simple DNA Splicing System**, *Proceedings of the 21st National Symposium on Mathematical Sciences (SKSM 21)*, AIP Conf. Proc., Vol 1605, 2014, pg. 586-590 (ISBN: 978-0-7354-1241-5).
4. Yuhani Yusof, Wen Li Lim, T.Elizabeth Goode, **Nor Haniza Sarmin**, Fong Wan Heng, Mohd Firdaus Abd Wahab, Molecular Aspects of DNA Splicing Systems, International Conference on Mathematics, Engineering & Industrial Applications 2014 (ICoMEIA 2014), 28-30 May, 2014, The Gurney Resort Hotel & Residences Penang, AIP Conf. Proc., Vol. 1660, 2015, pg. 050045 (ISSN: 1551-7616).



Research collaboration with State University of New York, Binghamton, New York, and Towson University, USA, 2010

Dr. Yuhani Yusof with her family during her convocation on 7 May 2012.

- **Title of research**:
  Mathematical Modelling of Splicing System in DNA Computing

- **PhD in Mathematics:**
  2009 - 2012

Dr. Fariba Karimi

Iran

Wet lab experiment at Universiti Teknologi Malaysia, 2012

Publications:

1. Fariba Karimi, Sherzod Turaev, **Nor Haniza Sarmin** and Wan Heng Fong, **Fuzzy Splicing Systems**, Lecture Notes in Artificial Intelligence, Computational Collective Intelligence: Technologies and Applications, Volume 8733, ISBN 978-3-319-11288-6, pg 20-29, proceedings in 6th *International Conference on Computational Collective Intelligence Technologies and Applications* (ICCCI 2014), Seoul, Korea, September 24-26, 2014.
2. Fariba Karimi, **Nor Haniza Sarmin** and Fong Wan Heng, "**Common-Crossing and Persistent Splicing Systems**" International Journal of Applied Mathematics & Statistic (IJAMAS), Vol. 43, No. 13, 2013, pp. 293-296. (ISSN: 0973-7545).
3. Fariba Karimi, **Nor Haniza Sarmin** and Fong Wan Heng, "**The Characterizations of Different Splicing Systems**", International Journal of Modern Physics: Conference Series, 2012, Vol 9: pg 89-94. (ISSN: 2010-1945)

Fuzzy Logic

Fuzzy logic is a form of many-valued logic in which the truth value of variables may be any real number between 0 and 1. Fuzzy logic is based on the observation that people make decisions based on imprecise and non-numerical information. Fuzzy models or sets are mathematical means of representing vagueness and imprecise information (hence the term fuzzy). These models have the capability of recognising, representing, manipulating, interpreting, and using data and information that are vague and lack certainty. Fuzzy logic has been applied to many fields, from control theory to artificial intelligence.

Dr. Fariba Karimi's viva on 30 May 2013.

- **Title of research:**
  DNA Splicing System Inspired by Bio Molecular Operations

- **MSc with Dissertation:**
  2010 – 2011

- Nurul Afidah Mohd Sebry, Nor Haniza Sarmin, Fong Wan Heng, and Sherzod Turaev. "**Sticker Systems Over Permutation Groups**". World Applied Sciences Journal (WASJ), 21(Special Issue of Applied Math), 119-126, 2013. (ISSN : 1818-4952).

Nurul Afidah Mohd Sebry

- **Title of research**:
  Finite Automata in DNA Splicing and Sticker Systems with the Presence of Weights
- **PhD in Mathematics:**
  2011 - 2014

Dr. Gan Yee Siang

School of Architecture, Feng Chia University, Taiwan

Research Grant:

Persistent Splicing Systems in DNA Computing

1 April 2011 – 31 March 2012

Research University Fund (RUF) Vote No. Q.J130000.7126.02J65

RM 40, 000.00

Fong Wan Heng, **Nor Haniza Sarmin**

Publications:

1. Sherzod Turaev, Gan Yee Siang, Mohamed Othman, **Nor Haniza Sarmin** and Fong Wan Heng, **Weighted Splicing Systems**, Computational Intelligence and Intelligent Systems, Communications in Computer and Information Science (CCIS), ISBN 978-3-642-34288-2, Volume 316, 2012, pg 416-424, Proceedings in *The 6th International Symposium on Intelligence Computation and Applications (ISICA 2012)*, Wuhan, China, 27-28 October 2012.
2. Yee Siang Gan, Wan Heng Fong, **Nor Haniza Sarmin** and Sherzod Turaev, **Some Characteristics on the Generative Power of Weighted One-Sided Splicing Systems**, *Proceedings of the 22nd National Symposium on Mathematical Sciences (SKSM 22)*, AIP Conf. Proc., Vol 1682, 2015, pg. 020044 1-7 (ISBN 978-0-7354-1329-0).
3. Wan Heng Fong, Yee Siang Gan, **Nor Haniza Sarmin**, and Sherzod Turaev, **The Generative Capacity of Weighted Simple and Semi-Simple Splicing Systems**, *Proceedings of the 23rd National Symposium on Mathematical Sciences (SKSM 23)*, AIP Conf. Proc., **Vol 1750, 2016**, pg. 050013 1-6 (ISBN: 978-0-7354-1407-5).

Dr. Gan Yee Siang received Pro-Chancellor Award during his convocation on 25 April 2015.

