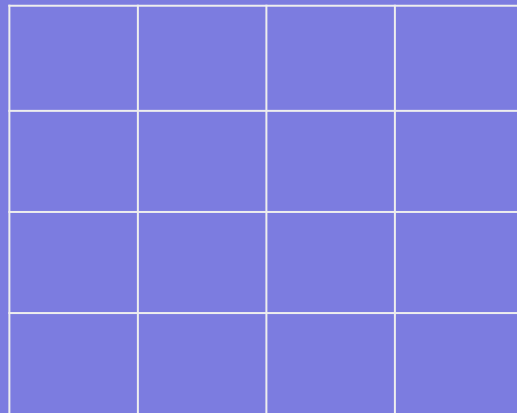


MAGIC OR MATHEMATICS ?!?

Prerona Chatterjee

NISER Bhubaneswar

THE POWER OF TWO !!



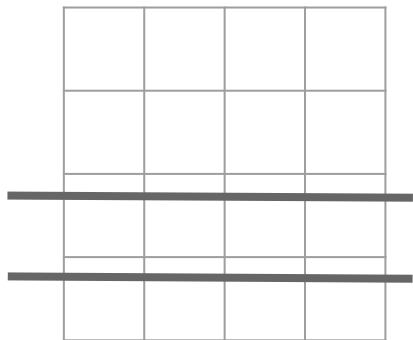
Fill arbitrarily
with red/black.

THE POWER OF TWO!!

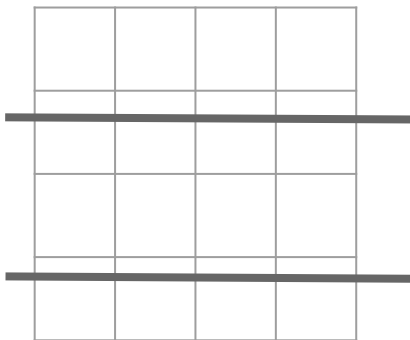
$B \equiv b_0 \ b_1 \ b_2 \ b_3 \in \{0,1\}^4$

0 : #black is even
1 : #black is odd

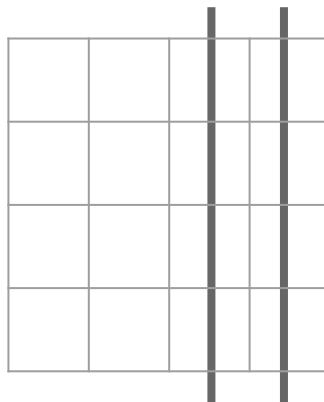
b_0



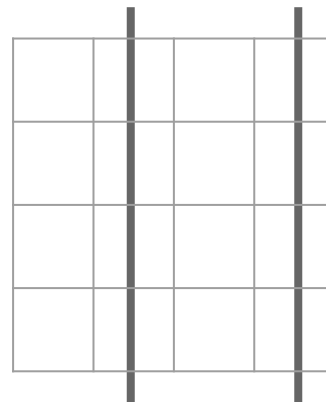
b_1



b_2



b_3



Given: Grid corresponding to
a0 a1 a2 a3

Given: Grid corresponding to
a0 a1 a2 a3

Want: Grid corresponding to
c0 c1 c2 c3

Given: Grid corresponding to
a0 a1 a2 a3

Want: Grid corresponding to
c0 c1 c2 c3

Step 1: Find b0 b1 b2 b3
such that

$$\begin{array}{rcccc} & a_0 & a_1 & a_2 & a_3 \\ \oplus & b_0 & b_1 & b_2 & b_3 \\ \hline & c_0 & c_1 & c_2 & c_3 \\ \hline \end{array}$$

Given: Grid corresponding to
a0 a1 a2 a3

Want: Grid corresponding to
c0 c1 c2 c3

Step 1: Find b0 b1 b2 b3
such that

$$\begin{array}{rcccc} & a_0 & a_1 & a_2 & a_3 \\ \oplus & b_0 & b_1 & b_2 & b_3 \\ \hline & c_0 & c_1 & c_2 & c_3 \\ \hline \end{array}$$

