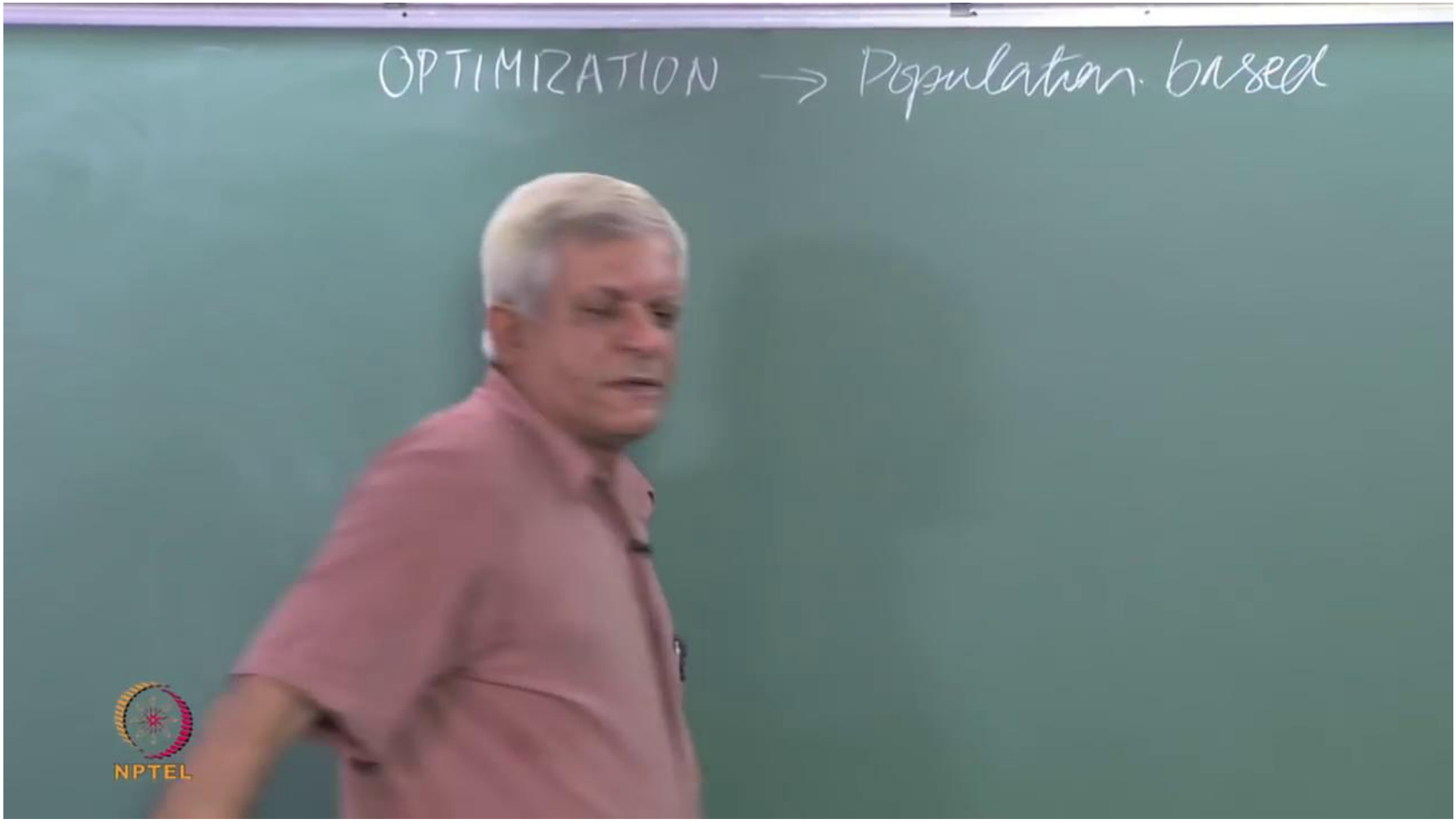
Video Lectures On

Artificial Intelligence

Lecture 16

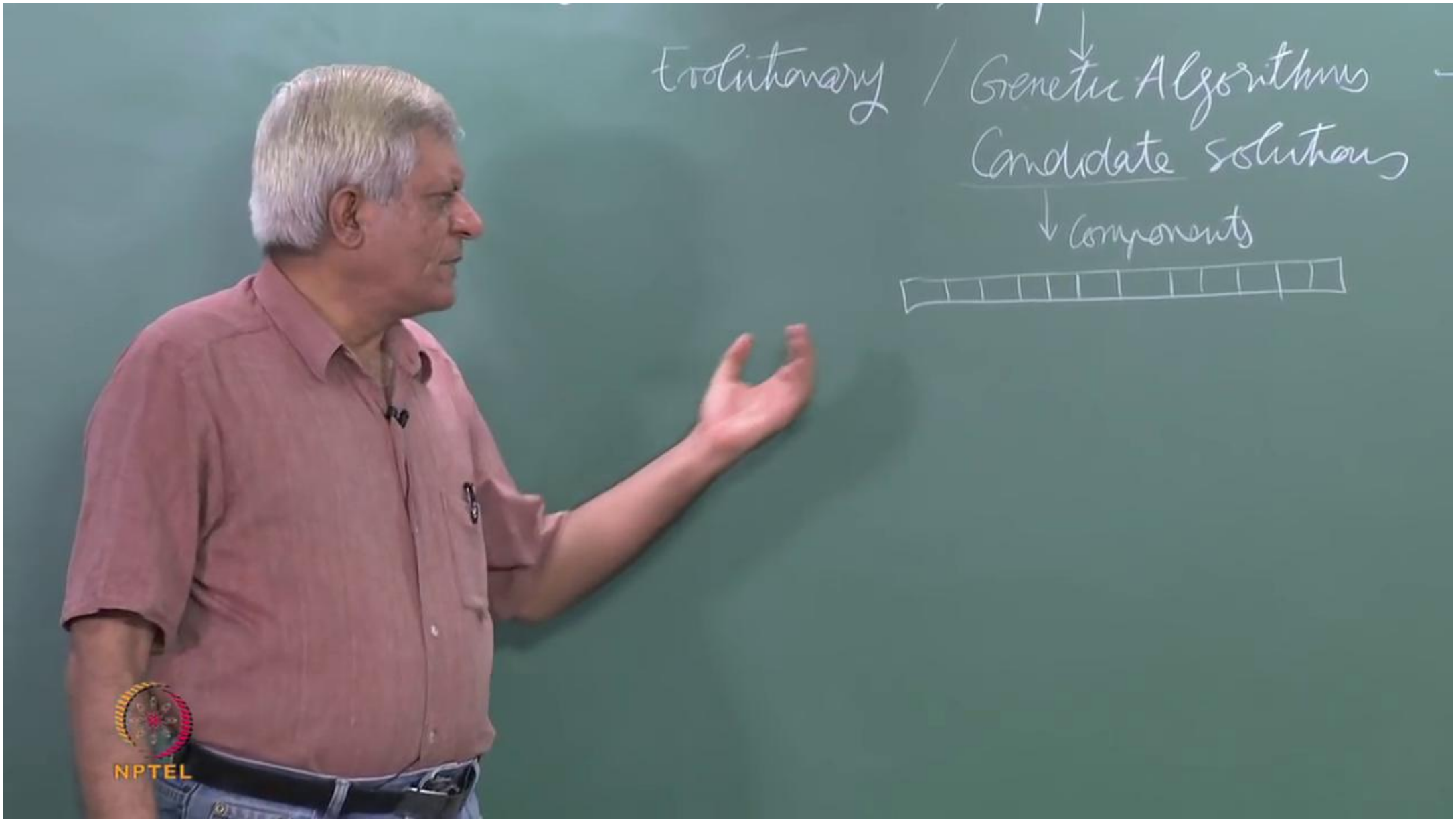
Population Based Methods for Optimization

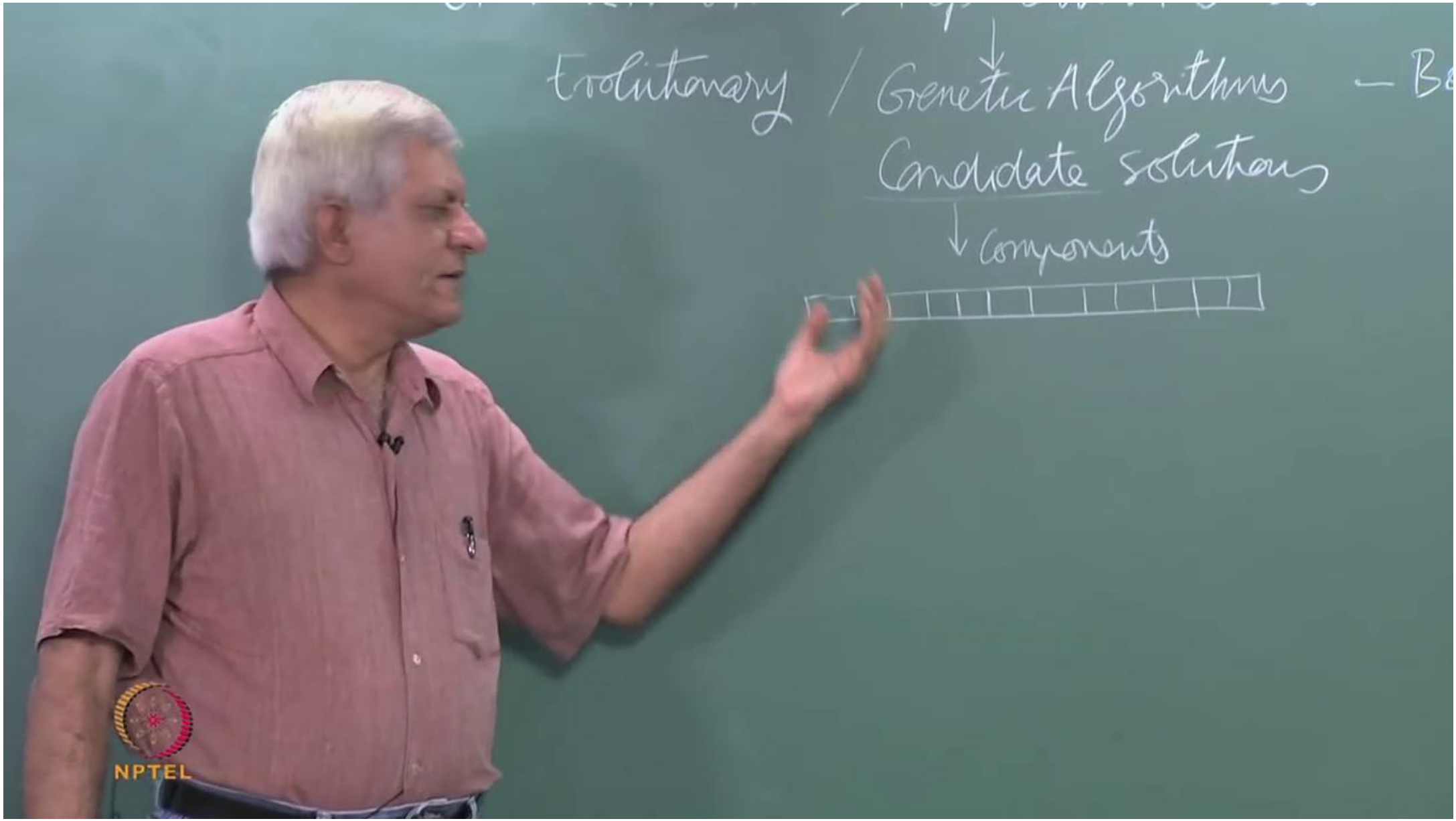
Prof. Deepak Khemani
Department of Computer Science
IIT Madras

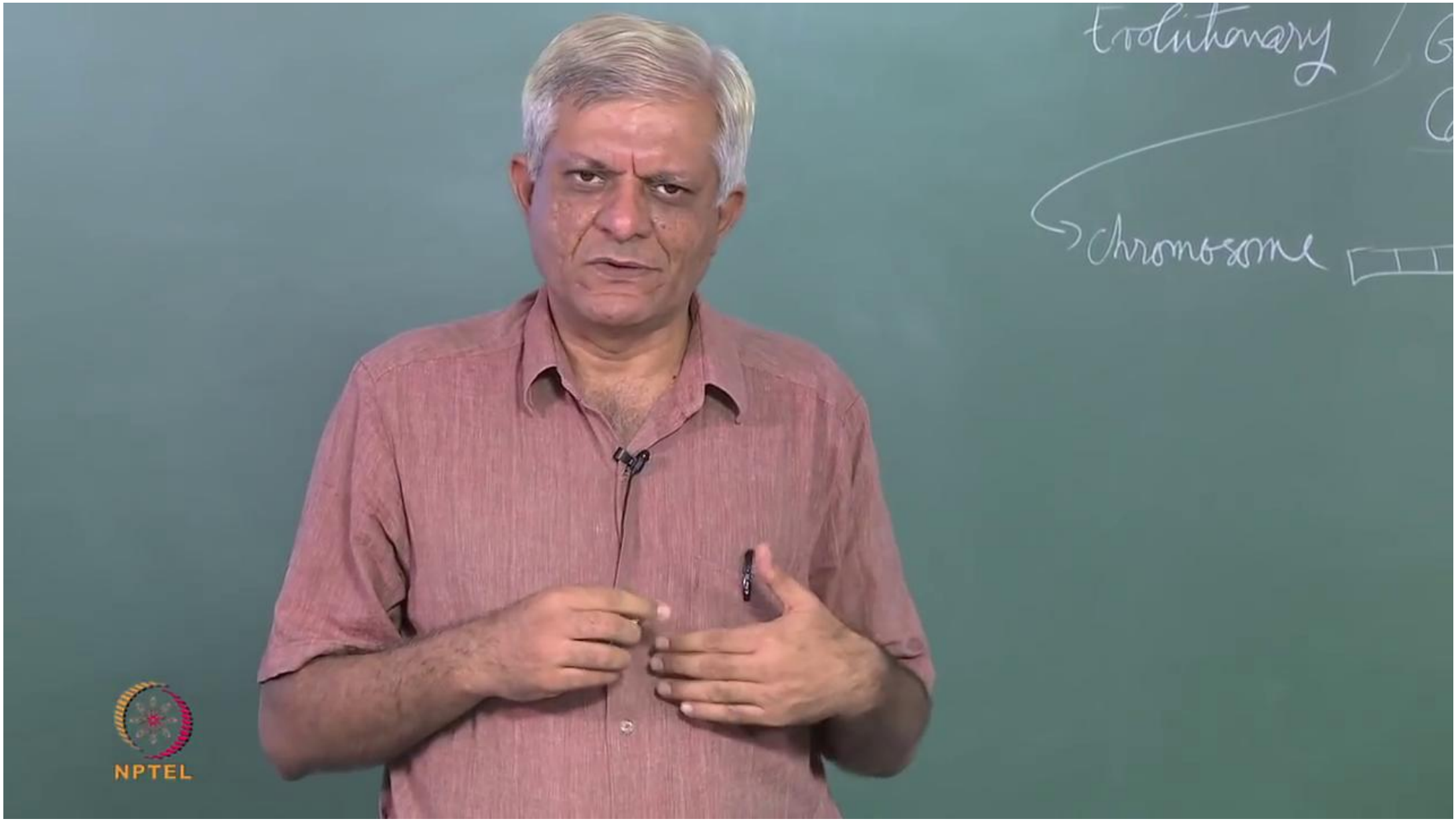

OPTIMIZATION → Population based
NPTEL

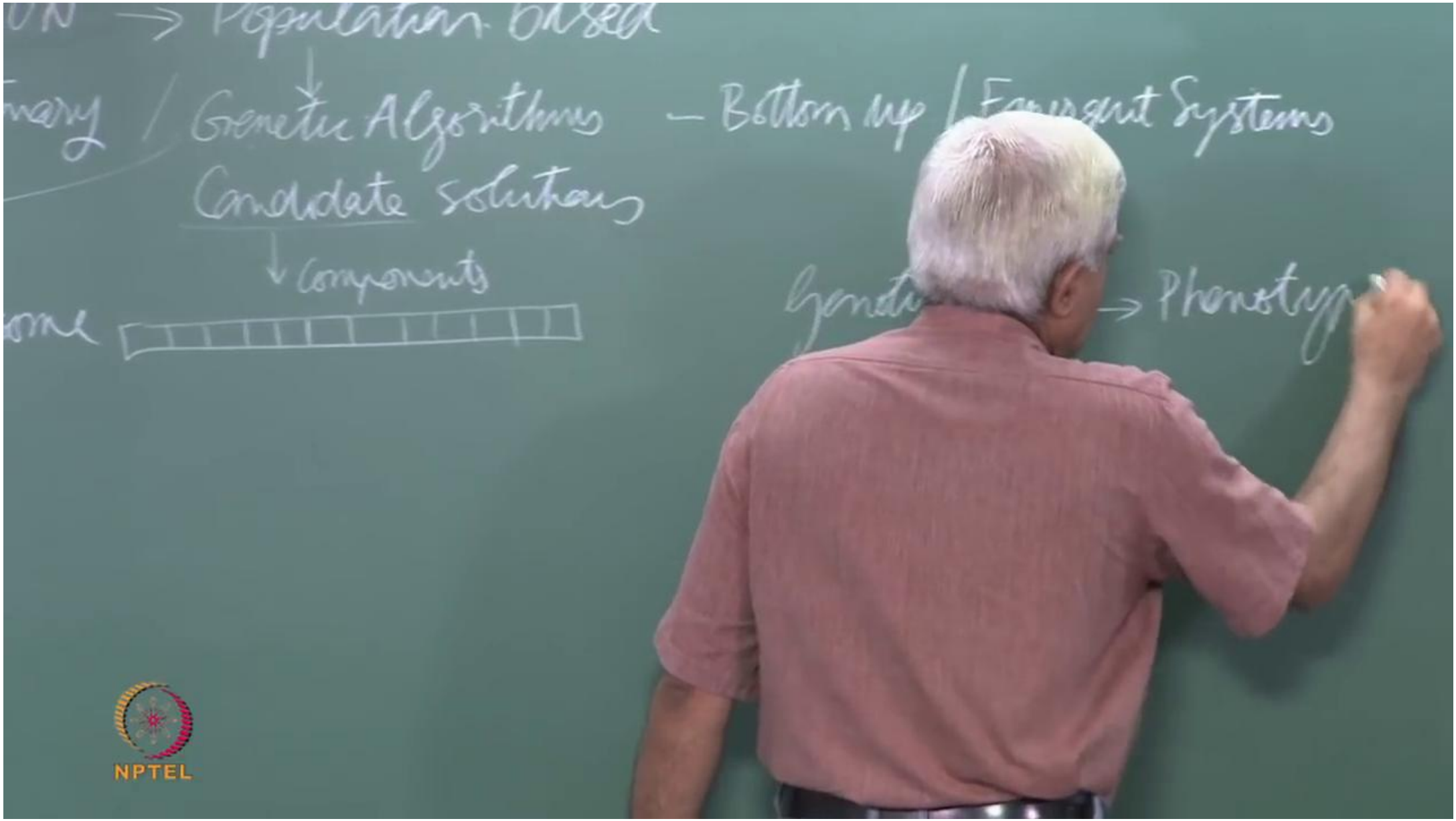
OPTIMIZATION → Population based

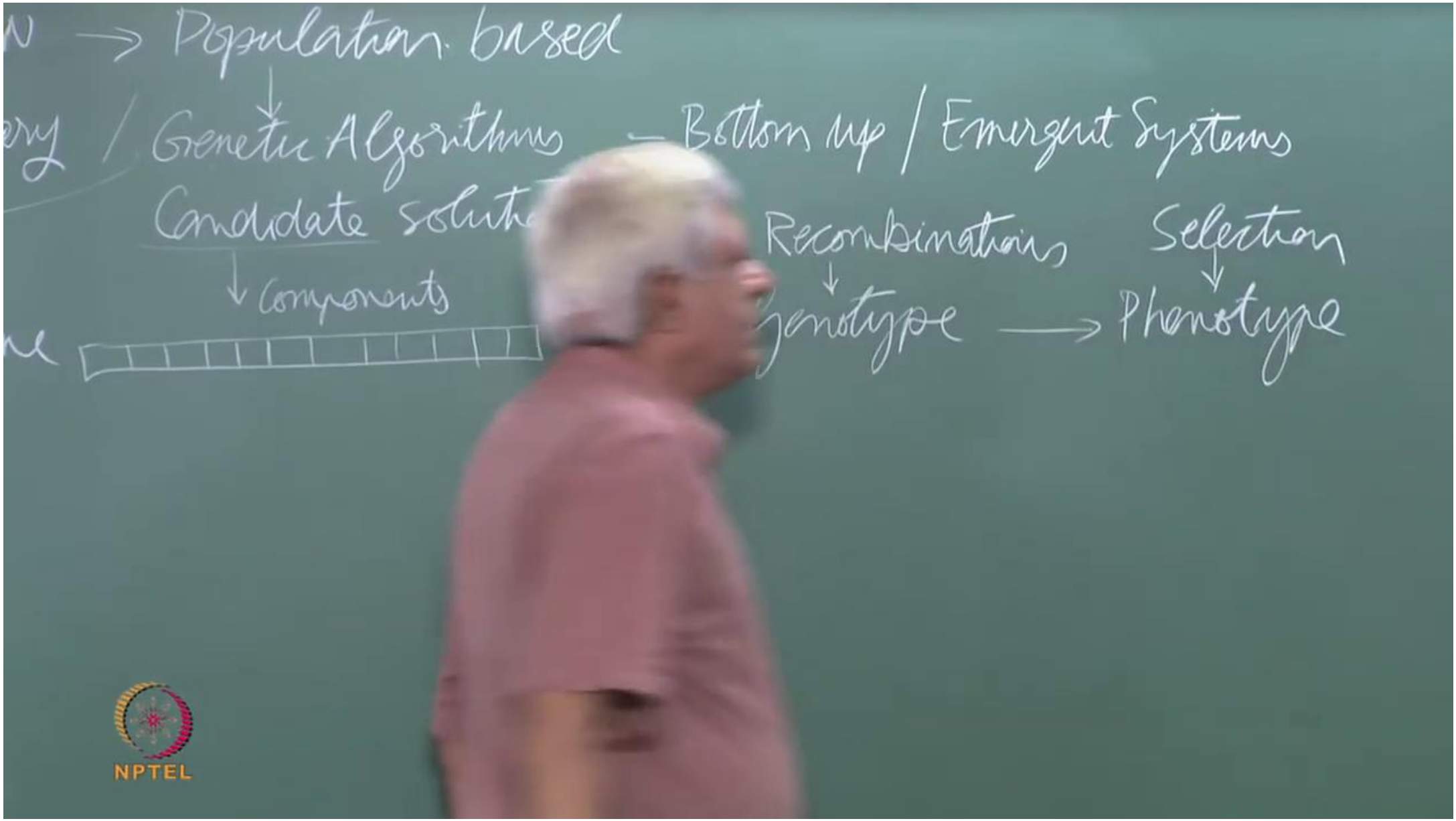
Evolutionary / Genetic Algorithms — Bottom up / Emergent Systems