- **Title of research**:
  Probabilistic Splicing System and Sticker Systems in DNA Computing

- **PhD in Mathematics:**
  2011 - 2014

Dr. Mathuri Selvarajoo

Lecturer, Faculty of Science and Mathematics, Universiti Teknologi MARA Shah Alam

Research Grant:

Computation of Sticker System in DNA Over Groups

1 December 2012 – 31 December 2013

Research University Fund (RUF) Vote No. Q.J130000.2626.07J41

RM 32, 000.00

Fong Wan Heng, **Nor Haniza Sarmin**

Publications:

1. Mathuri Selvarajoo, Fong Wan Heng, **Nor Haniza Sarmin** and Sherzod Turaev, **Some Characteristics of Probabilistic One-Sided Splicing Systems**, *Proceedings of the 20th National Symposium on Mathematical Sciences (SKSM 20)*, AIP Conf. Proc., Vol 1522, 2013, pg. 967-975(ISSN: 1551-7616).
2. Sherzod Turaev, Mathuri Selvarajoo, Mohd Hasan Selamat, **Nor Haniza Sarmin** and Fong Wan Heng, **Probabilistic Splicing Systems**, Advanced Methods for Computational Collective Intelligence, Studies in Computational Intelligence, ISBN 978-3-642-34300-1,Volume 457, 2013, pg 259-268, proceedings in *4th International Conference on Computational Collective Intelligence Technologies and Applications (ICCCI 2012)*, Ho Chi Minh city, Vietnam, 28-30 November 2012.
3. Mathuri Selvarajoo, Fong Wan Heng, **Nor Haniza Sarmin** and Sherzod Turaev, **Probabilistic Simple Splicing Systems**, *Proceedings of the 3rd International Conference on Mathematical Sciences (ICMS3)*, AIP Conf. Proc., Vol 1602, 2014, pg. 760-766. (ISBN: 978-0-7354-1236-1)
4. Mathuri Selvarajoo, Wan Heng Fong, **Nor Haniza Sarmin** and Sherzod Turaev, **Probabilistic Simple Sticker Systems**, *Proceedings of the 4th International Conference on Mathematical Sciences* (ICMS4 2016), AIP. Conf. Proc., 1830 (1), 2017, pg. 020057 1-9 (ISBN: 978-0-7354-1498-3)
5. Mathuri Selvarajoo, Fong Wan Heng, **Nor Haniza Sarmin** and Sherzod Turaev, **The characteristics of simple splicing languages over permutation groups**, AIP Conference Proceedings 2266, 060004 (2020); (doi: 10.1063/5.0018731)
6. Mathuri Selvarajoo, Fong Wan Heng, **Nor Haniza Sarmin**, Sherzod Turaev. **The Properties of Semi-Simple Splicing System Over Alternating Group, A3**, Journal of Physics Conference Series, 1770(1): 012001. Scopus.
7. Mathuri Selvarajoo, Fong Wan Heng, Nor Haniza Sarmin, and Sherzod Turaev. "**The properties of probabilistic simple regular sticker systems**", AIP Conference Proceedings 1682, 020047 (2015). (doi: 10.1063/1.4932456).

With Dr. Fong Wan Heng, Dr Mathuri, and Dr Hidayat Ullah during UTM convocation on 24 October 2015.

- **Title of research**:
  Second Order Limit Language and Its Properties in Yusof-Goode Splicing System

- **PhD in Mathematics:**
  2012 - 2015

Dr. Muhammad Azrin Ahmad

Lecturer, Faculty of Industrial Sciences & Technology, Universiti Malaysia Pahang

Research Grant:

Persistent and Permanent Properties of First Stage DNA Splicing Languages via Yusof-Goode Approach

25 Jun 2013 – 24 Jun 2015

Geran Penyelidikan Universiti, UMP (RDU 130354)

RM 32, 000.00

Dr Yuhani Yusof (UMP), Dr Norhayati Rosli (UMP), Dr. Mohd Sham Mohamad (UMP), Nadirah Mohd Nasir (UMP), **Prof. Dr. Nor Haniza Sarmin**

Publications:

1. Yuhani Yusof, **Nor Haniza Sarmin,** Fong Wan Heng, T. Elizabeth Goode and Muhammad Azrin Ahmad, **An Analysis of Four Variants of Splicing System**, *Proceedings of the 20th National Symposium on Mathematical Sciences (SKSM 20)*, AIP Conf. Proc., Vol 1522, 2013, pg. 888-895 (ISSN: 1551-7616).
2. Muhammad Azrin Ahmad, **Nor Haniza Sarmin**, Fong Wan Heng, Yuhani Yusof, **An Extension of First Order Limit Language**, *Proceedings of the 3rd International Conference on Mathematical Sciences (ICMS3)*, AIP Conf. Proc., Vol 1602, 2014, pg. 627-631. (ISBN: 978-0-7354-1236-1).
3. Muhammad Azrin Ahmad, **Nor Haniza Sarmin**, Yuhani Yusof and Wan Heng Fong, **Some Restrictions on the Existence of Second Order Limit Language**, *Proceedings of the 22nd National Symposium on Mathematical Sciences (SKSM 22)*, AIP Conf. Proc., Vol 1682, 2015, pg. 020048 1-7 (ISBN: 978-0-7354-1329-0).

Wet experiment at Universiti Teknologi Malaysia, 2015

Dr. Azrin on his convocation day, 22 October 2016.

- **Title of research**:
  The Modelling of Watson-Crick Petri Net and Place-Labelled Petri Net Controlled Grammar using Formal Language Theory