XOR (ADDITION MOD 2)

$$0 \oplus 0 = 0 = 1 \oplus 1$$

$$0 \oplus 1 = 1 = 1 \oplus 0$$

Given: Grid corresponding to
a0 a1 a2 a3

Want: Grid corresponding to
c0 c1 c2 c3

Step 1: Find b0 b1 b2 b3
such that

$$\begin{array}{rcccc} & a0 & a1 & a2 & a3 \\ \oplus & b0 & b1 & b2 & b3 \\ \hline & c0 & c1 & c2 & c3 \\ \hline \end{array}$$

XOR (ADDITION MOD 2)

$$0 \oplus 0 = 0 = 1 \oplus 1$$

$$0 \oplus 1 = 1 = 1 \oplus 0$$

	a0	a1	a2	a3
$\oplus$	b0	b1	b2	b3
	a0 $\oplus$ b0	a1 $\oplus$ b1	a2 $\oplus$ b2	a3 $\oplus$ b3

Given: Grid corresponding to
a0 a1 a2 a3

Want: Grid corresponding to
c0 c1 c2 c3

Step 1: Find b0 b1 b2 b3
such that

$$\begin{array}{rcccc} & a0 & a1 & a2 & a3 \\ \oplus & b0 & b1 & b2 & b3 \\ \hline & c0 & c1 & c2 & c3 \\ \hline \end{array}$$

XOR (ADDITION MOD 2)

$$0 \oplus 0 = 0 = 1 \oplus 1$$

$$0 \oplus 1 = 1 = 1 \oplus 0$$

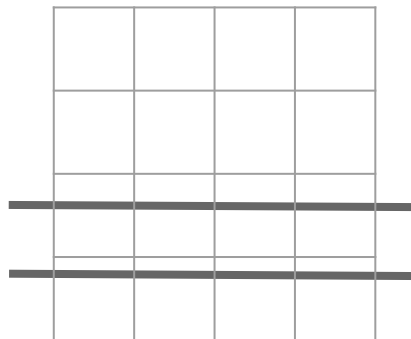
	a0	a1	a2	a3
$\oplus$	b0	b1	b2	b3
	a0 $\oplus$ b0	a1 $\oplus$ b1	a2 $\oplus$ b2	a3 $\oplus$ b3

Ans: a0 $\oplus$ c0 a1 $\oplus$ c1 a2 $\oplus$ c2 a3 $\oplus$ c3

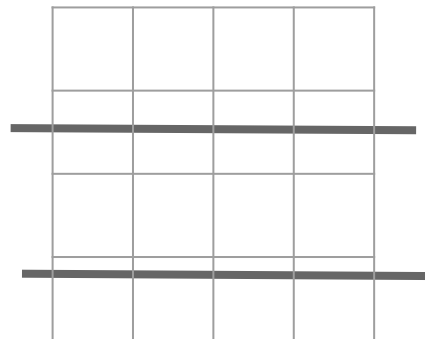
Step 2: Find position to switch
such that grid now
corresponds to c_0 c_1 c_2 c_3

Step 2: Find position to switch
such that grid now
corresponds to c_0 c_1 c_2 c_3