Evolutionary / Genetic Algorithms
Candidate solutions
Components
NPTEL


Evolutionary / Genetic Algorithms
Candidate solutions
Components
NPTEL

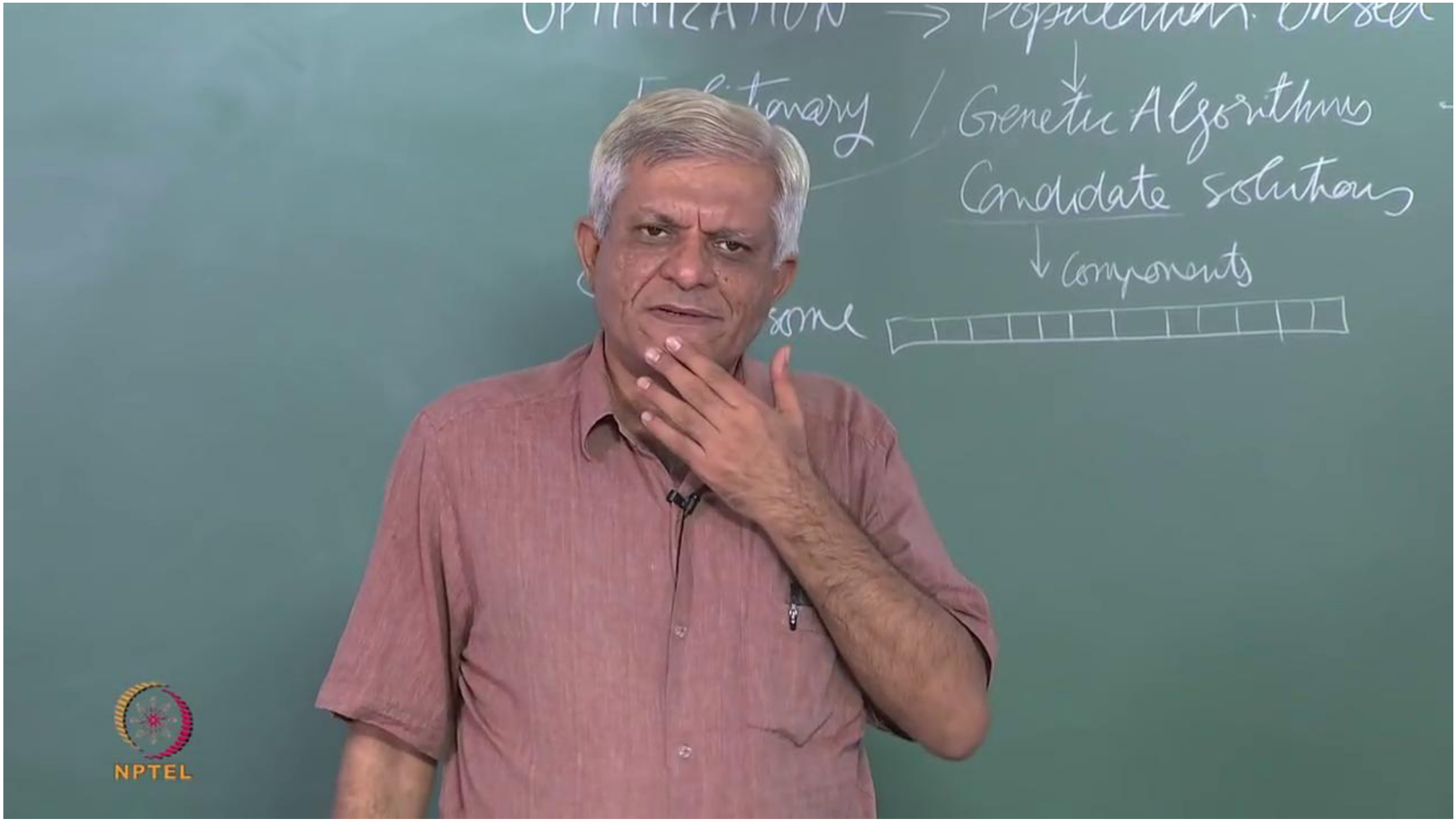

Evolutionary
Chromosome
NPTEL

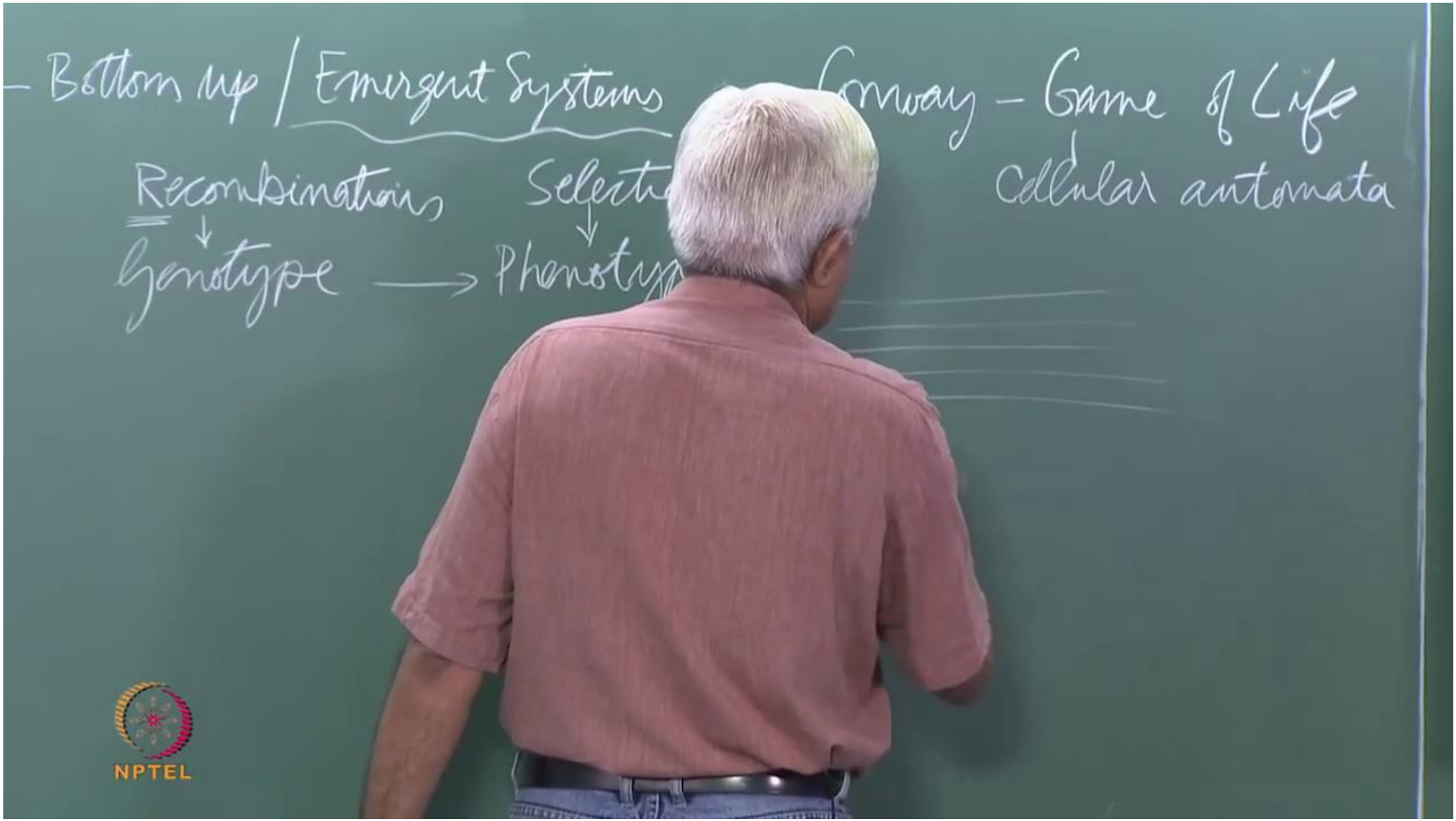

Genetic Algorithms
Candidate solutions
Components
Bottom up
NPTEL

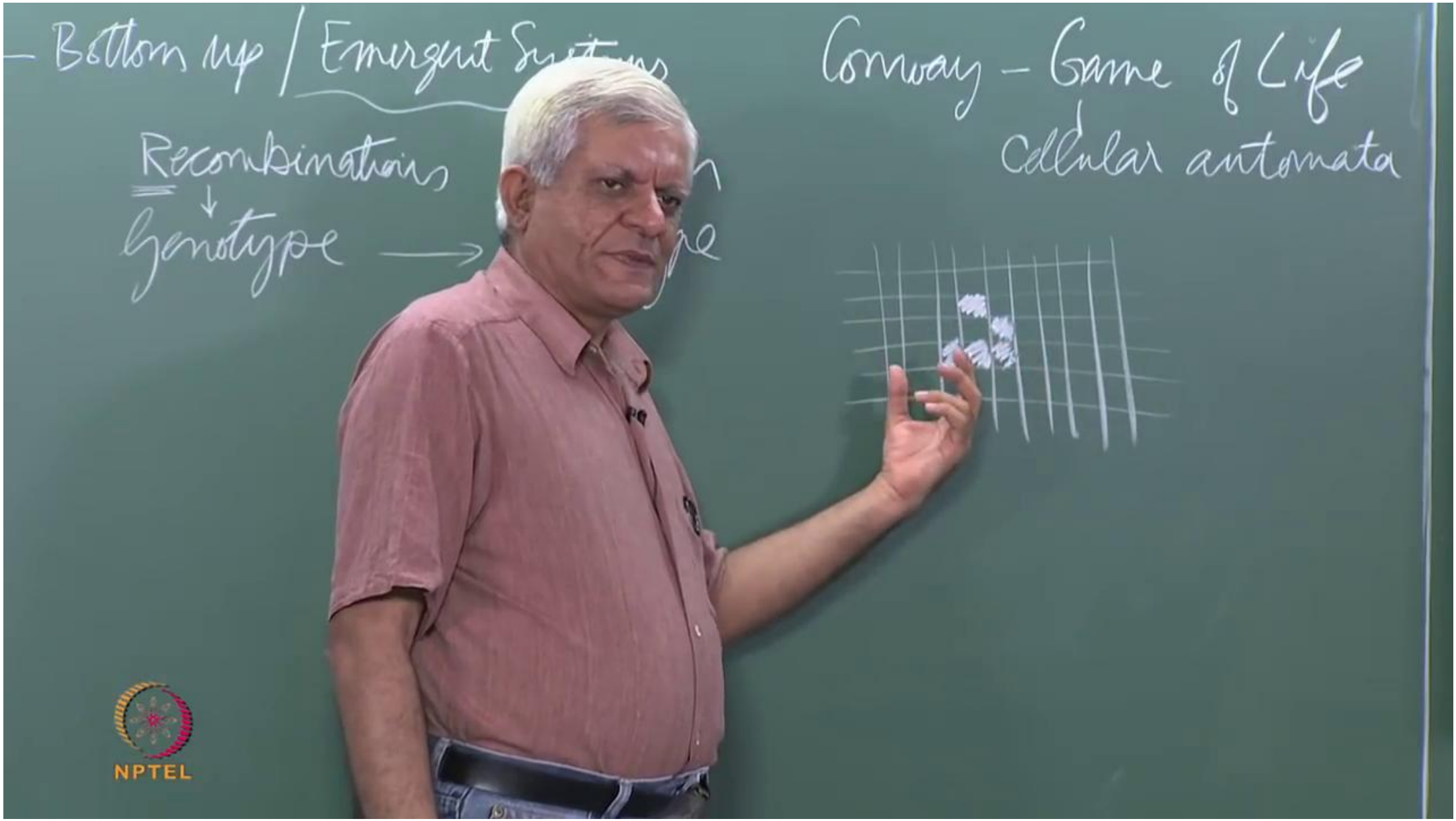

Population based
Genetic Algorithms
Bottom up / Emergent Systems
Candidate
Components
Recombination
Selection
Genotype
Phenotype
NPTEL

Recombinations → Genotype → Phenotype ← Selection

Recombinations → Genotype → Phenotype ← Selection

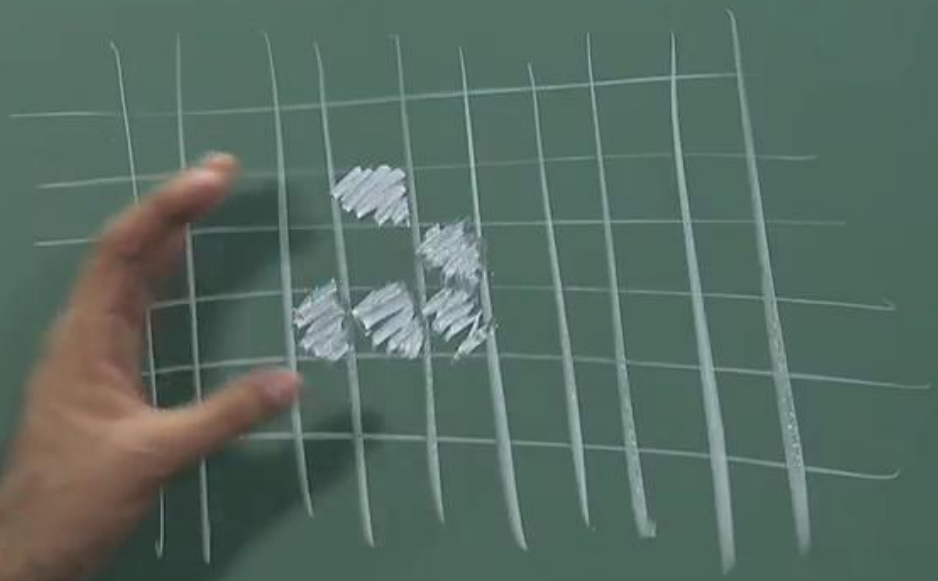

Genetic Algorithms
Candidate solutions
components


Bottom up / Emergent Systems
Conway - Game of Life
Recombinations
Selecti
Cellular automata
Genotype
Phenotyp
NPTEL


– Bottom up / Emergent
Recombinations
Genotype
Conway – Game of Life
cellular automata
NPTEL