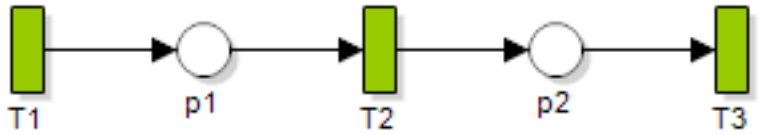
- **PhD in Mathematics:**
  2012 - 2016

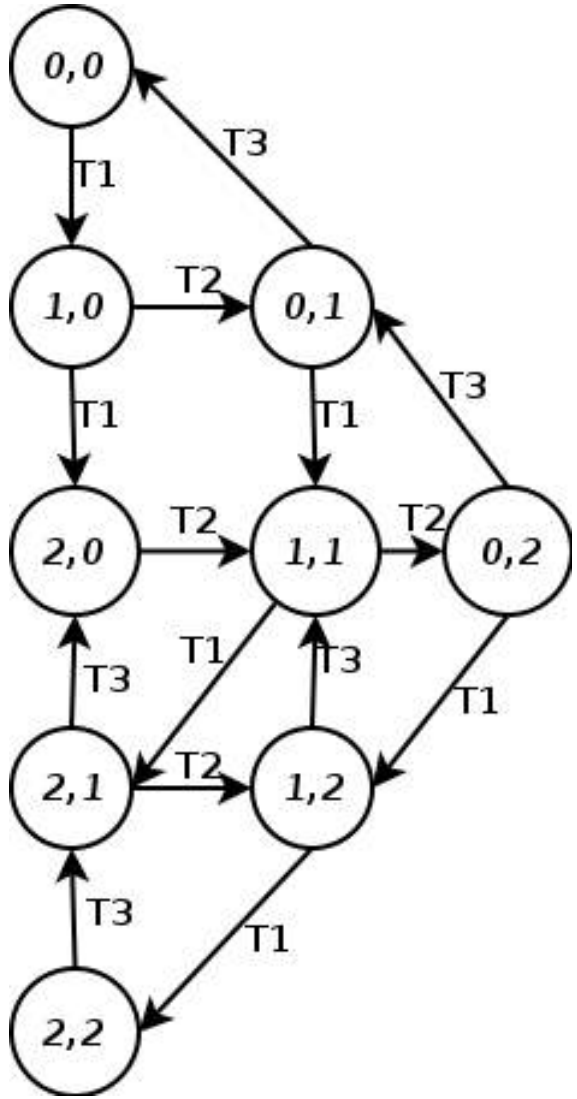
Dr. Nurhidaya Mohamad Jan

Senior Lecturer, Universiti Sains Islam Malaysia, Nilai, Negeri Sembilan

What is a Petri Net?

A Petri Net is **a graph model for the control behavior of systems exhibiting concurrency in their operation**. The graph is bipartite, the two node types being places drawn as circles, and transitions drawn as bars. The arcs of the graph are directed and run from places to transitions or vice versa.





Research Grant:

Watson-Crick Automata with Groups
1 May 2012 – 30 April 2013
Research University Fund (RUF) Vote No. Q.J130000.2626.05J15
RM 40, 000.00
Dr. Fong Wan Heng, **Prof. Dr. Nor Haniza Sarmin**

Regulated Splicing Systems and Formal Models for Food Authentication
1 October 2013 – 30 September 2016
Fundamental Research Grant Scheme (FRGS), MOHE (FRGS13-066-0307)
RM 96, 000.00
Asst. Prof. Dr. Sherzod Turaev, Prof. Dr. Irwandi Jaswir (IIUM), **Prof. Dr. Nor Haniza Sarmin**, Prof. Dr. Tengku Mohd Tengku Sembok (IIUM), Dr. Norsamerah Salleh (IIUM), Prof. Dr. Hamzah Salleh (IIUM), Asst. Prof. Dr. Imad Fakhri Taha Alshaikhli (IIUM).

A Fundamental Study on the Closure Properties of Watson-Crick Petri Net using Labelling Functions
1 December 2014 – 30 November 2016
Fundamental Research Grant Scheme (FRGS), MOHE (Vote No. R.J130000.7809.4F590)
RM 69, 400.00
Dr. Fong Wan Heng, **Prof. Dr. Nor Haniza Sarmin**, Dr. Nor Muhainiah Mohd Ali, Dr. Sherzod Turaev

Publications:

1. Nurhidaya Mohamad Jan, Sherzod Turaev, Fong Wan Heng, Nor Haniza Sarmin. “Place-labelled Petri Net Controlled Grammars”, ScienceAsia, 43S, 9 – 19, 2017.
2. Nurhidaya Mohamad Jan, Wan Heng Fong, Nor Haniza Sarmin, Sherzod Turaev, “State machine of place-labelled petri net controlled grammars”, Malaysian Journal of Fundamental and Applied Sciences, 13(4), 649-653, 2017.
3. Nurhidaya Mohamad Jan, Fong Wan Heng, Nor Haniza Sarmin and Sherzod Turaev, “k-Watson-Crick Petri Net Controlled Grammars”, International Journal of Applied Mathematics and Statistics (IJAMAS), Vol. 53(3) : 99-106, 2015.
4. Nurhidaya Mohamad Jan, FongWan Heng, Nor Haniza Sarmin, Sherzod Turaev. “Languages of Watson-Crick Petri Net”, Jurnal Teknologi (Sciences & Engineering) Special Issue in Science and Technology, 70(5): pg 97-101, 2014. (ISSN 2180-3722).

Dr. Nurhidaya Mohamad Jan and her family during her convocation on 29 April 2017.

Research Grant:

New Variants of Insertion and Deletion of Languages in Formal Language Theory using Indices as Restrictions
1 July 2016 – 30 June 2018
Research University Grant Grant (GUP), UTM (Vote No. Q.J130000.2526.13H18)
RM 50, 000.00
Dr. Fong Wan Heng, **Prof. Dr. Nor Haniza Sarmin**, Dr. Nor Muhainiah Mohd Ali, Dr. Sherzod Turaev

Publications:

1. Wan Heng Fong, **Nor Haniza Sarmin**, Sherzod Turaev and Ahmad Firdaus Yosman, **Generating Finite Cyclic and Dihedral Groups using Sequential Insertion Systems with Interactions**, AIP Conference Proceedings 1830, 070005 (2017). http://dx.doi.org/10.1063/1.4980954.

Research Grant:

Development of Second Order Limit Language in Various Splicing Models
25 August 2017 – 24 August 2019
Internal Grant, Universiti Malaysia Pahang, UMP (Vote No RDU1703278)
RM 20, 000.00
Dr. Muhammad Azrin Ahmad, Dr. Noraziah Adzhar, Dr. Mohd Sham Mohamad, **Prof. Dr. Nor Haniza Sarmin**

Publications:

1. Muhammad Azrin Ahmad, **Nor Haniza Sarmin,** Mohd Firdaus Abdul-Wahab, Fong Wan Heng, Yuhani Yusof, **Biomolecular Aspects of Second Order Limit Language**, Malaysian Journal of Fundamental and Applied Sciences 2018, 14(1): pg 15-19, (ISSN 2289-5981).