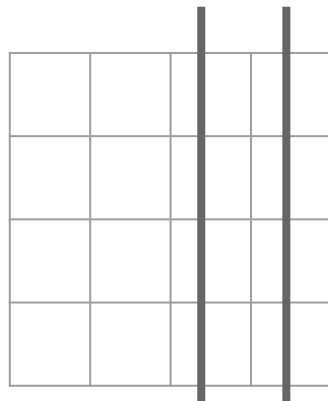
b_0



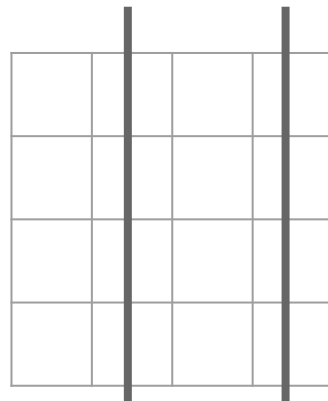
b_1



b_2



b_3

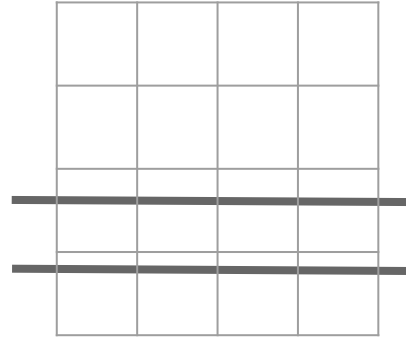


Step 2: Find position to switch
such that grid now
corresponds to c_0 c_1 c_2 c_3

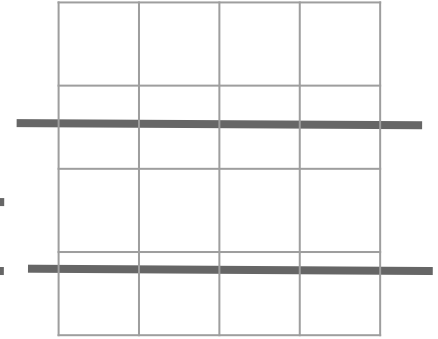
1 : One of the marked grid
points must be switched.

0 : None of the marked grid
points must be switched.

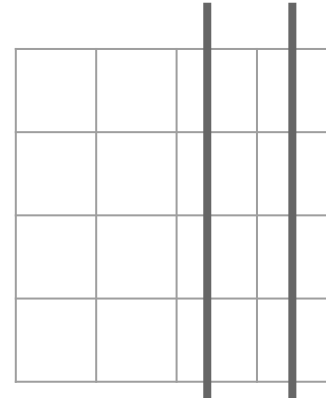
b_0



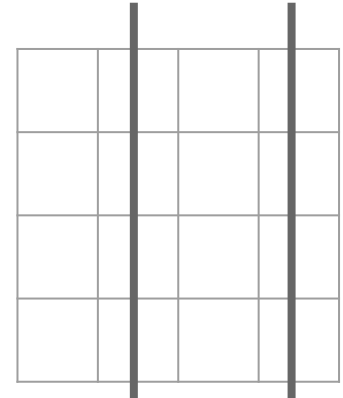
b_1



b_2



b_3



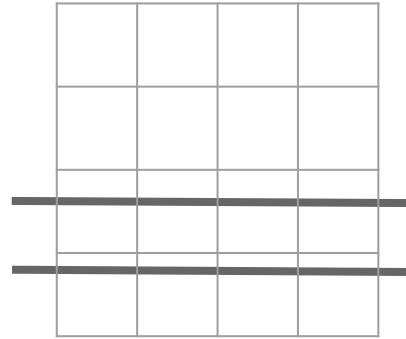
Step 2: Find position to switch
such that grid now
corresponds to c0 c1 c2 c3

1 : One of the marked grid
points must be switched.

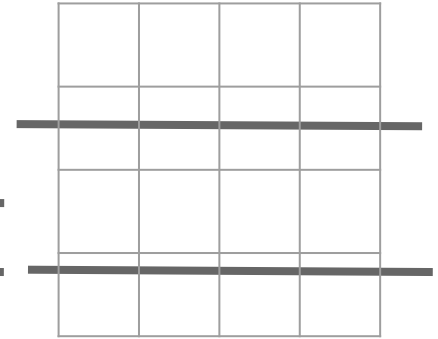
0 : None of the marked grid
points must be switched.