Conway – Game of Life

cellular automata



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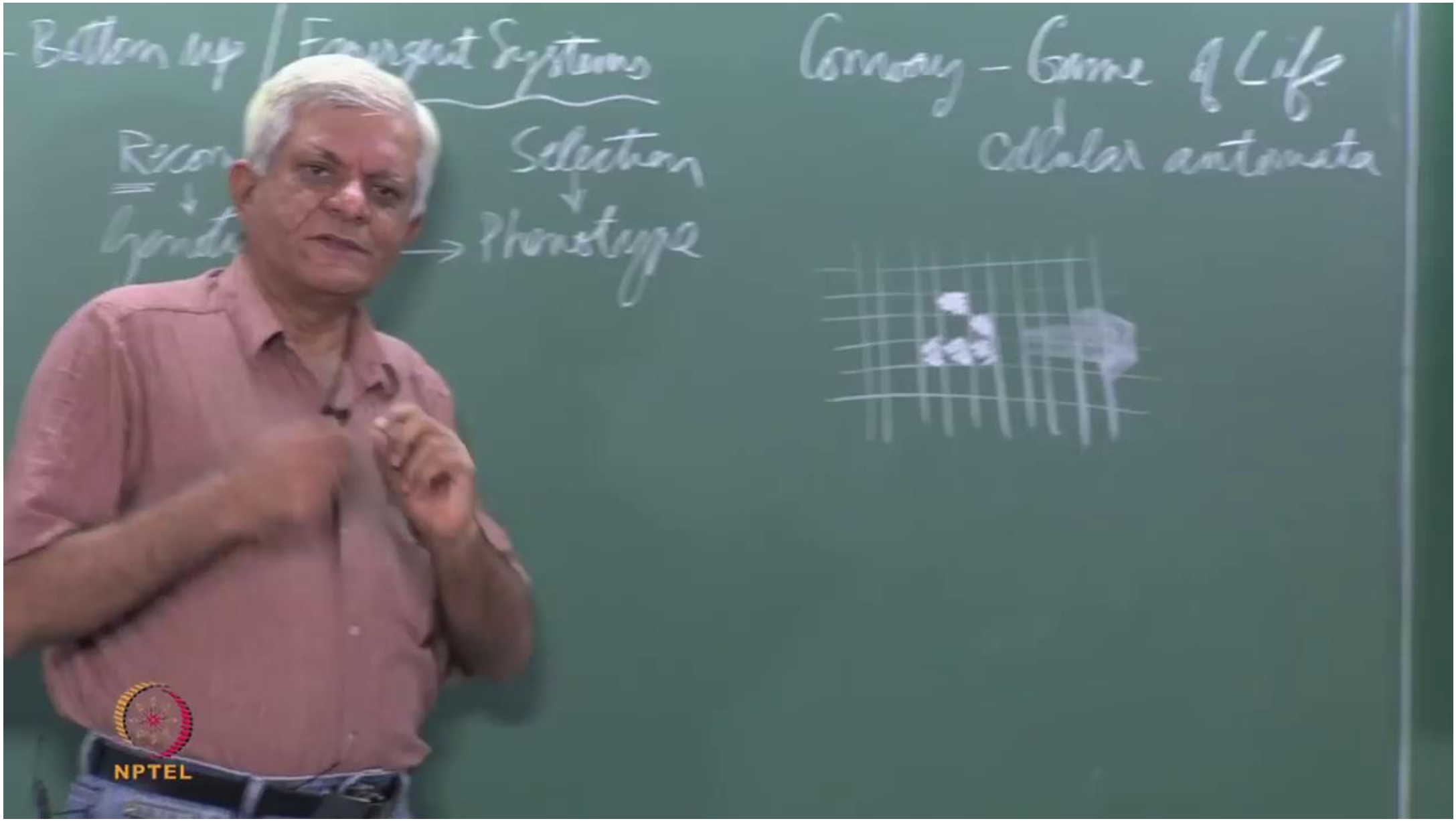
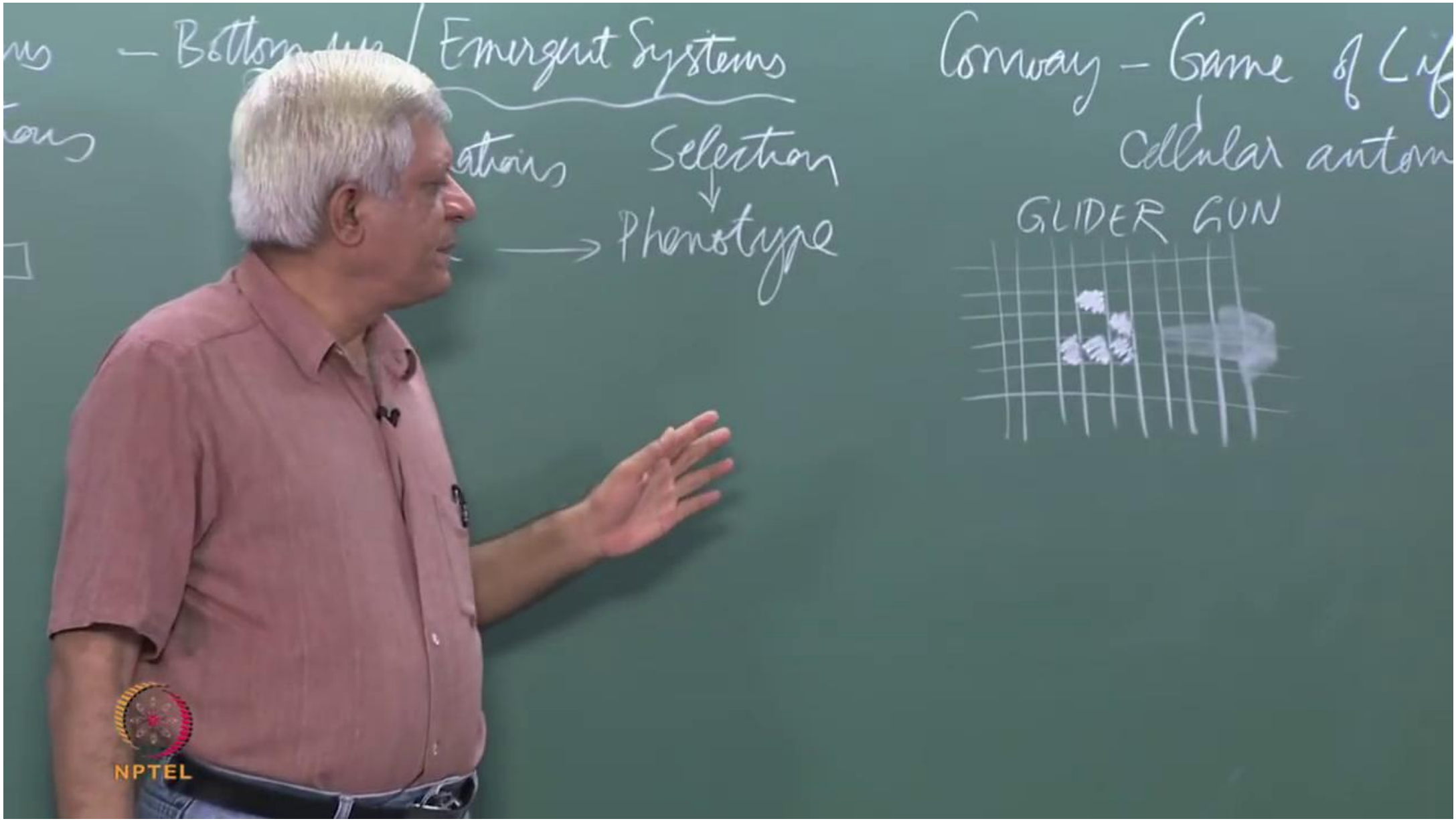
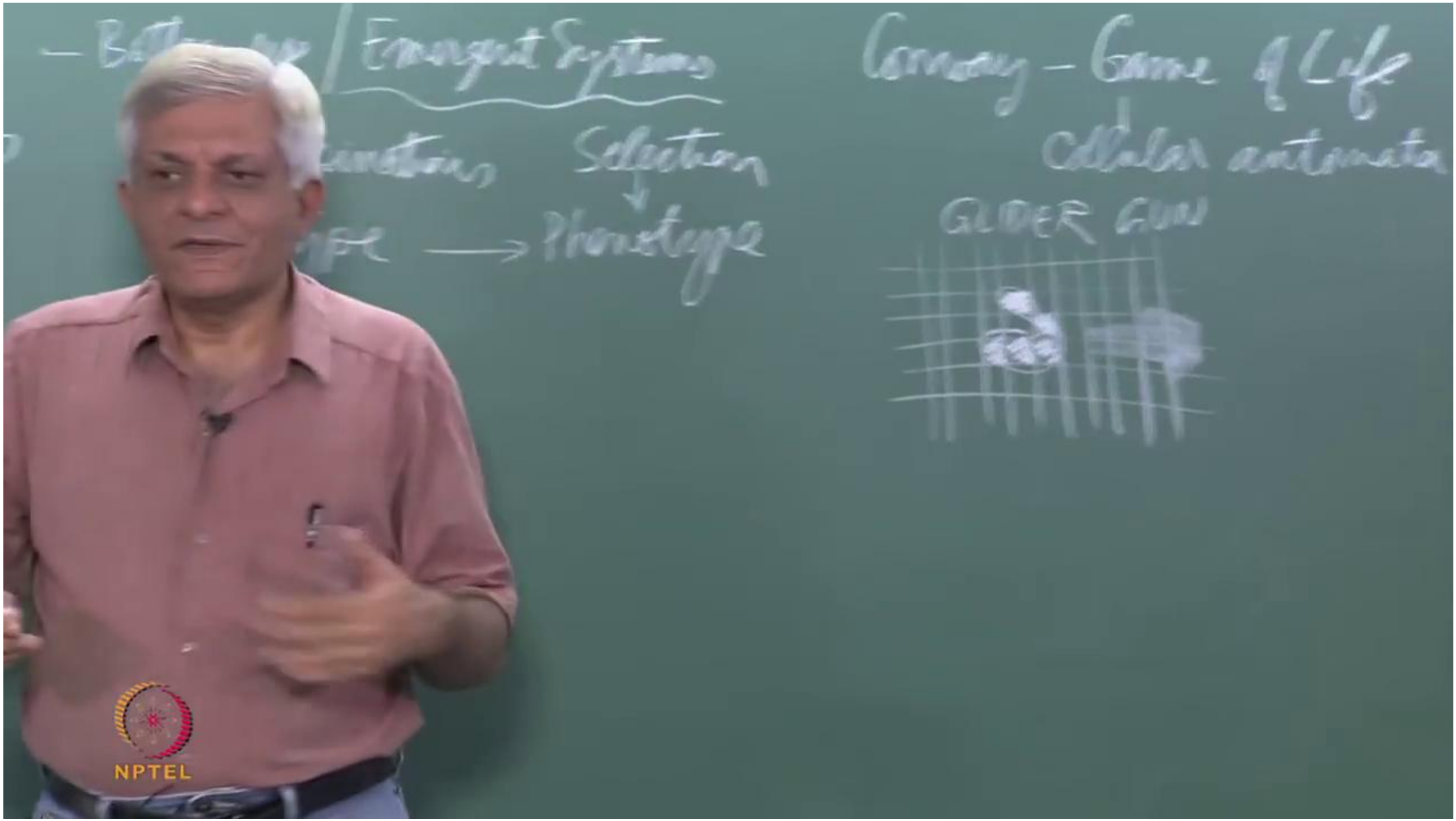
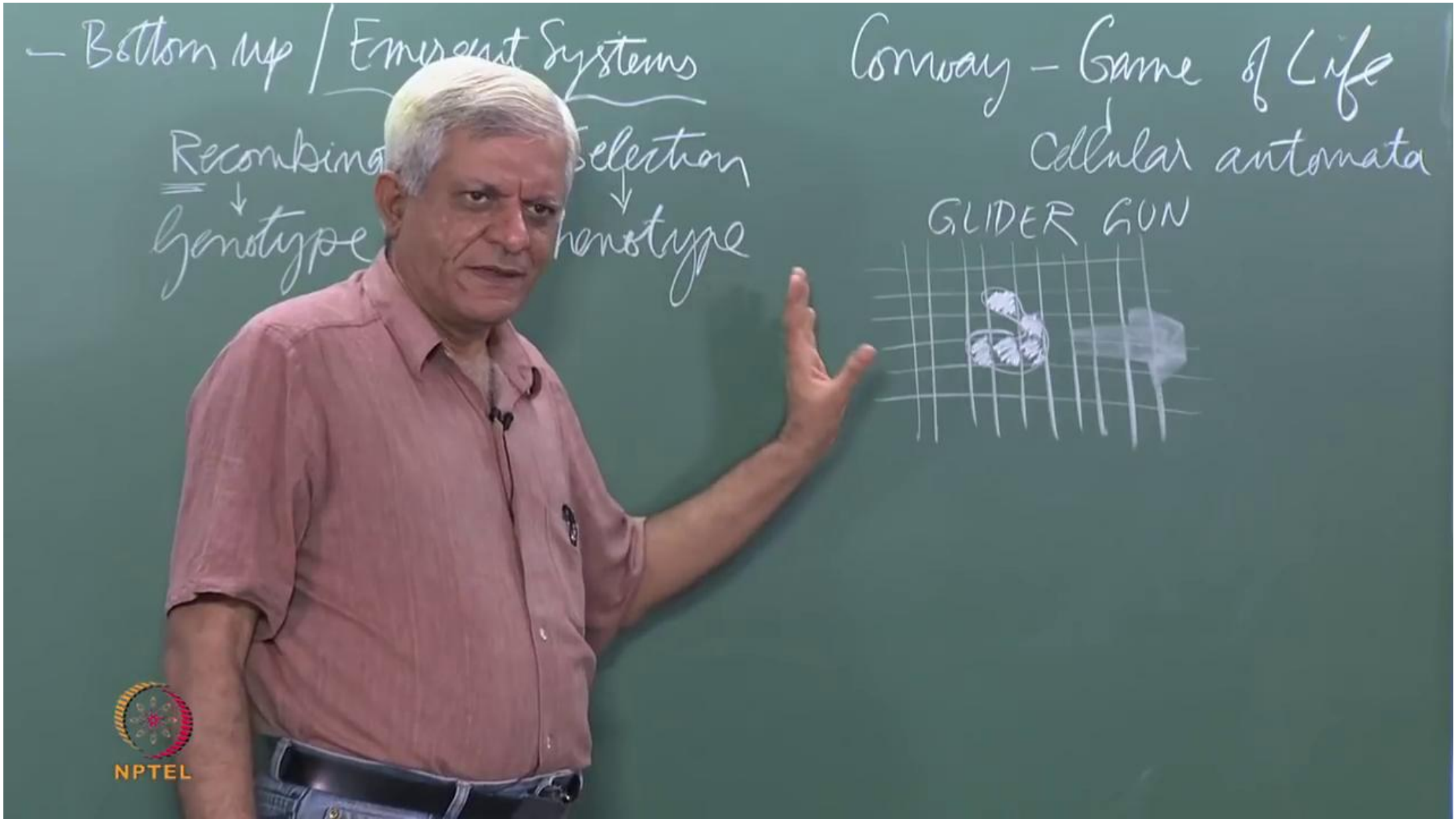
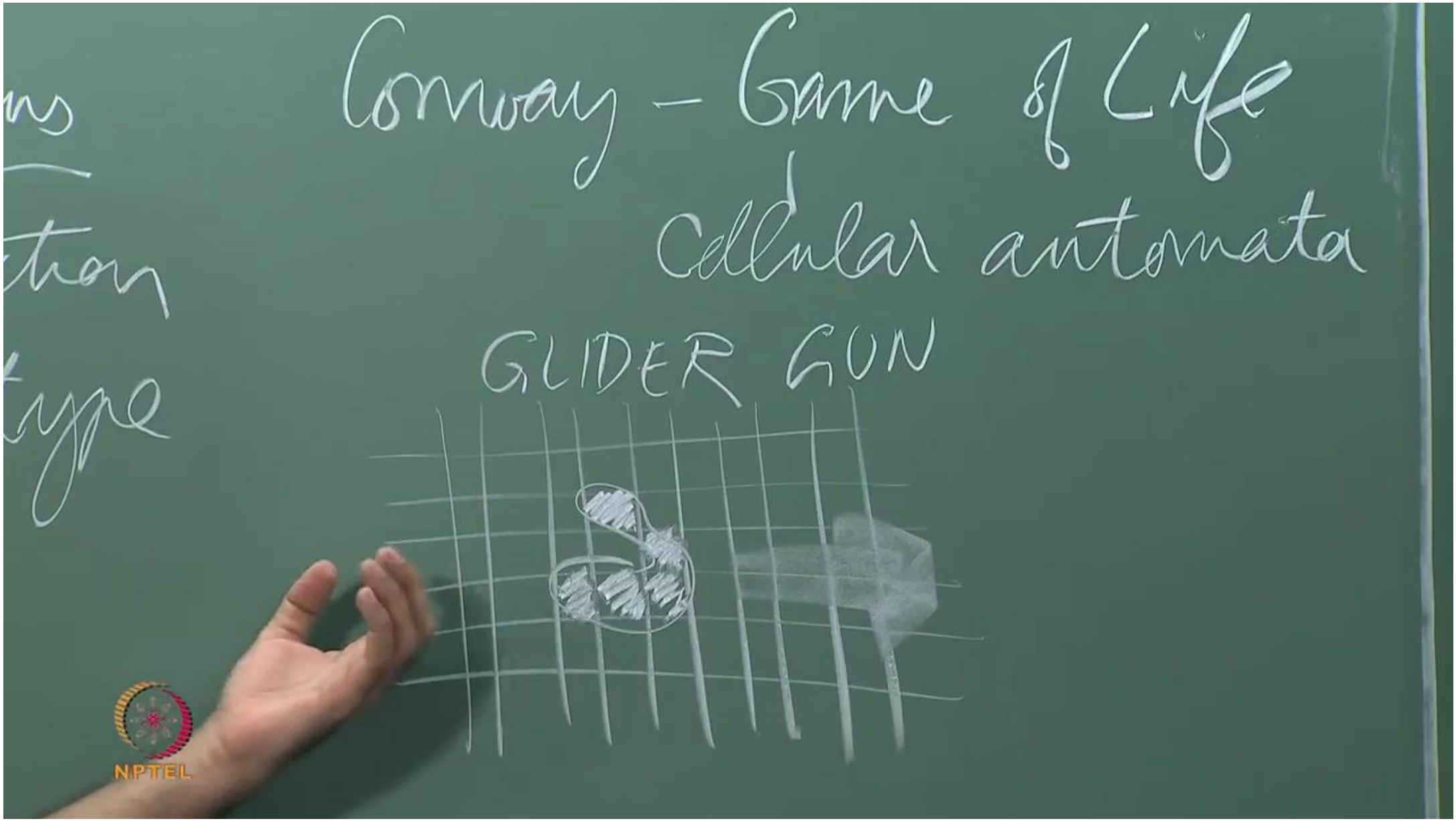
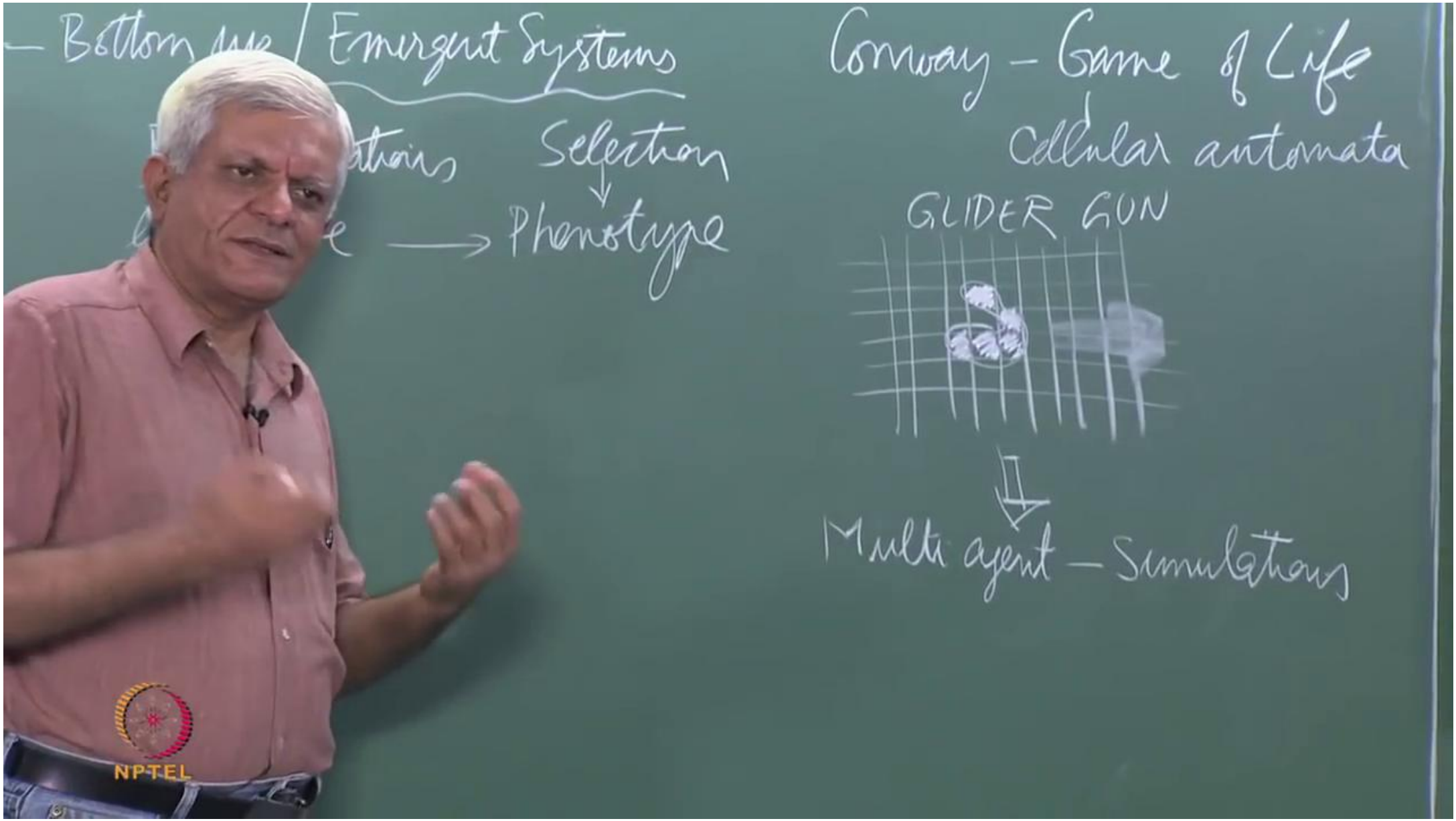

Bottom up
Emergent Systems
Recon
Selection
Phenotype
Conway – Game of Life
Cellular automata
NPTEL

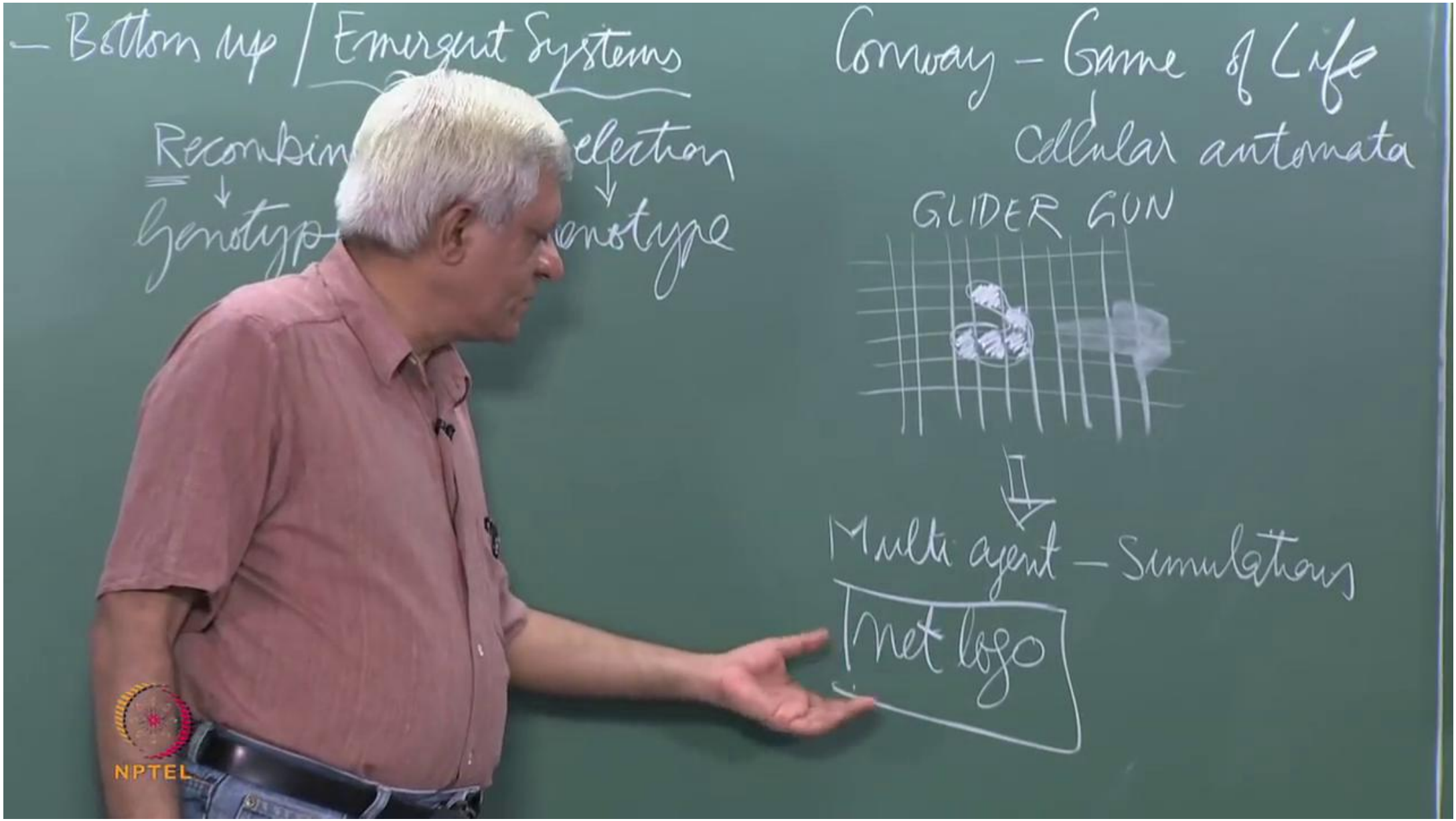

Emergent Systems
Selection
Phenotype
Conway – Game of Life
Cellular autom
GLIDER GUN
NPTEL