2014 2015 2016 2017 2018 2019 2020 2021 2022

- **Title of research**:
  Mathematical Modelling of DNA Splicing Systems with Palindromic and Non-Palindromic Restriction Enzymes

- **PhD in Mathematics:**
  2017 - 2021

Nurul Izzaty Ismail

Just Graduated

2014 2015 2016 2017 2018 2019 2020 2021 2022

Wet lab experiment Universiti Teknologi Malaysia, 2020

Publications:

1. Nurul Izzaty Ismail, Wan Heng Fong and **Nor Haniza Sarmin**, **Computation of Splicing Languages from DNA Splicing System with One Palindromic Restriction Enzyme**, Malaysian Journal of Fundamental and Applied Sciences 2018, 14(2): pg 188-192, (ISSN 2289-5981)
2. Wan Heng Fong, Nurul Izzaty Ismail and **Nor Haniza Sarmin**, **Automata for DNA Splicing Languages with Palindromic and Non-Palindromic Restriction Enzymes using Grammars**, MATEMATIKA: *Malaysian Journal of Industrial and Applied Mathematics,* December 2019, Special Issue: pg 1-14, (eISSN: 0127-9602)
3. Nurul Izzaty Ismail, Wan Heng Fong and **Nor Haniza Sarmin**, **DNA Splicing Systems with at Most Two Cutting Sites of a Non-Palindromic Restriction Enzyme**, MATEMATIKA: *Malaysian Journal of Industrial and Applied Mathematics,* 2019, 35(2): pg 129-137, (eISSN: 0127-9602)
4. Nurul Izzaty Ismail, Wan Heng Fong and **Nor Haniza Sarmin**, **Molecular aspects on generalisations of splicing languages**, AIP Conference Proceedings 2266, 060008 (2020); (doi: 10.1063/5.0018377)
5. Nurul Izzaty Ismail, Wan Heng Fong, **Nor Haniza Sarmin**, **Generalisations of Splicing Languages in DNA Splicing Systems Involving Two Palindromic Restriction Enzymes**, Malaysian Journal of Fundamental and Applied Sciences (MJFAS), WoS and Scopus. 17(2), 128-138, 2021.

- **Title of research**:
  New Computational Models for Biological Data Analysis Based on Static Watson-Crick Grammars

- **PhD in Mathematics:**
  Since 2017

Aqilahfarhana Abdul Rahman
Active Student

Publications:

1. Aqilahfarhana Abdul Rahman, Wan Heng Fong, **Nor Haniza Sarmin** and Sherzod Turaev**, Closure properties of static Watson-Crick linear and context-free grammars**, AIP Conference Proceedings 2266, 060005 (2020); (doi: 10.1063/5.0018350)
2. Aqilahfarhana Abdul Rahman, Wan Heng Fong, **Nor Haniza Sarmin**, Sherzod Turaev and Nurul Liyana Mohamad Zulkufli, **Static Watson-Crick Linear Grammars and Its Computational Power**, *Malaysian Journal of Industrial and Applied Mathematics (MATEMATIKA)*. 2019. 35(3): 283-296.
3. Aqilahfarhana Abdul Rahman, Wan Heng Fong, **Nor Haniza Sarmin**, Sherzod Turaev. **1-Normal Form for Static Watson-Crick Regular and Linear Grammars**, *ASM Science Journal*. 2019. 13, 1-7.
4. Wan Heng Fong, Aqilahfarhana Abdul Rahman, **Nor Haniza Sarmin** and Sherzod Turaev, **Static Watson-Crick Context-Free Grammars**, *International Journal of Online and Biomedical Engineering*. 2019. 15(10): 65-76.
5. Aqilahfarhana Abdul Rahman, Wan Heng Fong, **Nor Haniza Sarmin**, Sherzod Turaev and Nurul Liyana Mohamad Zulkufli, **Static Watson-Crick regular grammar**, *Malaysian Journal of Fundamental and Applied Sciences - Special Issue on Natural Sciences and Mathematics*. 2018. 457-462.

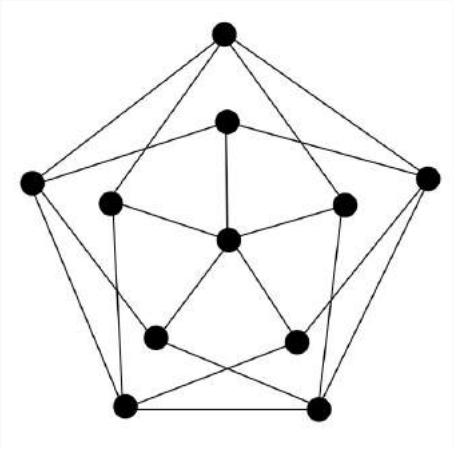
- **Title of research**:
  Spliced Graphs of Graph Splicing Systems
- **PhD in Mathematics:**
  Since 2019