0000	0001	0010	0011
0100	0101	0110	0111
1000	1001	1010	1011
1100	1101	1110	1111

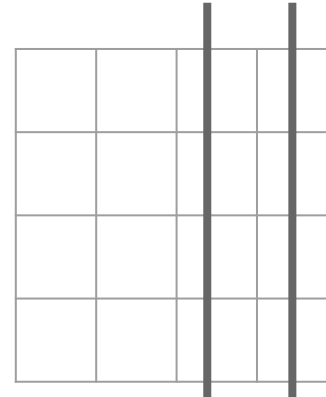
b0



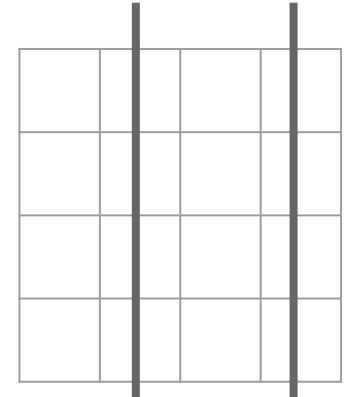
b1



b2



b3



CODING THEORY

Corruption of Data

- Weak Signal
- Cables affected
- Damaged SD Card

CODING THEORY

Corruption of Data

- Weak Signal
- Cables affected
- Damaged SD Card

Corruption can happen...

Either because the channel
is affected

Or damage occurs over time.

CODING THEORY

REINFORCING THE DATA TO HANDLE CORRUPTION

Message

Corruption of Data

- Weak Signal
- Cables affected
- Damaged SD Card

Corruption can happen...

Either because the channel
is affected

Or damage occurs over time.

CODING THEORY

Corruption of Data

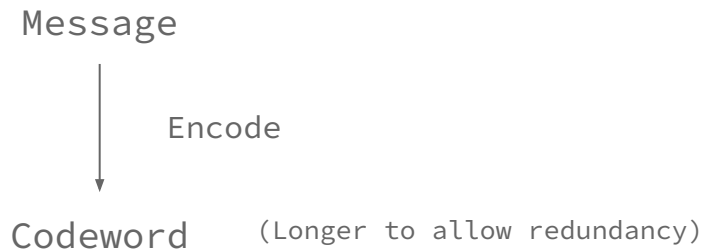
- Weak Signal
- Cables affected
- Damaged SD Card

Corruption can happen...

Either because the channel
is affected

Or damage occurs over time.

REINFORCING THE DATA TO HANDLE CORRUPTION



CODING THEORY

Corruption of Data

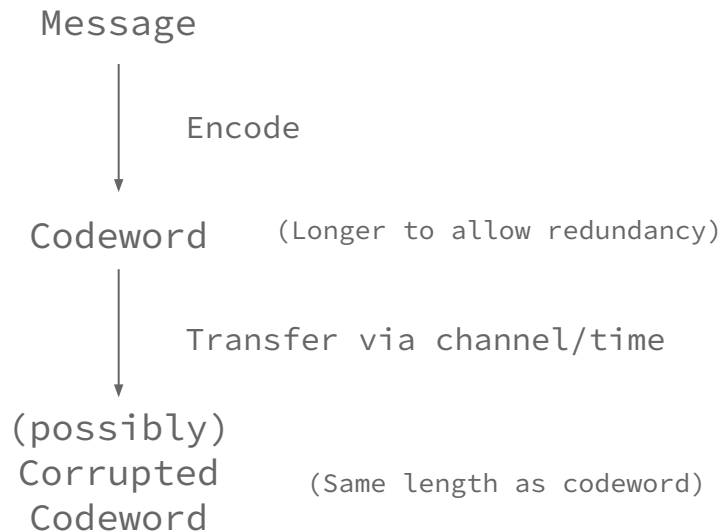
- Weak Signal
- Cables affected
- Damaged SD Card

Corruption can happen...

Either because the channel
is affected

Or damage occurs over time.