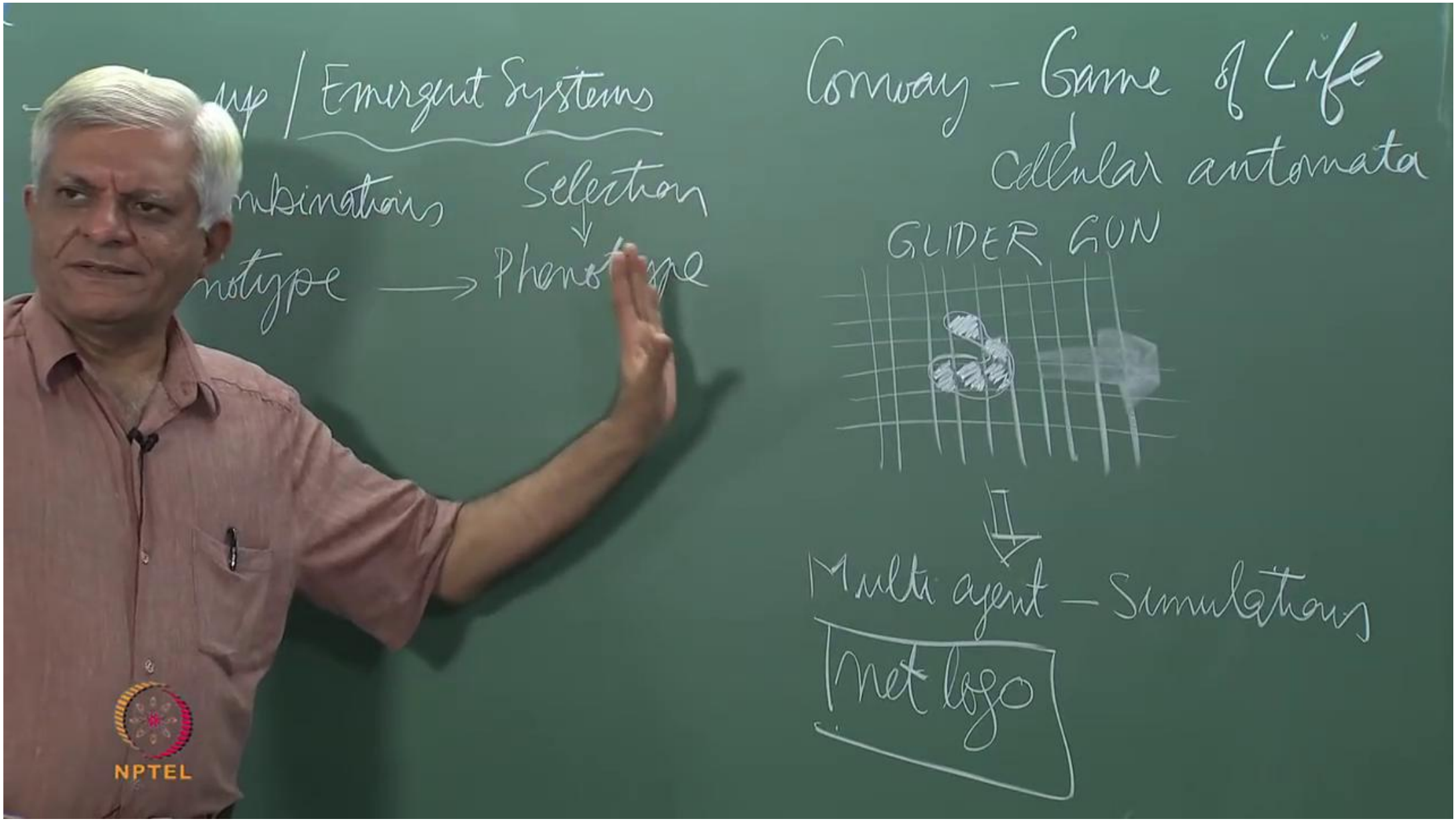

Emergent Systems
Selection
Prototype
Game of Life
Cellular automata
GLIDER GUN

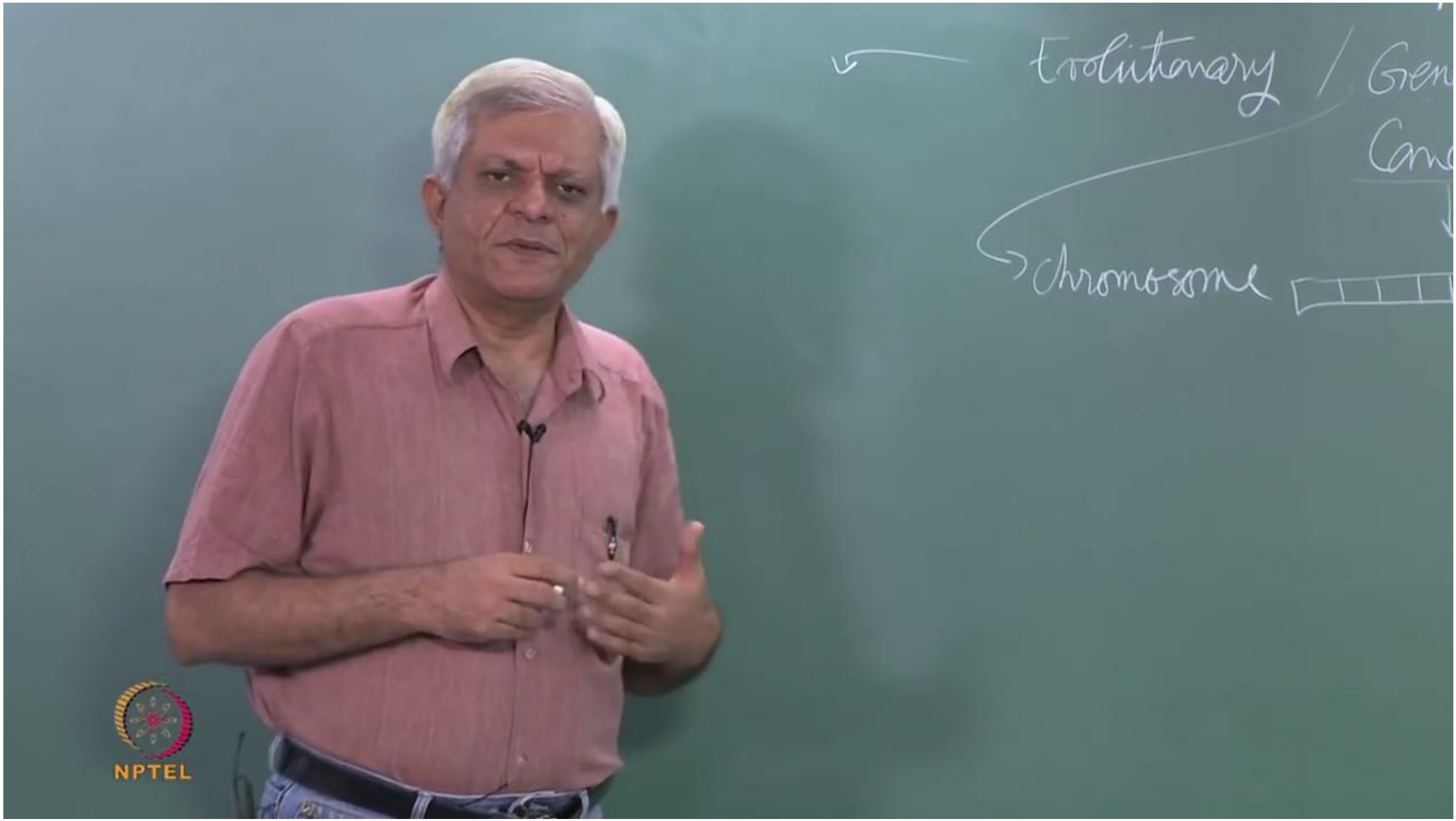

– Bottom up / Emergent Systems
Recombina
Genotype
Selection
Phenotype
Conway – Game of Life
Cellular automata
GLIDER GUN
NPTEL

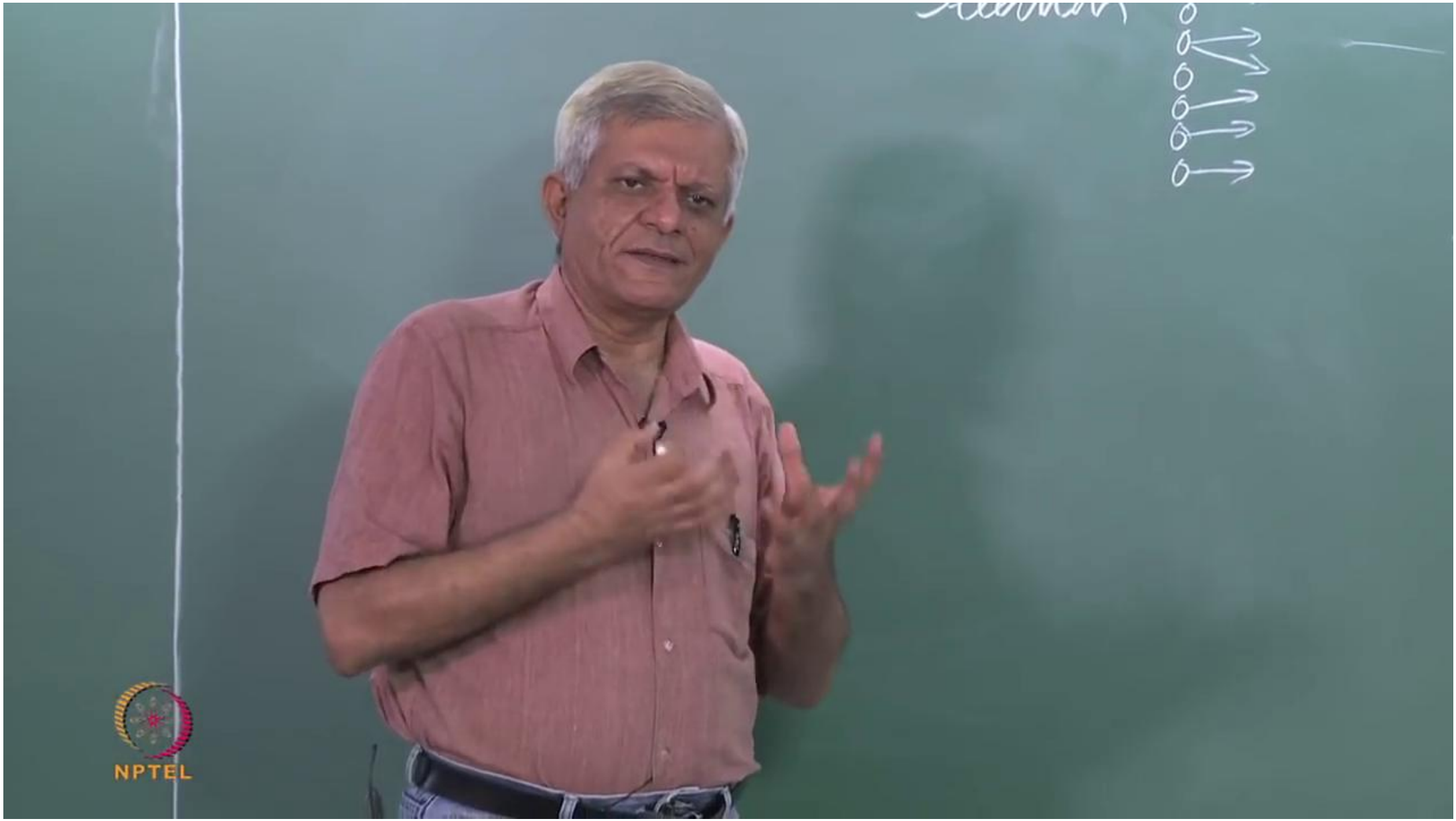

Conway – Game of Life
cellular automata
GLIDER GUN
NPTEL

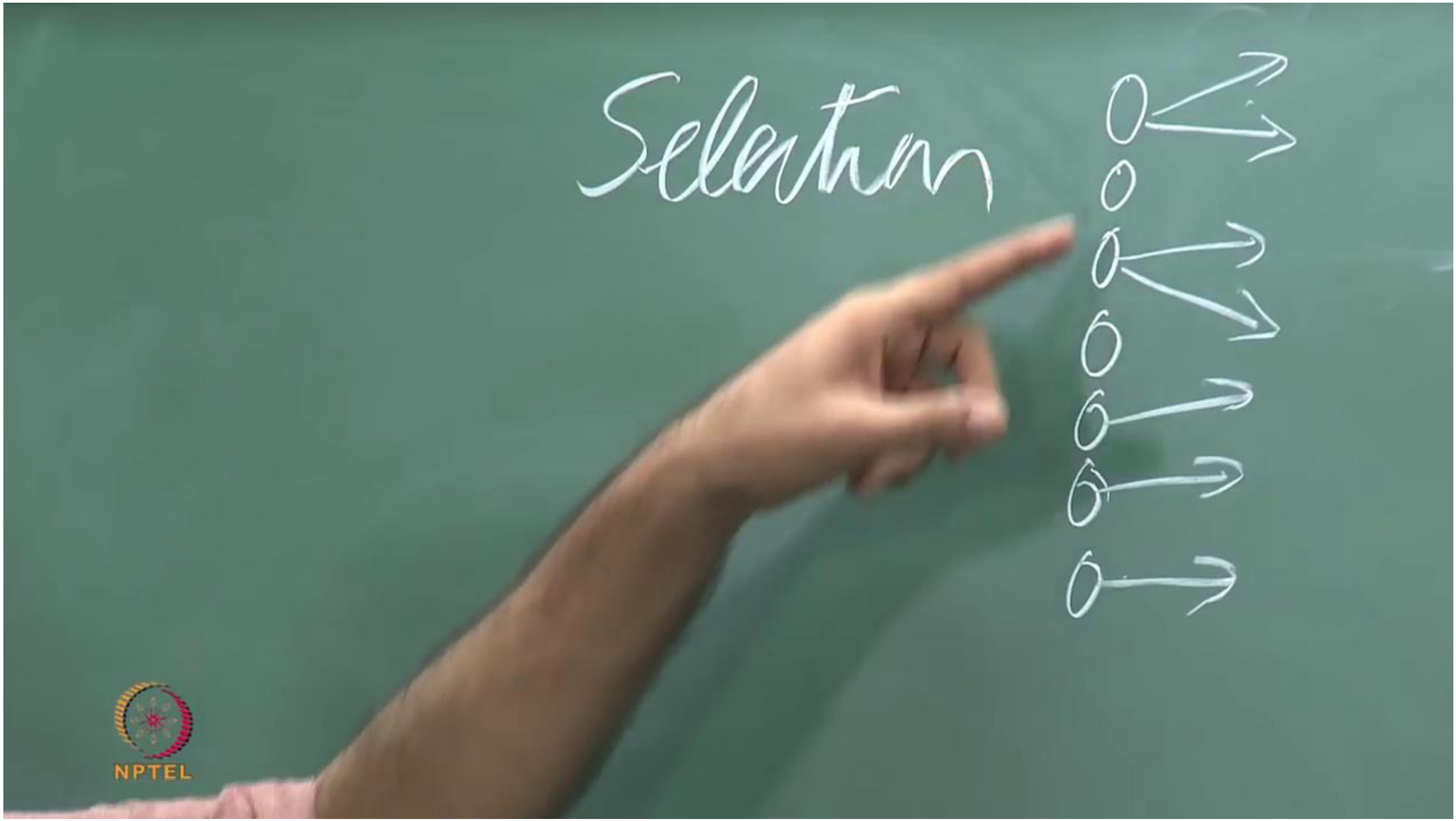

Emergent Systems
Selection
Phenotype
Conway – Game of Life
Cellular automata
GLIDER GUN
Multi agent – Simulations
NPTEL

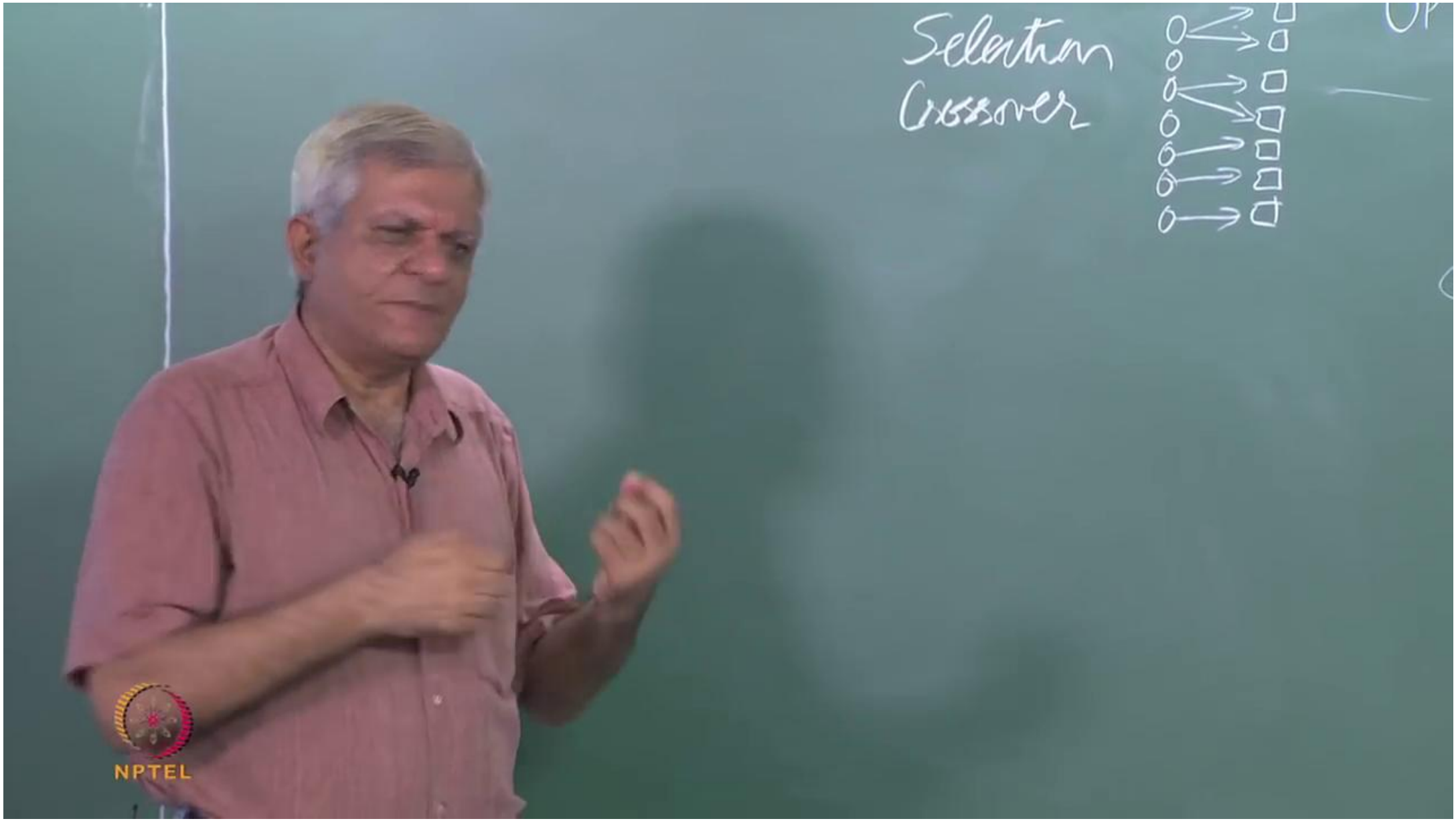

– Bottom up / Emergent Systems
Conway – Game of Life
Cellular automata
GLIDER GUN
Multi agent – Simulations
net logo
NPTEL