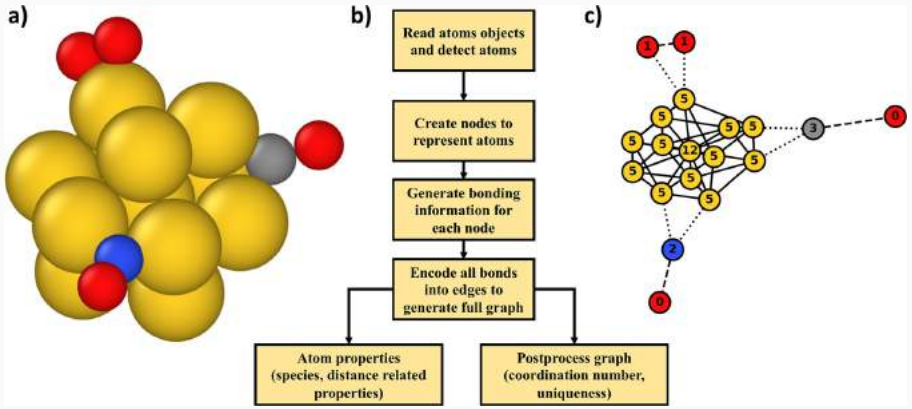
Muhammad Nur Syiham Abdul Razak

Active Student

Graph Theory

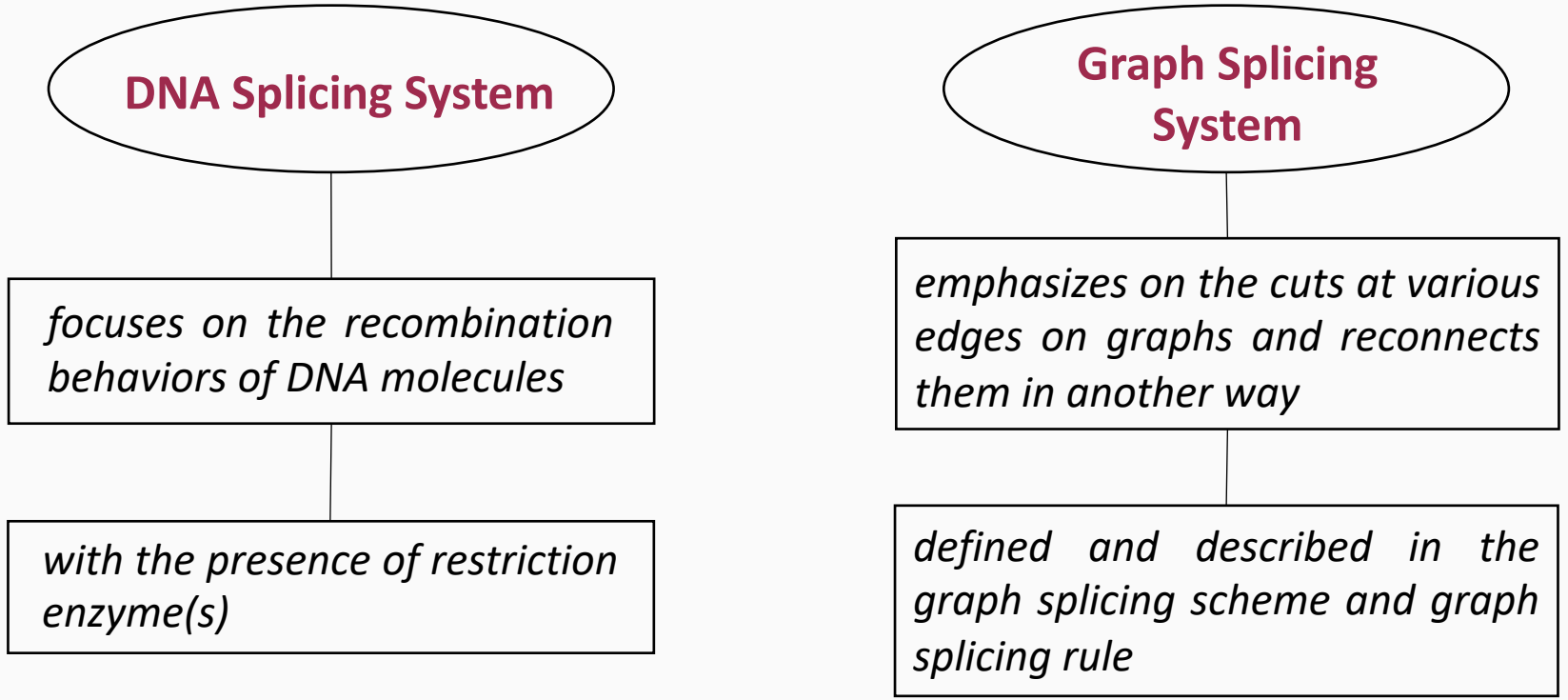
- Graph is mathematical structure consists of two finite sets called as vertex, V and edges, E.





Splicing System in Graph Theory

- Graph splicing system is originally introduced by Freund in 1995 to describe the DNA splicing system in the form of graphs instead of one-dimensional strings.



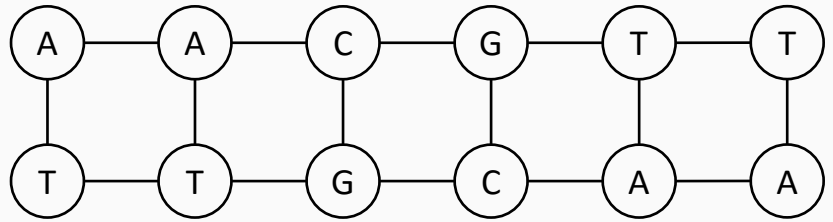
Freund, R. Splicing systems on graphs, in 1st Int. Symp. On Intelligence in Neural and Biological Systems, INBS'95 (IEEE, Washington, DC, 1995), 189-194.

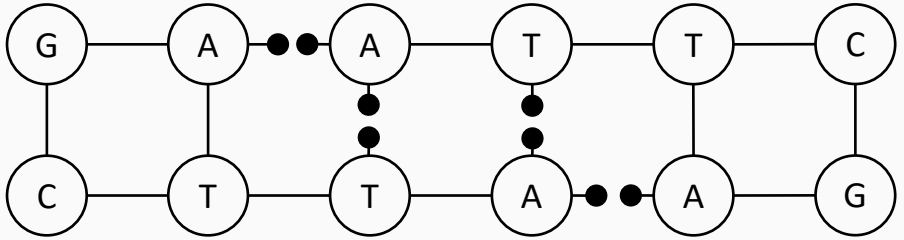
Graph Splicing Rule (Cont.)