REINFORCING THE DATA TO HANDLE CORRUPTION



CODING THEORY

Corruption of Data

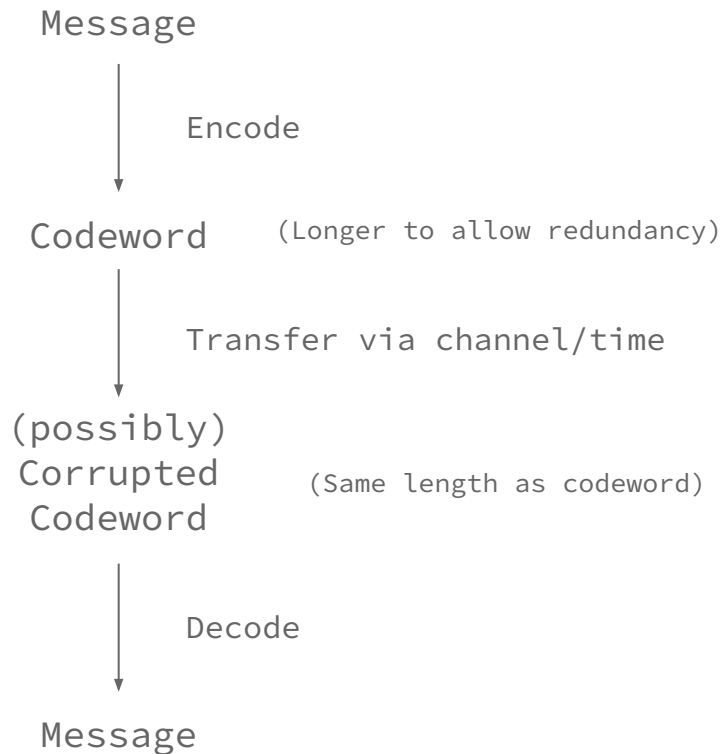
- Weak Signal
- Cables affected
- Damaged SD Card

Corruption can happen...

Either because the channel
is affected

Or damage occurs over time.

REINFORCING THE DATA TO HANDLE CORRUPTION



CODING THEORY

Corruption of Data

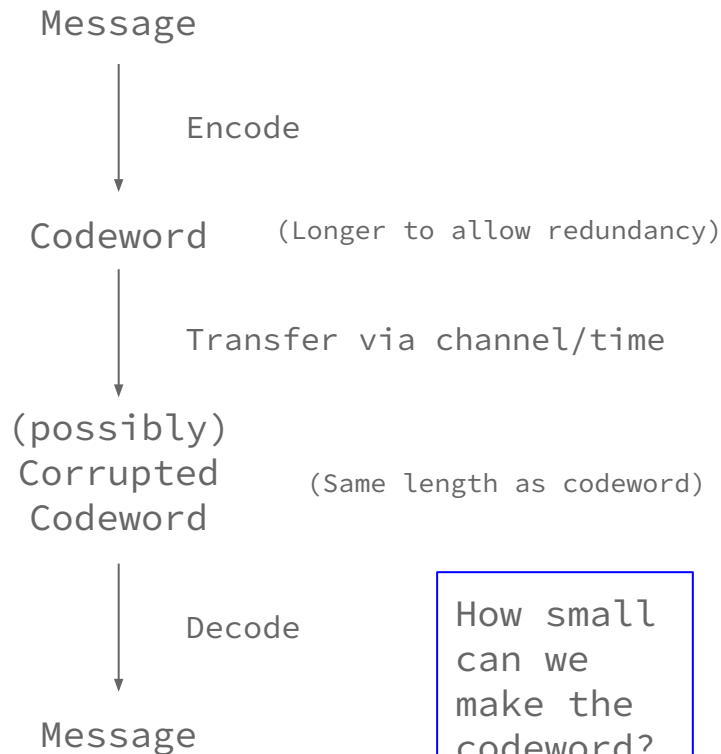
- Weak Signal
- Cables affected
- Damaged SD Card

Corruption can happen...

Either because the channel
is affected

Or damage occurs over time.

REINFORCING THE DATA TO HANDLE CORRUPTION



How small
can we
make the
codeword?