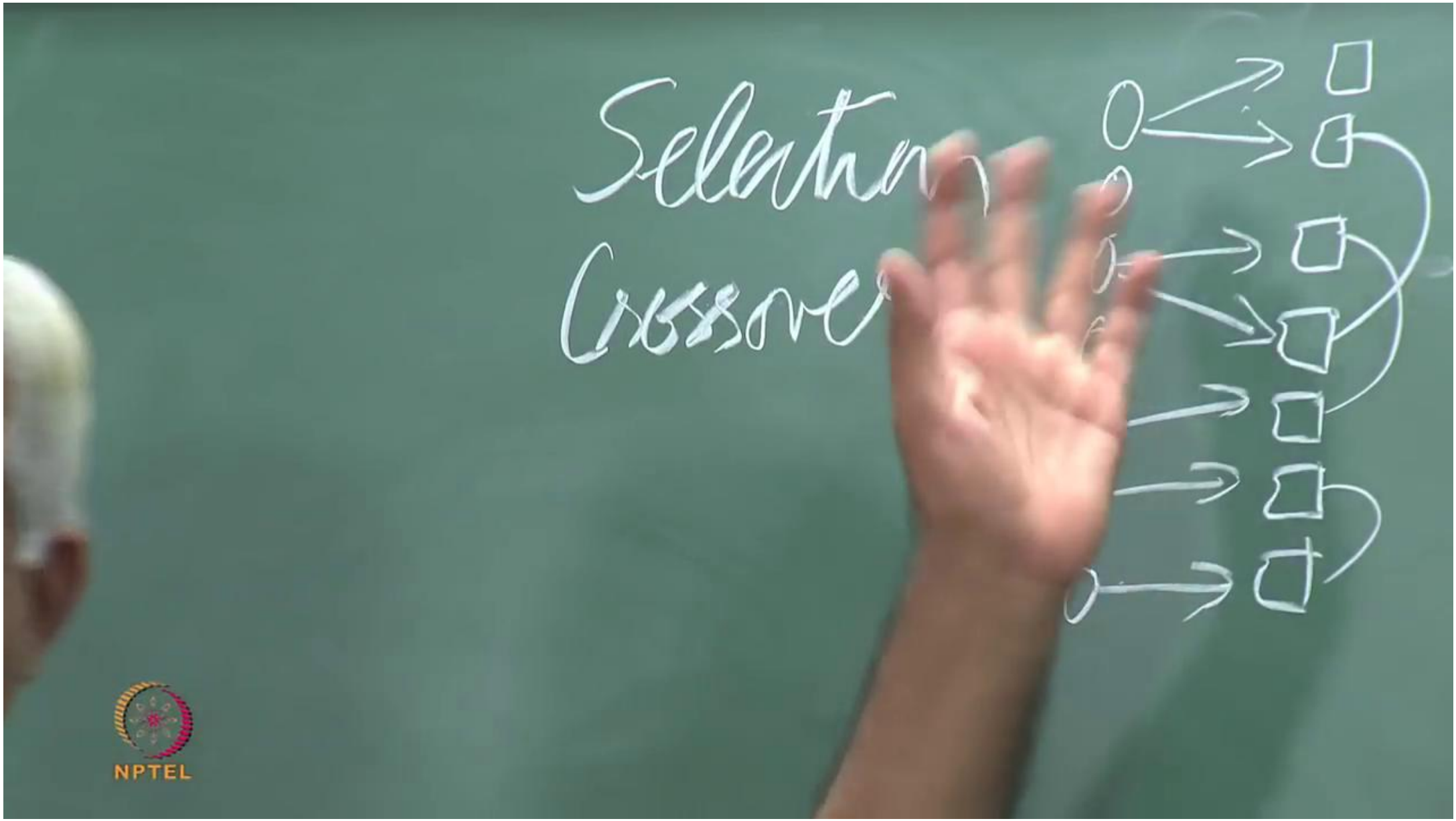

Emergent Systems
Selection
Phenotype
Conway – Game of Life
Cellular automata
GLIDER GUN
Multi agent – Simulations
Net logo
NPTEL