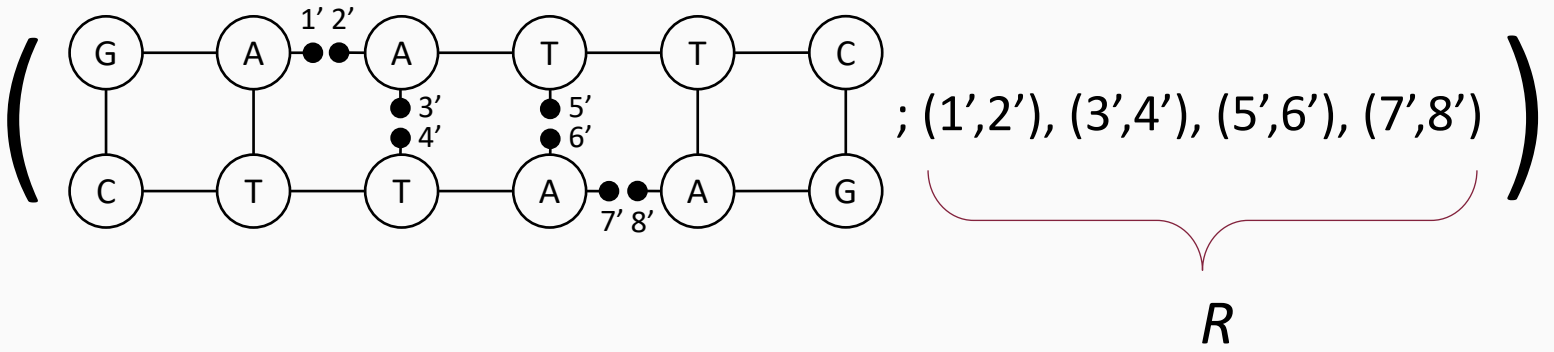
- A graph splicing rule consisting the enzyme *Acl*I can be written as follows.

$$p = ((h, E'); R)$$

*EcoR*I: $\begin{Bmatrix} \text{AA} & \text{CG} & \text{TT} \\ \text{TT'} & \text{GC'} & \text{AA} \end{Bmatrix}$

$h =$ 

$(h, E') =$ 

$p =$ 

Research Grant:

Graphs of a Mathematical Model Depicting Bonding in DNA Recombination using Formal Language Theory

1 October 2021 – 30 September 2023

UTMShine (Vote No. Q.J130000.2454.09G89)

RM 40, 000.00

AP. Dr. Fong Wan Heng, **Prof. Dr. Nor Haniza Sarmin**, AP. Dr. Nor Muhainiah Mohd Ali, Dr. Hazzirah Mat Hassim

Publications:

1. Muhammad Nur Syiham Abdul Razak, Wan Heng Fong, **Nor Haniza Sarmin**. **Folding Technique on n-Cut Spliced Semigraph in Splicing System**. In. AIP Conference Proceedings 2266: 060011 (2020); 1-10. (doi: 10.1063/5.0026045)
2. Muhammad Nur Syiham Abdul Razak, Wan Heng Fong and **Nor Haniza Sarmin**, **Graph splicing rules with cycle graph and its complement on complete graphs**, Journal of Physics: Conference Series, 1988: 012067, 2021.
3. Muhammad Nur Syiham Abdul Razak, Wan Heng Fong and **Nor Haniza Sarmin**. **Spliced Graphs of One Cutting Site in Graph Splicing Systems**. Proceedings of Science and Mathematics, Vol 7 (2022); 1-4
4. Wan Heng Fong, Muhammad Nur Syiham Abdul Razak and **Nor Haniza Sarmin**. **On n-Cut Splicing and Its Properties**, AIP Conference Proceedings 2465: 020016 (2022); (doi: 10.1063/5.0078670)

- **Title of research**:
  Bounded-Addition Fuzzy Splicing Systems and Their Variants
- **Master in Mathematics (UiTM)**:
  Since 2021
- **Main Supervisor**:
  Dr Mathuri Selvarajoo (UiTM)

Mohd Pawiro Santono bin Othman

Active Student

Research Grant:

A Theoretical DNA Based Computer Model for Food Authentification Process

September 2019 – August 2021

RACER/1/2019/STG06/UITM//1

RM 51, 200.00

Dr. Mathuri Selvarajoo, AP. Dr. Fong Wan Heng, **Prof. Dr. Nor Haniza Sarmin**.

Publications:

1. Mohd Pawiro Santono, Mathuri Selvarajoo, Wan Heng Fong, **Nor Haniza Sarmin**. **Some Properties of Bounded-Addition Fuzzy Splicing Systems**, Kalahari Journals, vol. 6, no. 3, pp. 2698–2705, 2021

2. Mohd Pawiro Santono, Mathuri Selvarajoo, Wan Heng Fong and **Nor Haniza Sarmin**, **Bounded-Addition Fuzzy Simple Splicing Systems**, Journal of Algebraic Statistics, vol. 13, no. 2, pp. 2079–2089, 2022.

Active Collaborator on DNA Splicing System

Focus of study:

1. Formal Languages and Automata
2. DNA Computing
3. Artificial Intelligence
4. Cryptography

Ass. Prof. Dr. Sherzod Turaev

College of Information Technology, United Arab Emirates University

Active Collaborator on DNA Splicing System

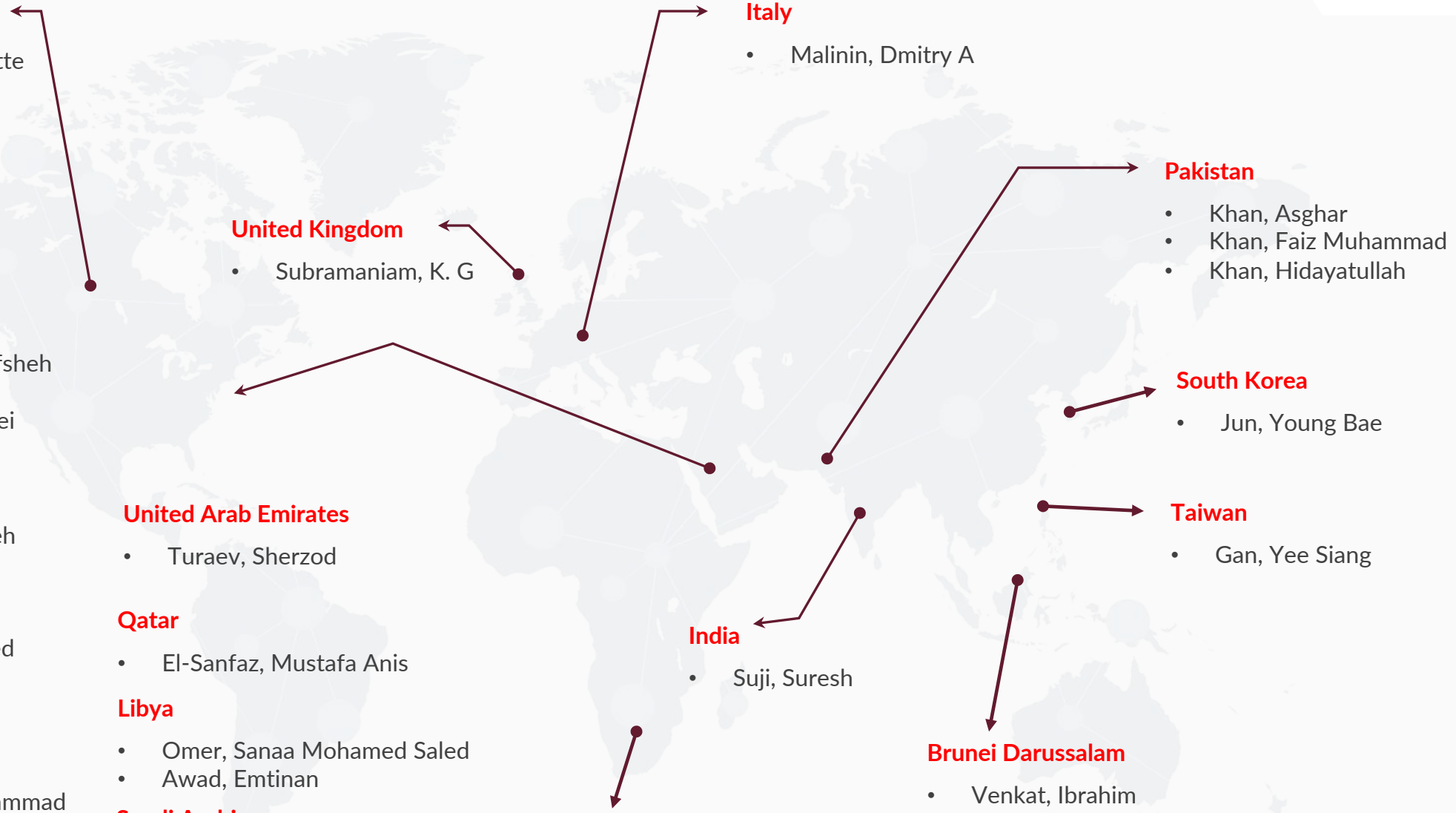
Focus of study:

1. Spectral of Laplacian hypergraph and graph
2. Distance matrices and quadratic embedding of graphs
3. Machine learning
4. DNA sequencing

Dr. Alfi Yusrotis Zakiyyah

Lecturer in Mathematics and Statistics, School of Computer Science, Bina Nusantara University, Jakarta, Indonesia

My Collaborators Around the World



United States
- Kappe, Luise-Charlotte
- Goode, Elizabeth
- Beuerle, James R
- Visscher, Matthew P

Italy
- Malinin, Dmitry A

United Kingdom
- Subramaniam, K. G

Pakistan
- Khan, Asghar
- Khan, Faiz Muhammad
- Khan, Hidayatullah

Iran
- Davvaz, Bijan
- Mohammad Reza Darafsheh
- Ahmad Erfanian
- Mohammad Reza Molaei
- Tolue, Behnaz
- Rashid, Samad
- Moradipour, Kayvan
- Karimi, Fariba A.Hediyeh
- Jahandideh, M
- Barakat, Yasamin
- Ghouchan, Mohammad Farrokhi Derakhshanded
- Jafarabadi, Hossein M
- Rashid, Samad

South Korea
- Jun, Young Bae

Taiwan
- Gan, Yee Siang

United Arab Emirates
- Turaev, Sherzod

Qatar
- El-Sanfaz, Mustafa Anis

India
- Suji, Suresh

Libya
- Omer, Sanaa Mohamed Saled
- Awad, Emtinan

Brunei Darussalam
- Venkat, Ibrahim

Iraq
- Khasraw, Sanhan Muhammad Salih
- Samin, Nizar Majeed
- Mohialdeen, Vian Salah

Saudi Arabia
- Mukhtar, Safyan

South Africa
- Engelbrecht, Andries Petrus
- Russo, Francesco G

Acknowledgment

Department of Mathematical Sciences and Faculty of Science

Lecturer, since 2 May 1991; Head, Department of Postgraduate Studies (2007 – 2012)

Acknowledgment

School of Postgraduate Studies (SPS)

Deputy Dean
Program Development & Customer Relation
April 1, 2014 – March 31, 2016

Deputy Dean
Admission & Customer Relation
August 1, 2012 – March 31, 2014

Acknowledgment
UTM International

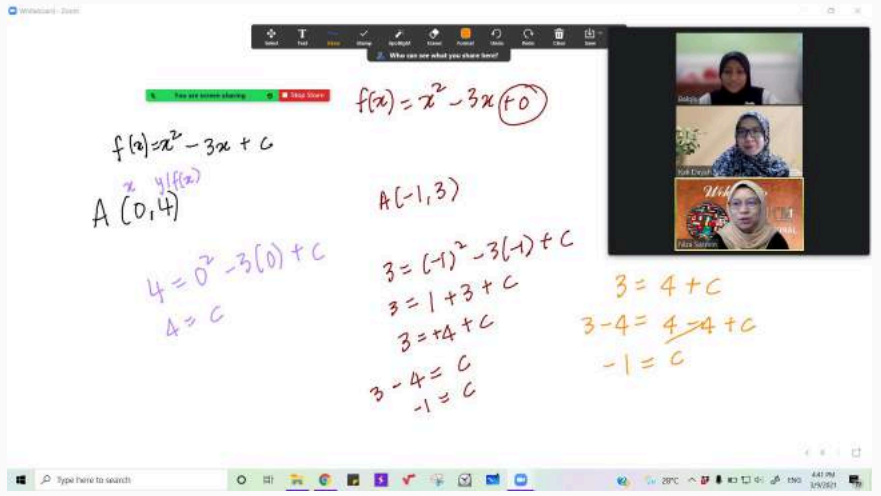
Acting Director
Since 1 August 2022

Associate Director
Global Strategy and Engagement
August 15, 2019 – December 31, 2022