SENDING SECRET
MESSAGES!!

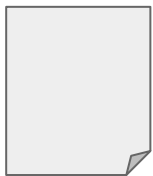
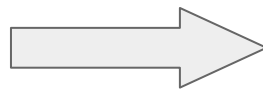
SENDING SECRET MESSAGES



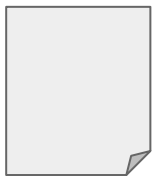
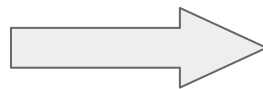
SENDING SECRET MESSAGES



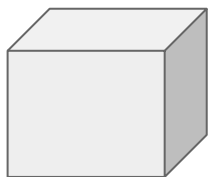
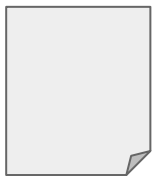
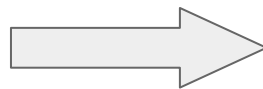
SENDING SECRET MESSAGES



SENDING SECRET MESSAGES



SENDING SECRET MESSAGES



SENDING SECRET MESSAGES

- A puts the note in the box and locks it. Gives it to B.

SENDING SECRET MESSAGES

- A puts the note in the box and locks it. Gives it to B.
- B gives it to C.

SENDING SECRET MESSAGES

- A puts the note in the box and locks it. Gives it to B.
- B gives it to C.
- C adds their lock as well. Gives it to B.

SENDING SECRET MESSAGES

- A puts the note in the box and locks it. Gives it to B.
- B gives it to C.
- C adds their lock as well. Gives it to B.
- B gives it to A.

SENDING SECRET MESSAGES

- A puts the note in the box and locks it. Gives it to B.
- B gives it to C.
- C adds their lock as well. Gives it to B.
- B gives it to A.
- A removes their lock using their key. Gives it to B.

SENDING SECRET MESSAGES

- A puts the note in the box and locks it. Gives it to B.
- B gives it to C.
- C adds their lock as well. Gives it to B.
- B gives it to A.
- A removes their lock using their key. Gives it to B.
- B gives it to C.

SENDING SECRET MESSAGES

- A puts the note in the box and locks it. Gives it to B.
- B gives it to C.
- C adds their lock as well. Gives it to B.
- B gives it to A.
- A removes their lock using their key. Gives it to B.
- B gives it to C.
- C unlocks their lock using their key to reveal note.

SENDING SECRET MESSAGES

- A puts the note in the box and locks it. Gives it to B.
- B gives it to C.
- C adds their lock as well. Gives it to B.
- B gives it to A.
- A removes their lock using their key. Gives it to B.
- B gives it to C.
- C unlocks their lock using their key to reveal note.

This protocol is secure assuming B does not have any equipment to break the lock.

CRYPTOGRAPHY

When one is setting up any kind of password:

- UPI Pin
- GMail Password
- Netbanking Password

CRYPTOGRAPHY

When one is setting up any kind of password:

- UPI Pin
- GMail Password
- Netbanking Password

Or when two parties are communicating for the first time and want to set up a “secure” line..

CRYPTOGRAPHY

When one is setting up any kind of password:

- UPI Pin
- GMail Password
- Netbanking Password

Or when two parties are communicating for the first time and want to set up a “secure” line..

They use the “Diffie Helman Key Exchange Protocol”.

CRYPTOGRAPHY

When one is setting up any kind of password:

- UPI Pin
- GMail Password
- Netbanking Password

Or when two parties are communicating for the first time and want to set up a “secure” line..

They use the “Diffie Helman Key Exchange Protocol”.

DIFFIE-HELMAN KEY EXCHANGE



f : EASY TO COMPUTE BUT HARD TO INVERT FUNCTION

IN REAL-LIFE: $f \equiv$ MULTIPLYING 2 LARGE PRIME NUMBERS

CRYPTOGRAPHY

When one is setting up any kind of password:

- UPI Pin
- GMail Password
- Netbanking Password

Or when two parties are communicating for the first time and want to set up a “secure” line..