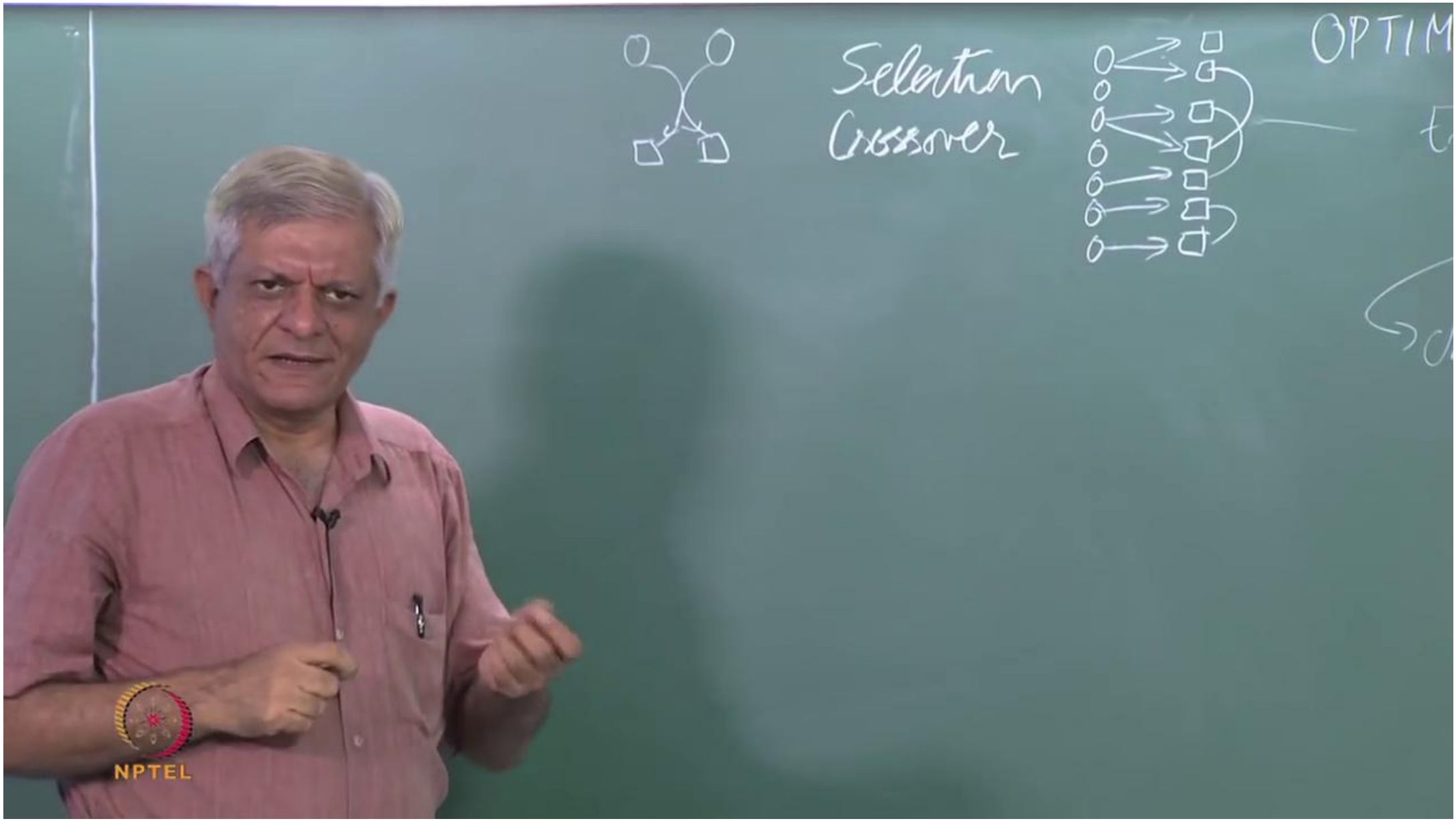

Evolutionary
Chromosome
NPTEL

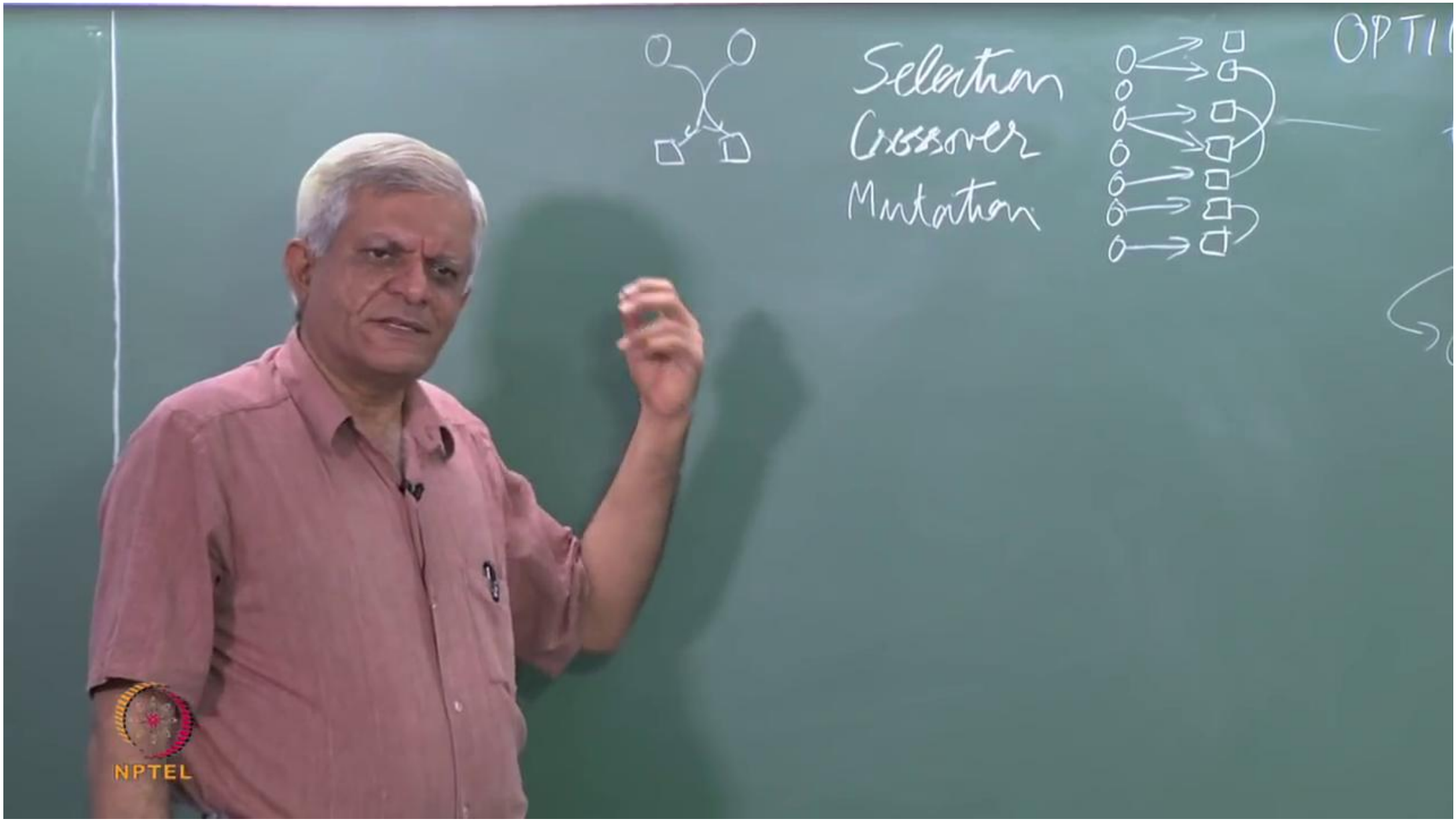

NPTEL

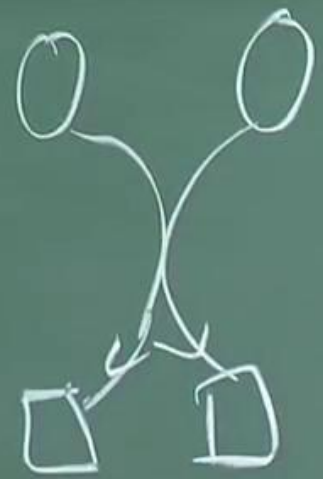

Selection


Selection
Crossover
NPTEL


Selection
Crossover
NPTEL


Selection
Crossover
OPTIM
NPTEL


Selection
Crossover
Mutation
NPTEL

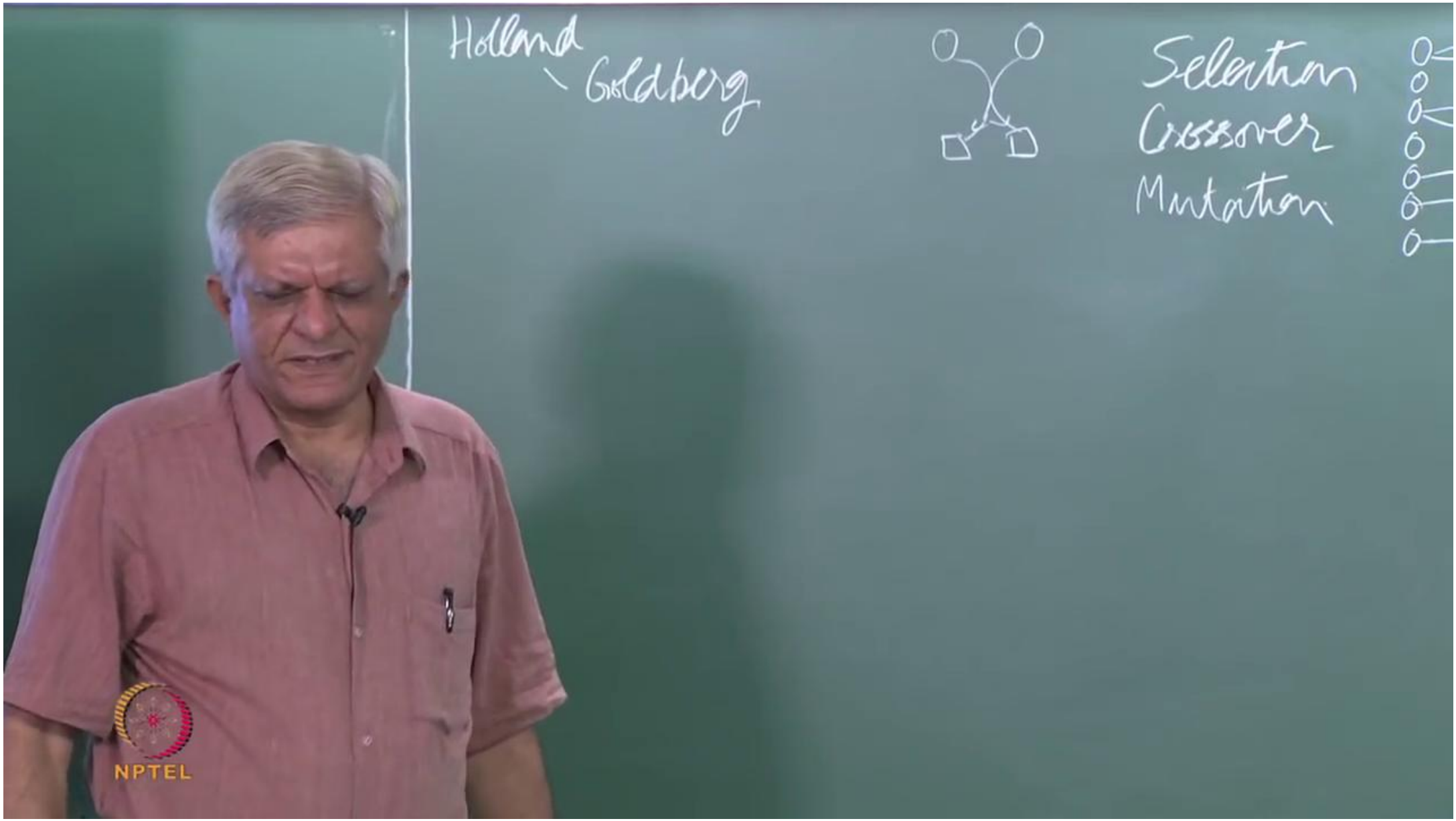


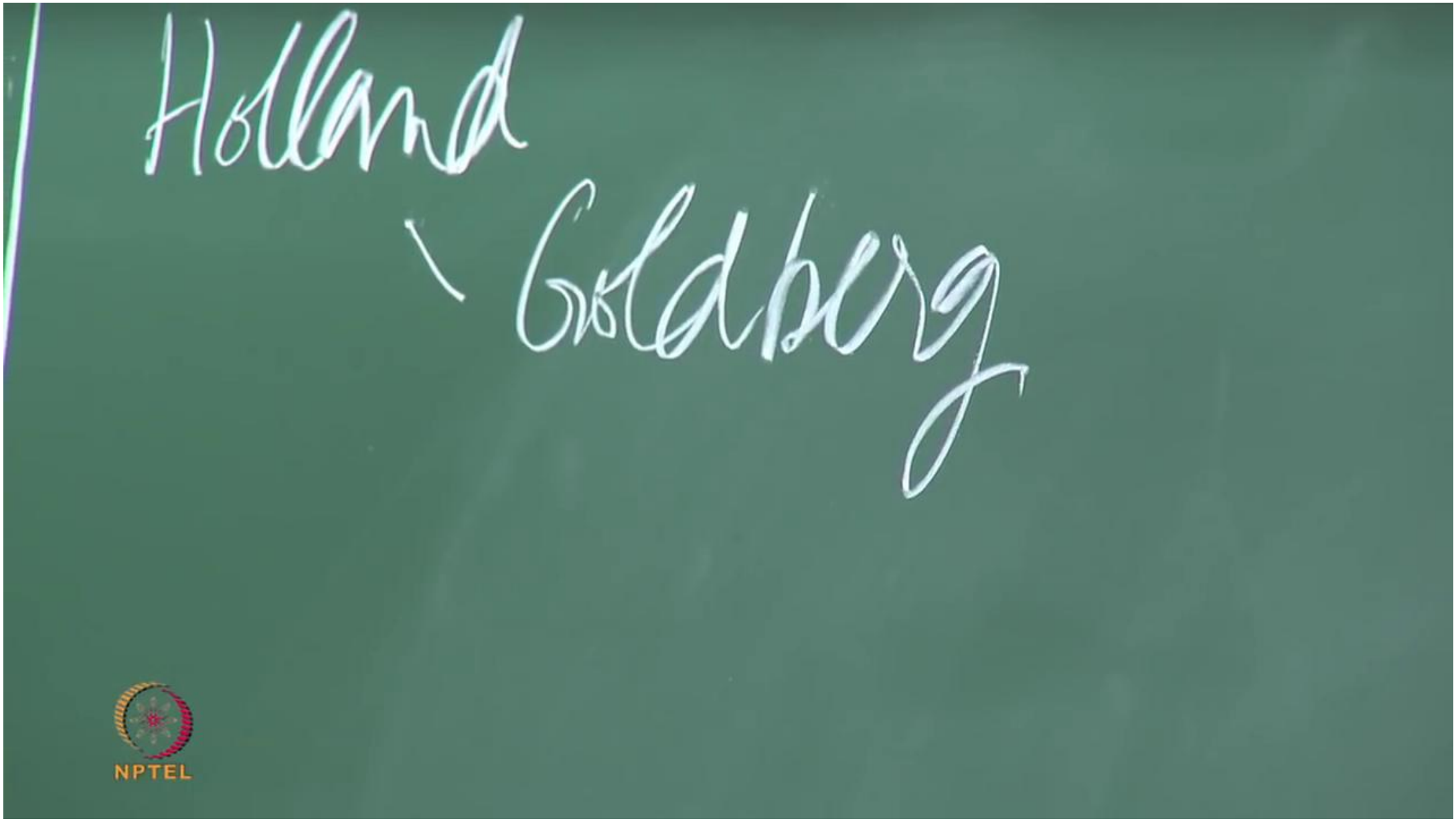
Selection

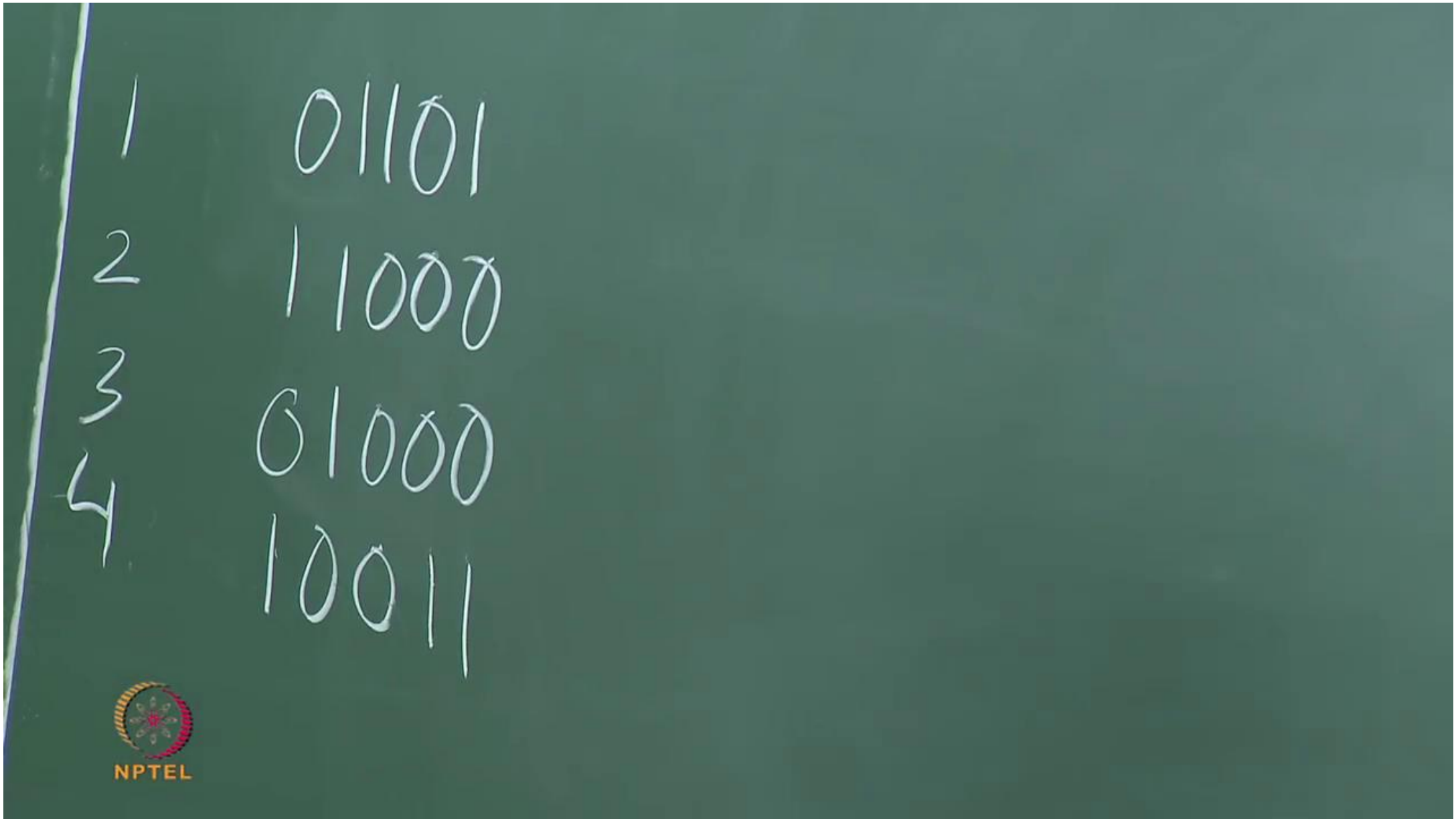
Crossover

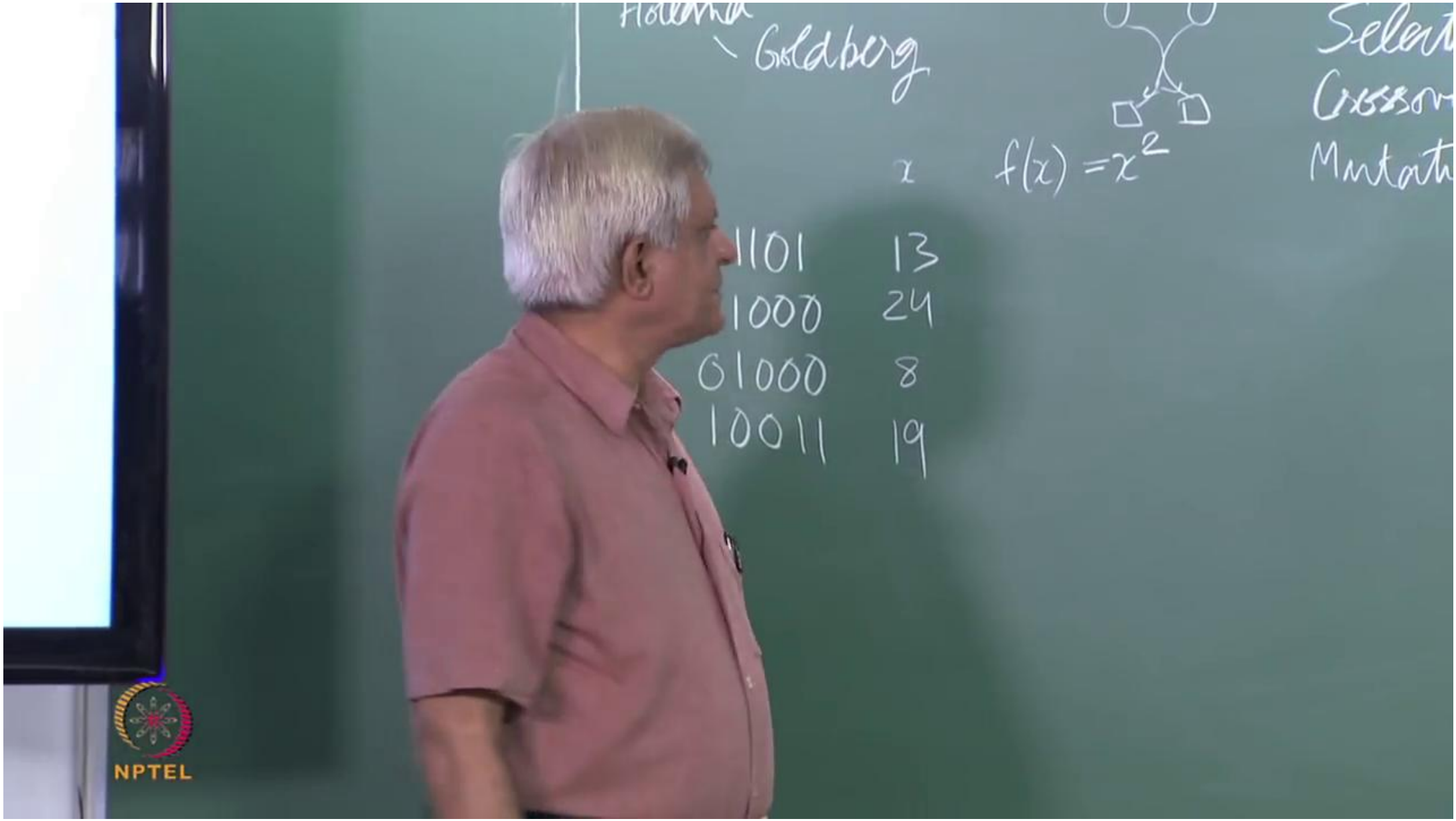
Mutation

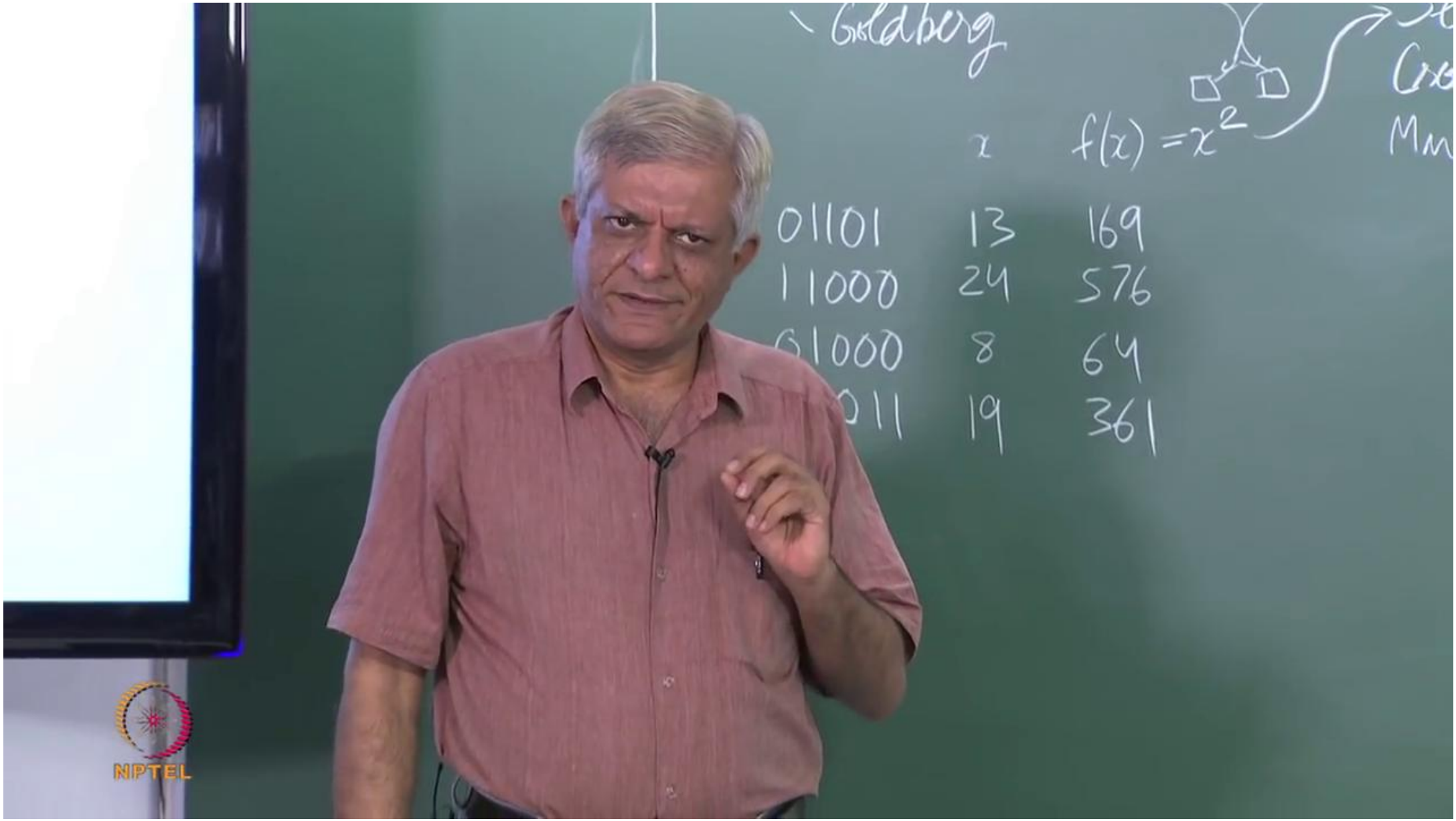
NPTEL

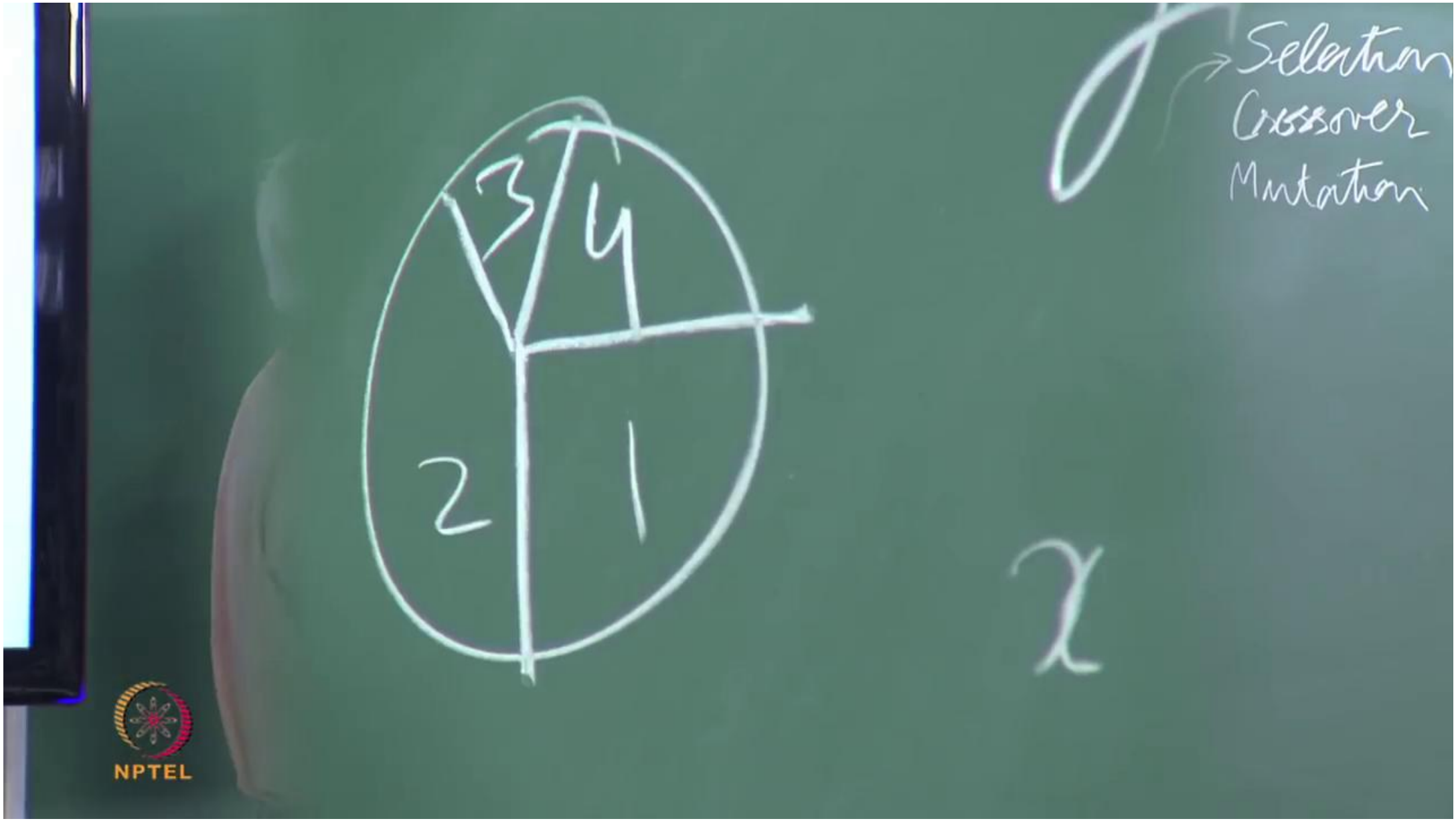

Holland
Goldberg
Selection
Crossover
Mutation
NPTEL

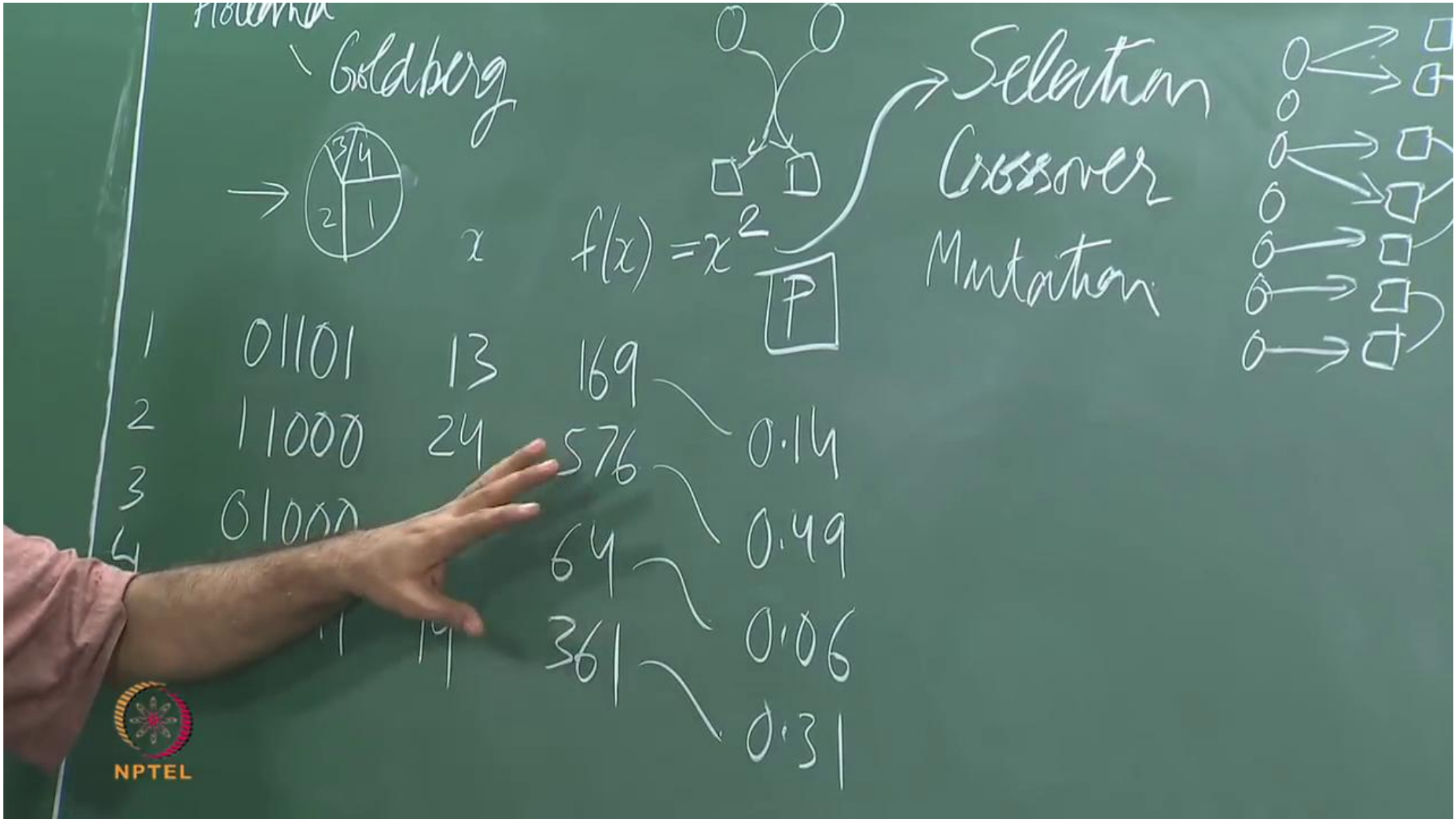

Holland
Goldberg
NPTEL


1 01101
2 11000
3 01000
4 10011
NPTEL

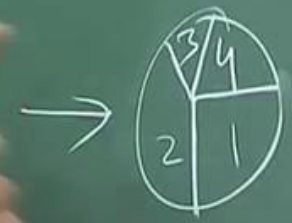

Goldberg
Select
Crossov
Mutati
x
$f(x) = x^2$
1101 13
1000 24
01000 8
10011 19
NPTEL


Goldberg
x
f(x) = x²
01101 13 169
11000 24 576
01000 8 64
011 19 361
NPTEL


3
4
2
1
Selection
Crossover
Mutation
NPTEL


Goldberg
3
4
2
1
x
f(x) = x²
P
Selection
Crossover
Mutation
1 01101 13 169 0.14
2 11000 24 576 0.49
3 01000 64 0.06
4 10011 19 361 0.31
NPTEL