Associate Director
Student Services and Global Education Experience
April 1, 2018 – August 14, 2019

Director
Global Education and Student Experience
April 1, 2016 – March 31, 2018

Acknowledgment
UTM International

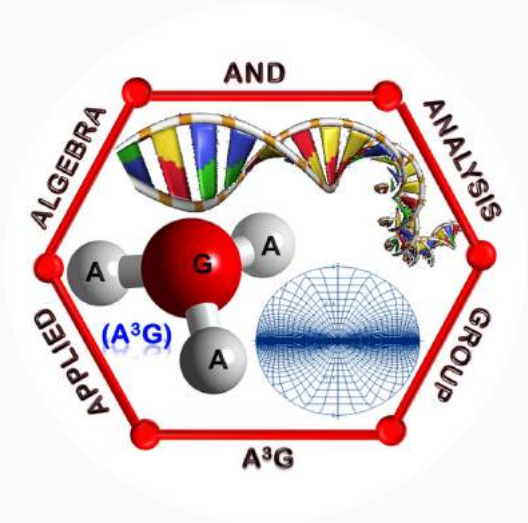


Acknowledgment

Universiti Teknologi Malaysia

Acknowledgment

Applied Algebra and Analysis Group (AAAG)



Acknowledgment

PhD Students (49 students)

Acknowledgment

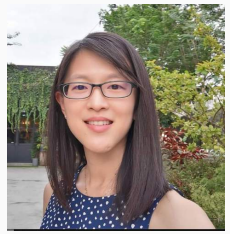
Master Students (28 students)



Idariyana








Abir Naser

Nizar Samin










Acknowledgment

Persatuan Sains Matematik Malaysia (PERSAMA)

Acknowledgment

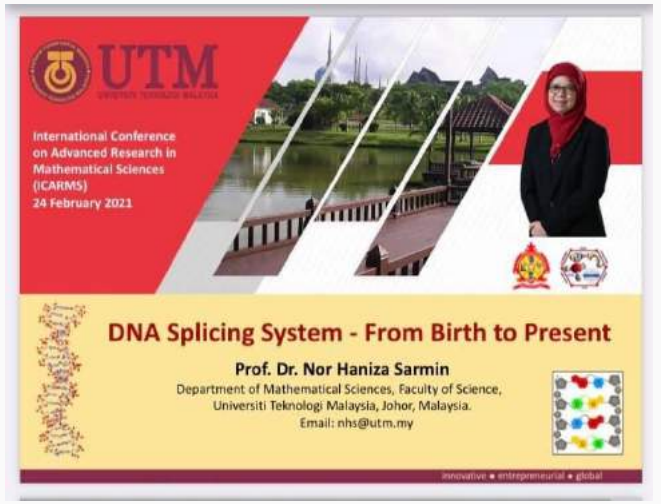
UTM Toastmasters Club (UTMTMC)

UTM TOASTMASTERS CLUB

Members since 2016

Acknowledgment

UTM Toastmasters Club (UTMTMC)



Dedication ❤

Prof Luise-Charlotte Kappe

May 1998

Dedication ❤

Prof Luise-Charlotte Kappe

Viva Day,
1998

Virtual Conference,
2021

Special Acknowledgment

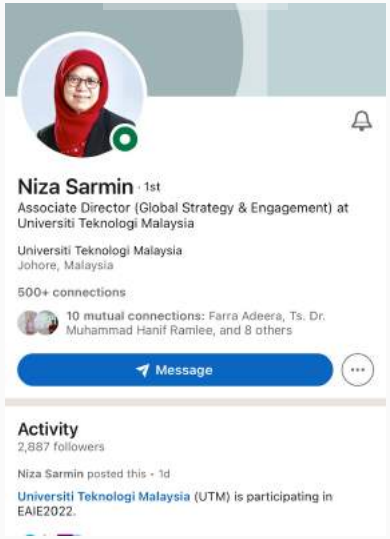
My family

My Social Medias

Website

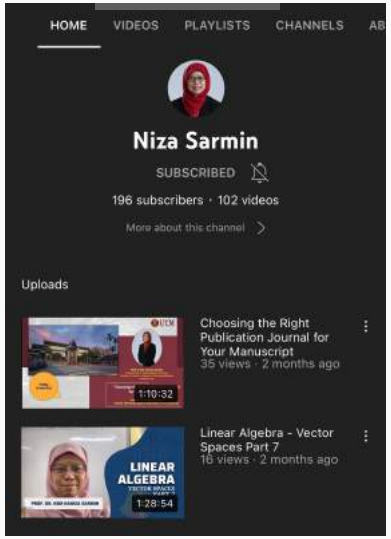
https://people.utm.my/nizasarmin/

Linked In



Niza Sarmin

Youtube



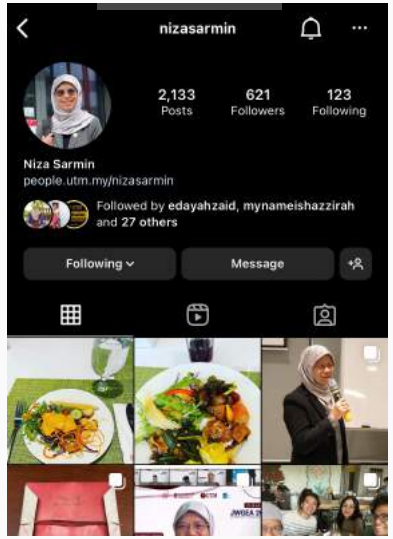
Niza Sarmin

Facebook

Niza Sarmin

Twitter

Instagram



nhs@utm.my

In the Name of God for Mankind

w w w . u t m . m y

Credit slides:

Muhammad Nur Syiham Abdul Razak

Thank you!