They use the “Diffie Helman Key Exchange Protocol”.

Q: How to communicate via a messenger you don't trust?

DIFFIE-HELMAN KEY EXCHANGE



f : EASY TO COMPUTE BUT HARD TO INVERT FUNCTION

IN REAL-LIFE: $f \equiv$ MULTIPLYING 2 LARGE PRIME NUMBERS

CRYPTOGRAPHY

When one is setting up any kind of password:

- UPI Pin
- GMail Password
- Netbanking Password

Or when two parties are communicating for the first time and want to set up a “secure” line..

They use the “Diffie Helman Key Exchange Protocol”.

Q: How to communicate via a messenger you don't trust?

Ans: Encryption and Decryption !!

DIFFIE-HELMAN KEY EXCHANGE



f : EASY TO COMPUTE BUT HARD TO INVERT FUNCTION

IN REAL-LIFE: $f \equiv$ MULTIPLYING 2 LARGE PRIME NUMBERS

CRYPTOGRAPHY

When one is setting up any kind of password:

- UPI Pin
- GMail Password
- Netbanking Password

Or when two parties are communicating for the first time and want to set up a “secure” line..

They use the “Diffie Helman Key Exchange Protocol”.

Q: How to communicate via a messenger you don't trust?

Ans: Encryption and Decryption !!

Alter the message to make it look meaningless in such a way that if you have the “key” you can “decrypt”

DIFFIE-HELMAN KEY EXCHANGE



F : EASY TO COMPUTE BUT HARD TO INVERT FUNCTION

IN REAL-LIFE: $F \equiv$ MULTIPLYING 2 LARGE PRIME NUMBERS

BACKUP GAMES

USING PROBABILITIES

Interactive Proofs

How does one make sure that those claiming to be experts are actually so?

Keep asking questions till you are (almost) sure... :)

USING PROBABILITIES

Interactive Proofs

How does one make sure that those claiming to be experts are actually so?

Keep asking questions till you are (almost) sure... :)

Secure Computation

How does one solve a problem as a team when no one trusts anyone?

Ensuring Privacy: Don't reveal anything more than necessary.

USING PROBABILITIES

Interactive Proofs

How does one make sure that those claiming to be experts are actually so?

Keep asking questions till you are (almost) sure... :)

Secure Computation

How does one solve a problem as a team when no one trusts anyone?

Ensuring Privacy: Don't reveal anything more than necessary.

These can't be done always.
The question is for what problems can these be done?

THEORETICAL COMPUTER SCIENCE

- A PROBLEM THAT NEEDS TO BE SOLVED.

- A PROBLEM THAT NEEDS TO BE SOLVED.
- A MATHEMATICAL MODEL THAT DESCRIBES THE ABILITIES/RESTRICTIONS OF THE SOLVER.

- A PROBLEM THAT NEEDS TO BE SOLVED.
- A MATHEMATICAL MODEL THAT DESCRIBES THE ABILITIES/RESTRICTIONS OF THE SOLVER.

STUDY THE AMOUNT OF RESOURCES NEEDED BY
THE MODEL TO SOLVE THE PROBLEM.

HIGHER STUDIES IN
MATH/CS THEORY

EXAMS AND INSTITUTES

Undergraduate Level

- JEE (IISc, IITs & NITs)
- CMI
- ISI
- IAT (IISERs)
- NEST (NISER and CEBS)

Graduate Level (PhD/Int. PhD)

- NET
- GATE
- JEST
- TIFR-GS
- NBHM

TIFR, IISc,
CMI, ISI, HRI,
NISER, ISI,
IISERs, IITs.

Master's Level

- JAM (for MSc in IISc, IITs & NITs)
- GATE (for MTech in IITs and NITs)
- CMI
- ISI

THANK YOU !

[prerona.ch @ gmail.com](mailto:prerona.ch@gmail.com)

<https://preronac.bitbucket.io/>