Goldberg

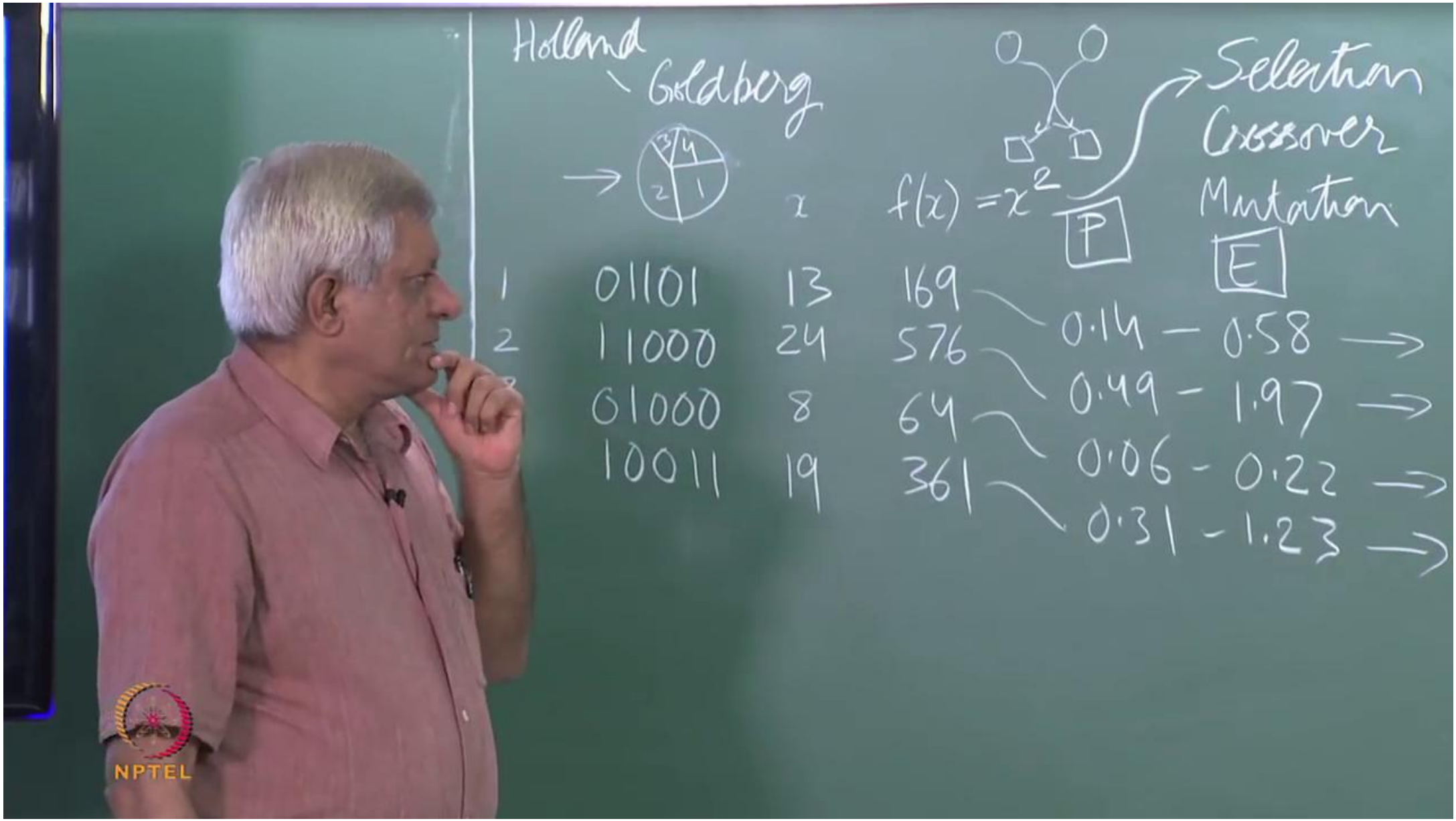


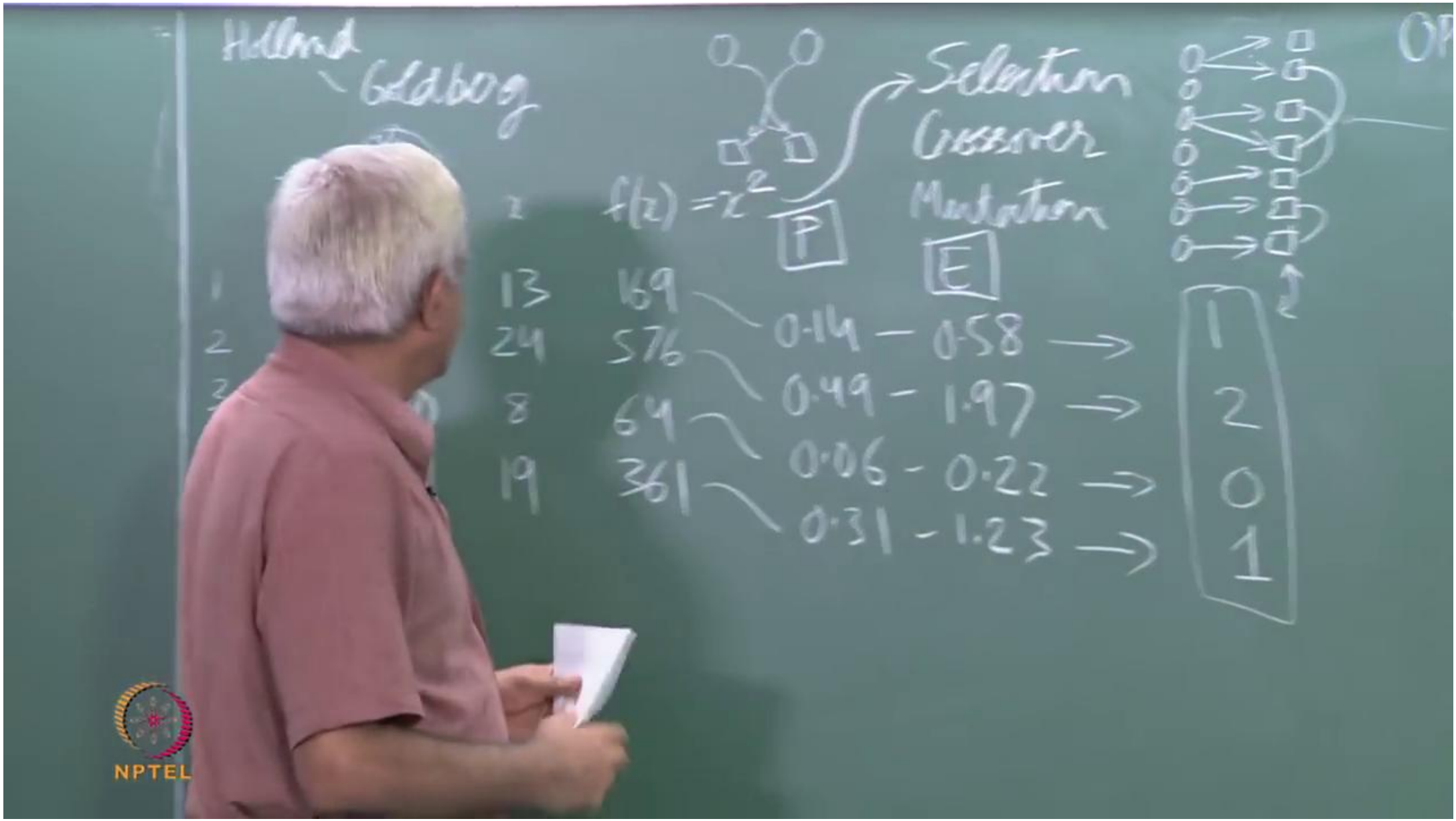
Selection
Crossover
Mutation

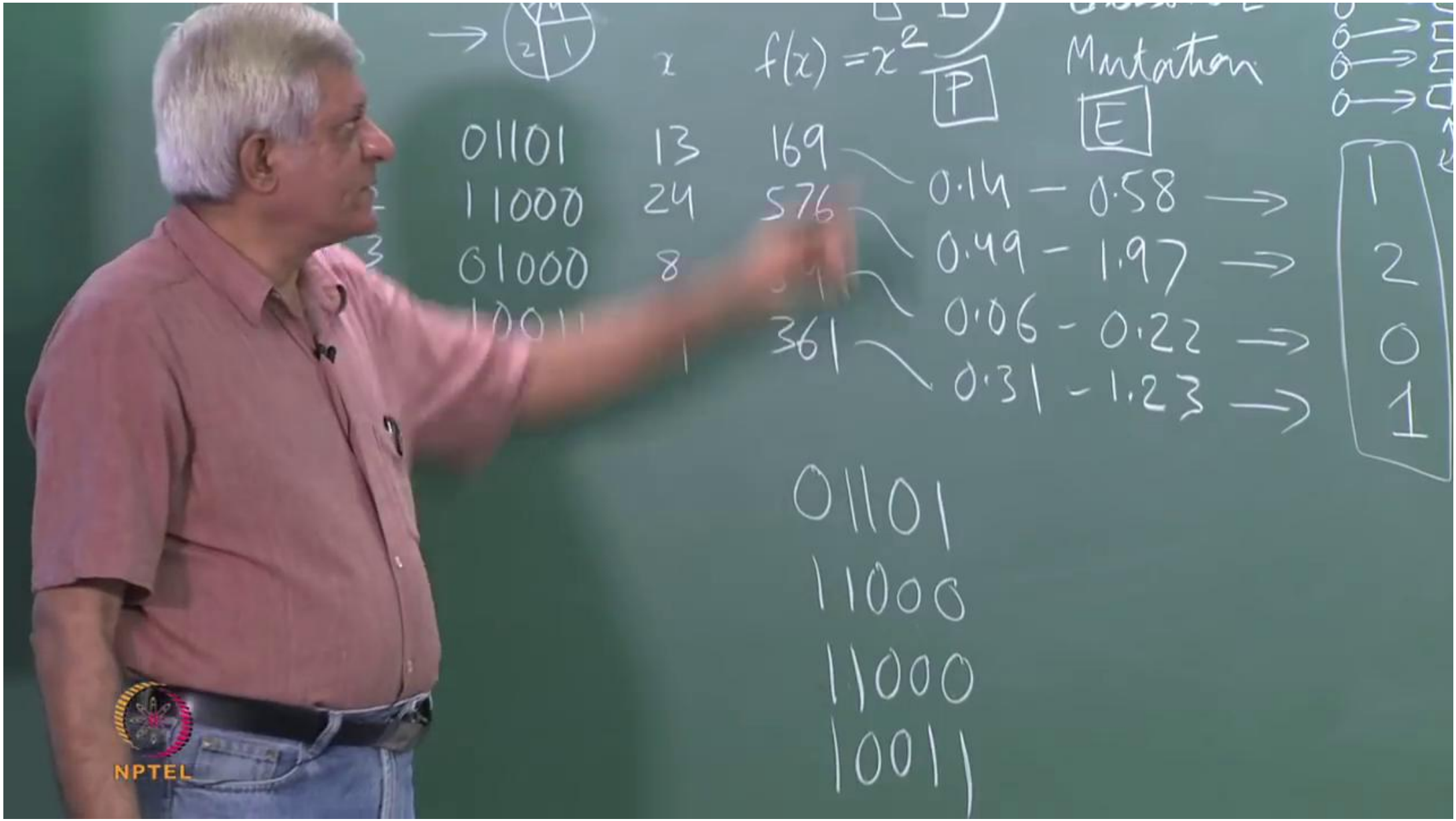
	x	$f(x) = x^2$	
01101	13	169	0.14
11000	24	576	0.49
01000	8	64	0.06
10011	19	361	0.31

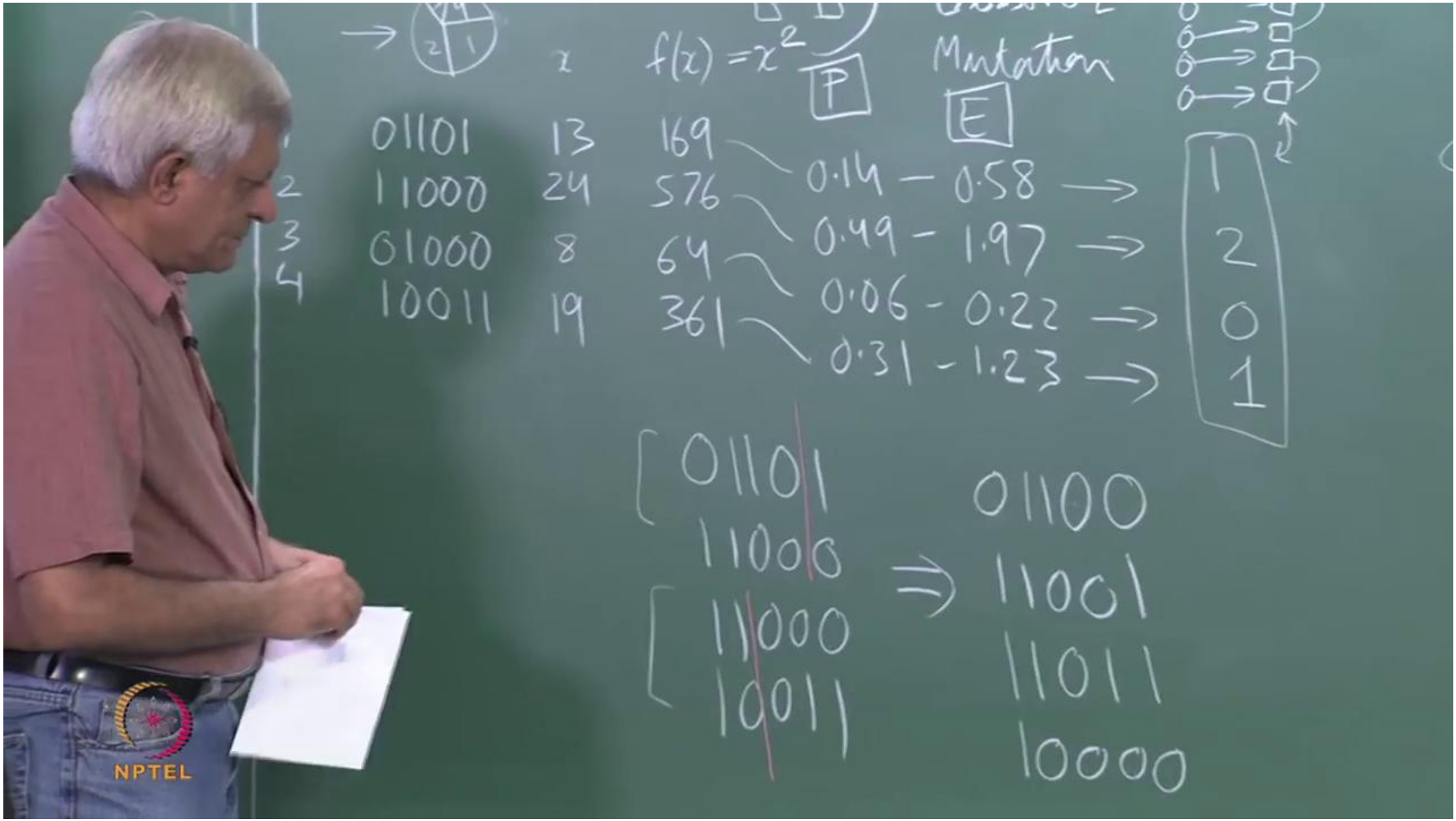
P

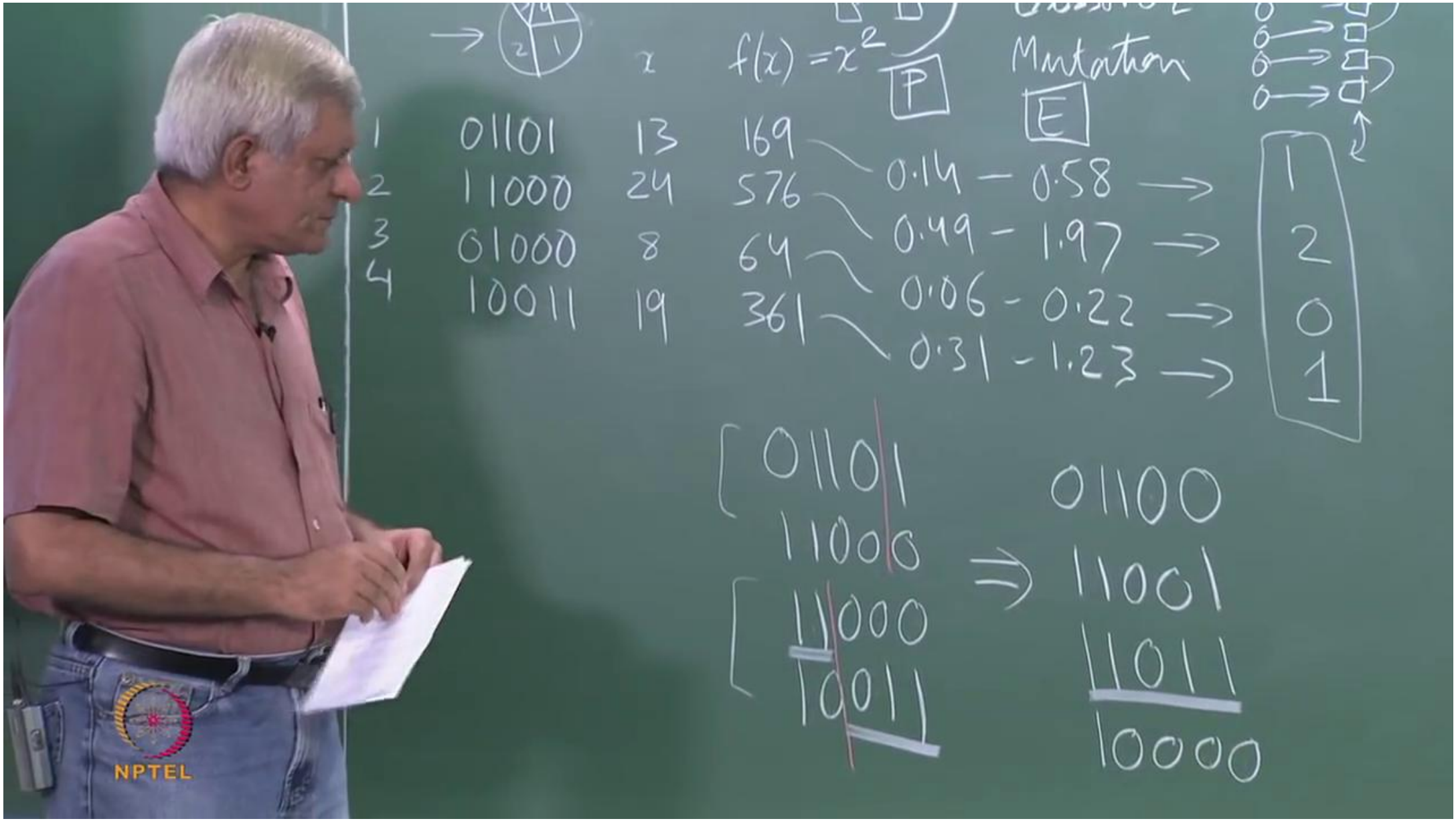
NPTEL

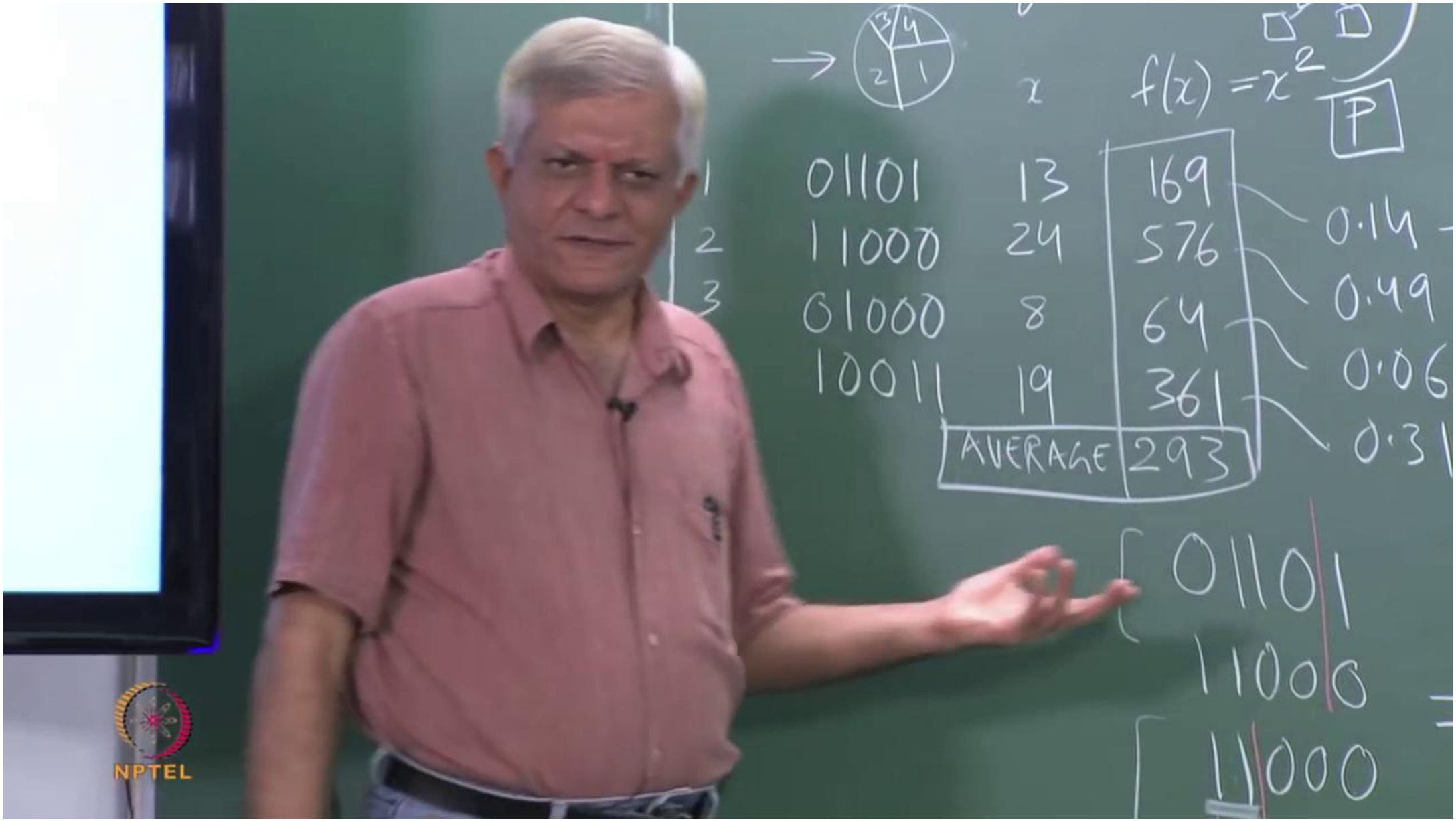

Holland
Goldberg
3/4
2
1
x
f(x) = x²
P
Selection
Crossover
Mutation
E
1 01101 13 169
2 11000 24 576
01000 8 64
10011 19 361
0.14 - 0.58
0.49 - 1.97
0.06 - 0.22
0.31 - 1.23
NPTEL

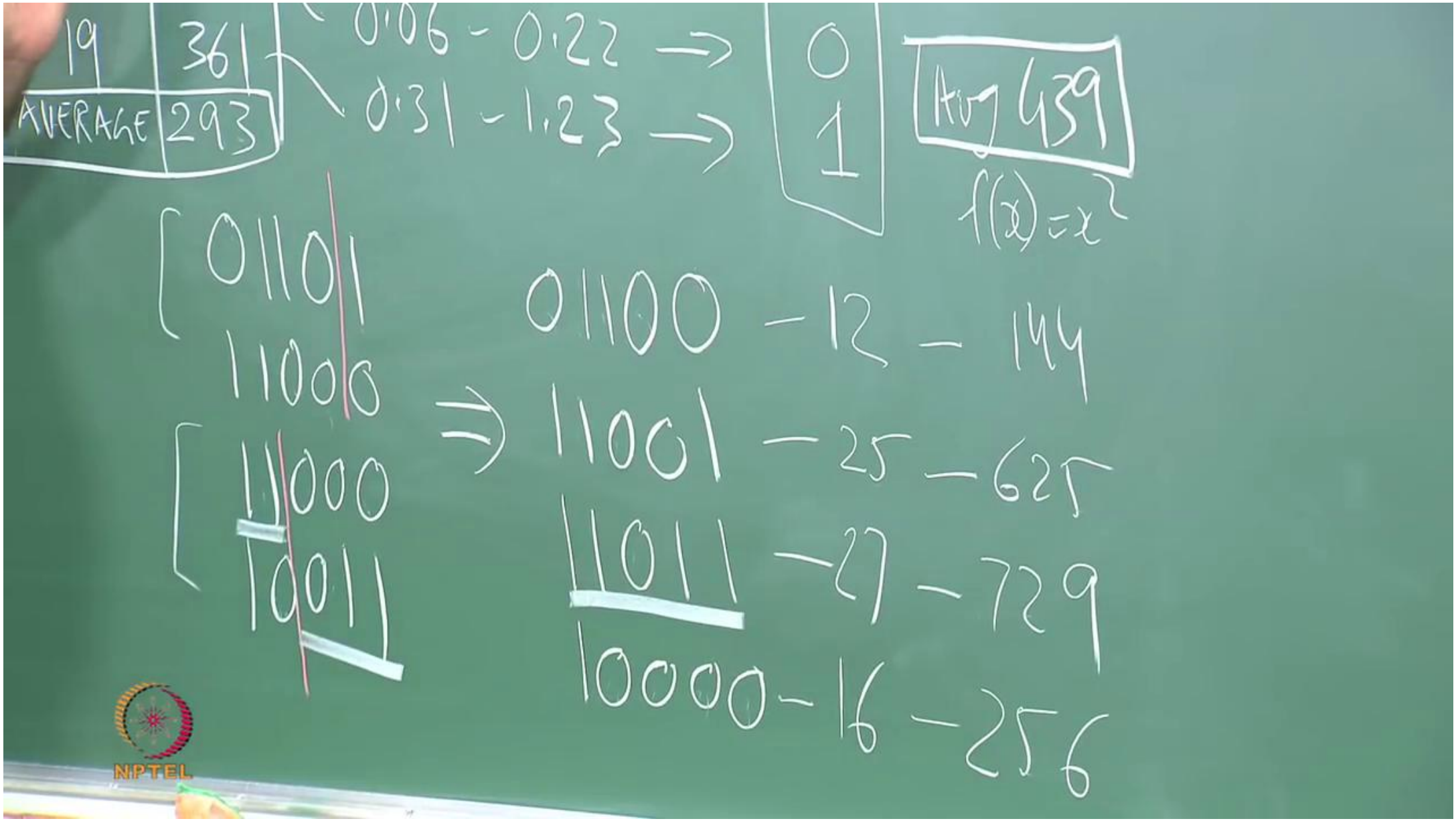

Holland
Goldberg
f(x) = x²
P
Selection
Crossover
Mutation
E
13
24
8
19
169
576
64
361
0.14 - 0.58
0.49 - 1.97
0.06 - 0.22
0.31 - 1.23
1
2
0
1

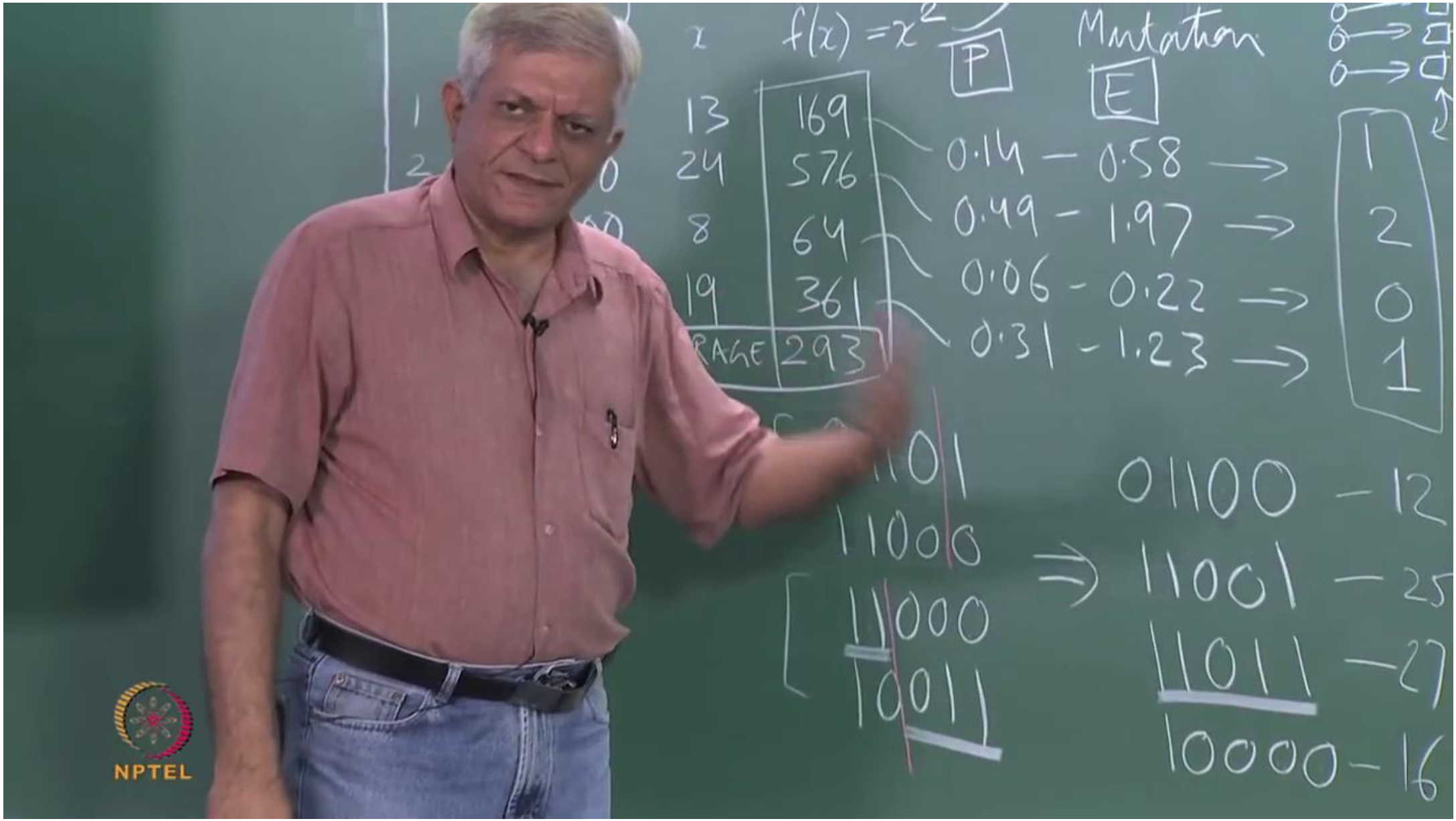

x
f(x) = x²
Mutation
P
E
01101 13 169
11000 24 576
01000 8
10011 361
0.14 - 0.58
0.49 - 1.97
0.06 - 0.22
0.31 - 1.23
1
2
0
1
01101
11000
11000
10011
NPTEL

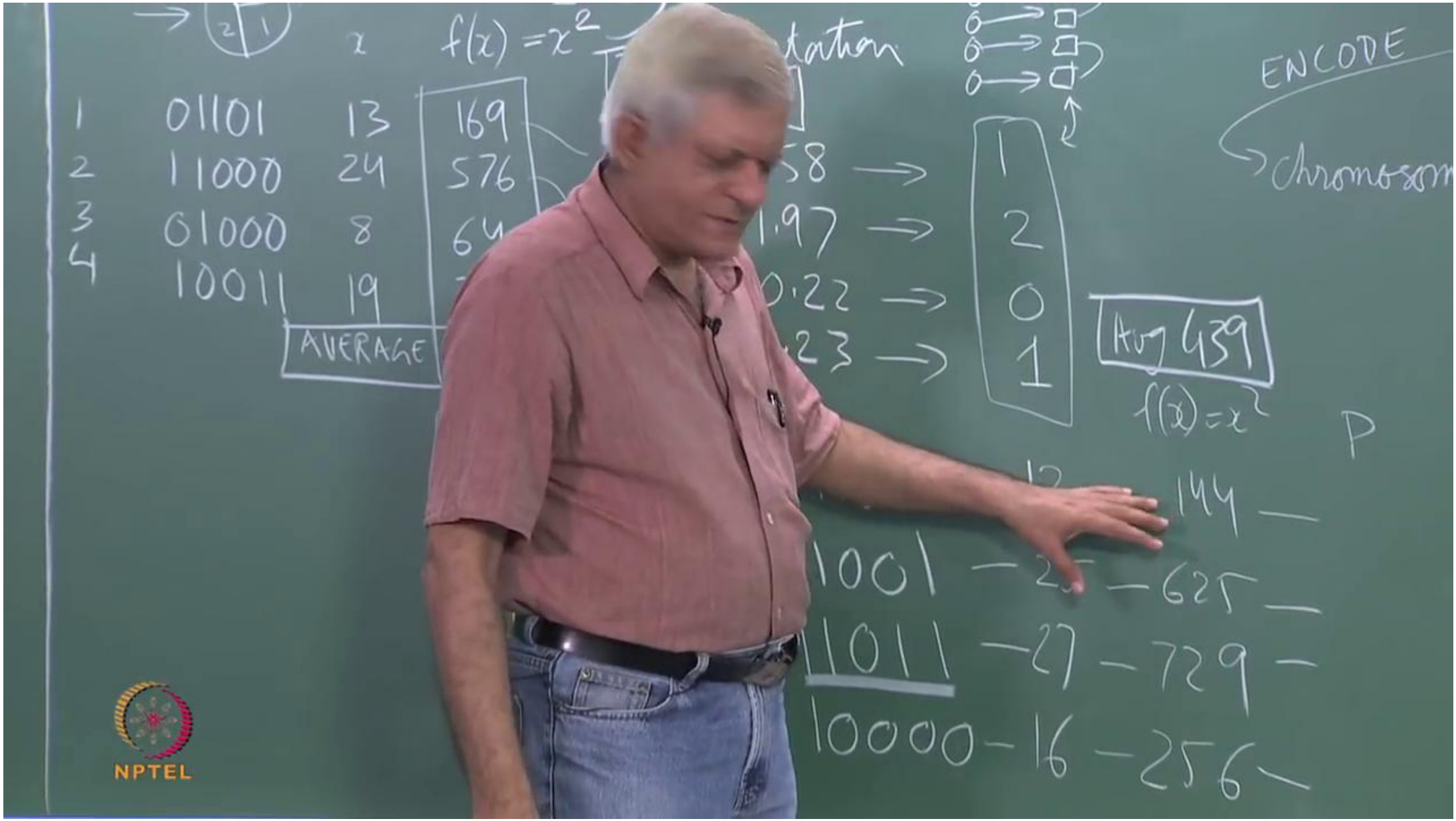

x
f(x) = x²
Mutation
P
E
1 01101 13 169
2 11000 24 576
3 01000 8 64
4 10011 19 361
0.14 - 0.58 → 1
0.49 - 1.97 → 2
0.06 - 0.22 → 0
0.31 - 1.23 → 1
01101
11000
11000
10011
⇒
01100
11001
11011
10000
NPTEL


x
$f(x) = x^2$
Mutation
P
E
1 01101 13 169
2 11000 24 576
3 01000 8 64
4 10011 19 361
0.14 - 0.58
0.49 - 1.97
0.06 - 0.22
0.31 - 1.23
1
2
0
1
01101
11000
01100
11001
11000
10011
11011
10000
NPTEL

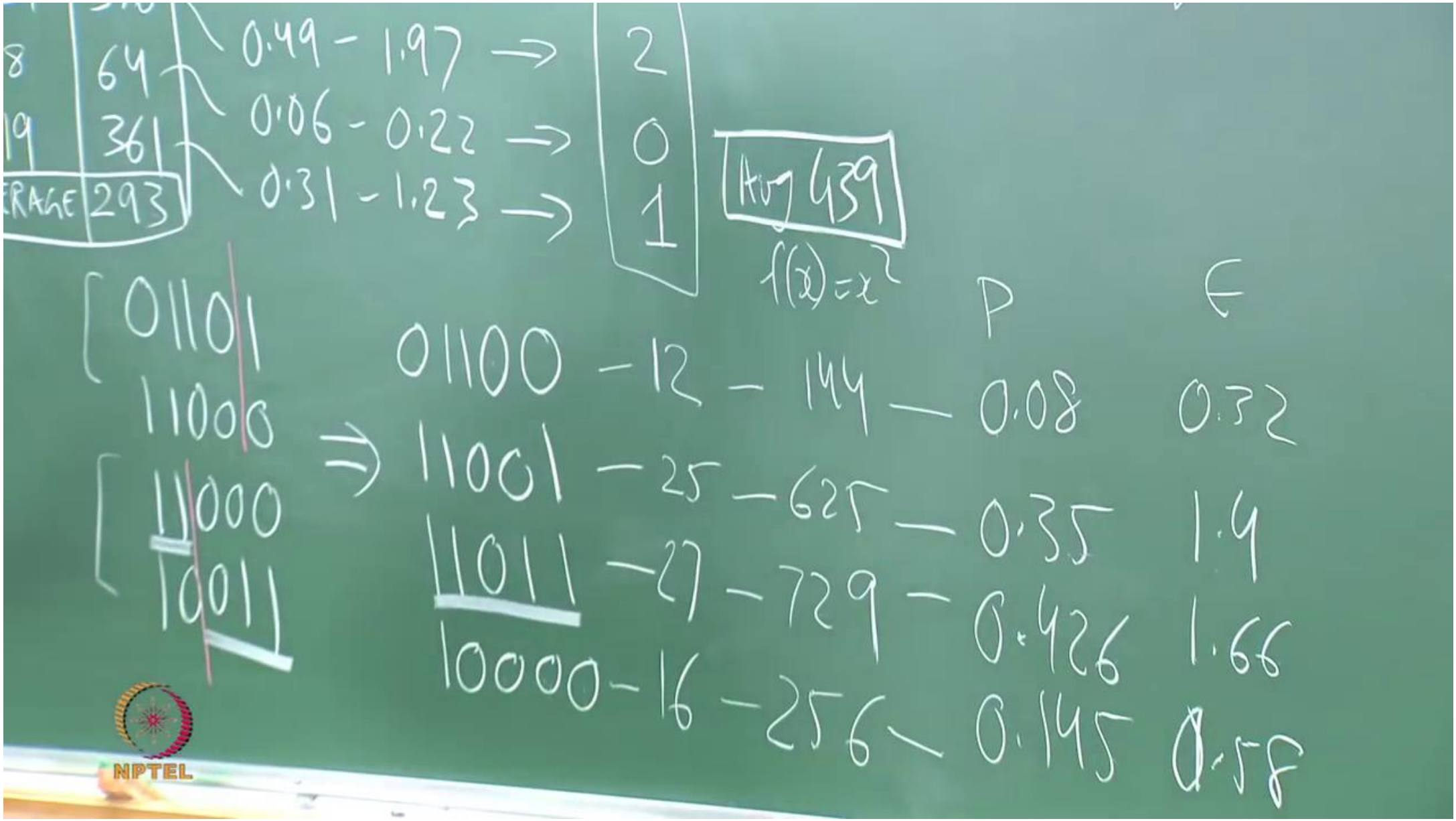

3 4
2 1
x
f(x) = x²
P
1 01101 13 169
2 11000 24 576
3 01000 8 64
10011 19 361
AVERAGE 293
0.14
0.49
0.06
0.31
01101
11000
11000

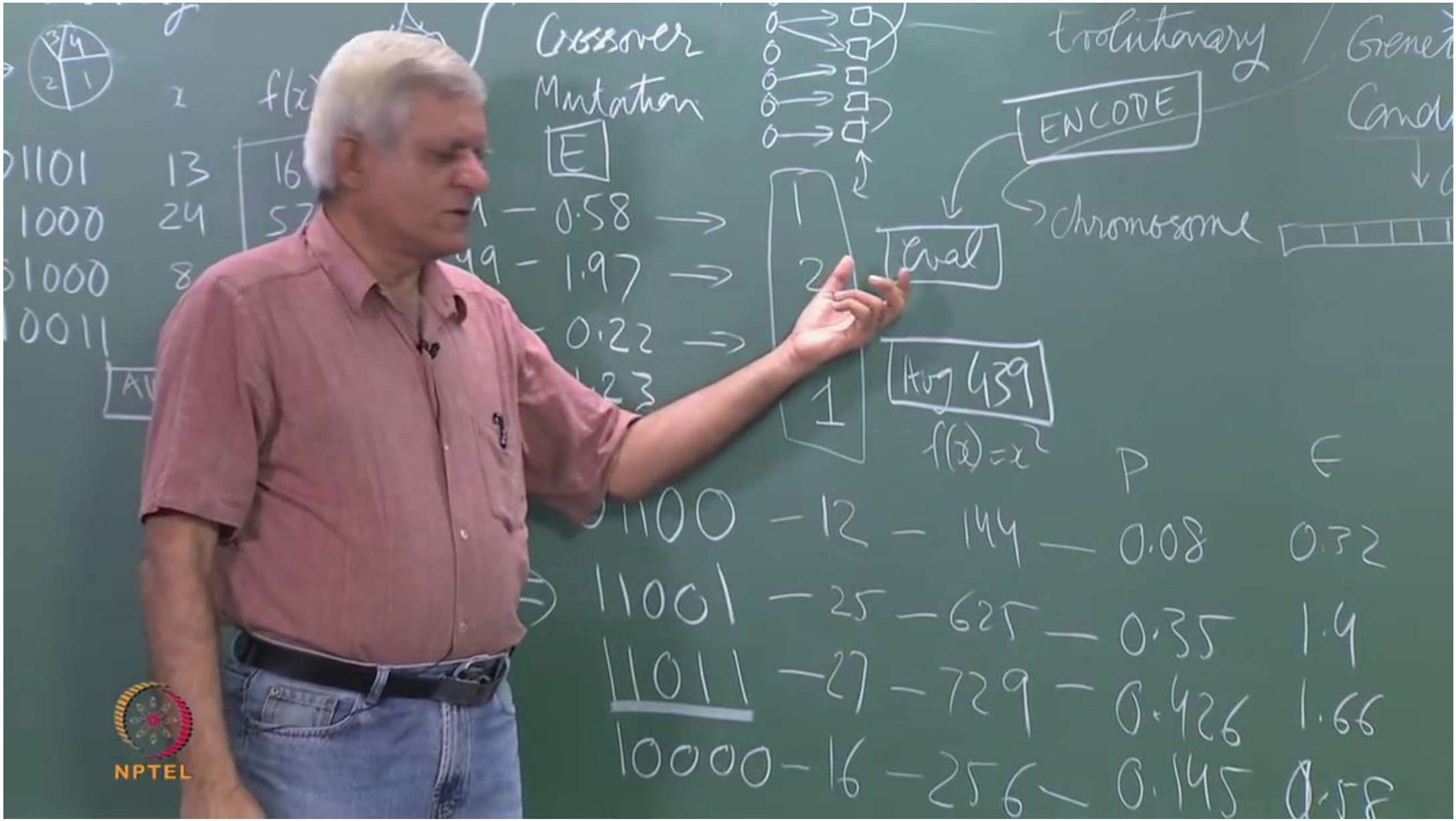

19 361
AVERAGE 293
0.06 - 0.22 ⇒ 0
0.31 - 1.23 ⇒ 1
Avg 439
f(x) = x²
01101
11000
11000
10011
⇒
01100 - 12 - 144
11001 - 25 - 625
11011 - 27 - 729
10000 - 16 - 256
NPTEL

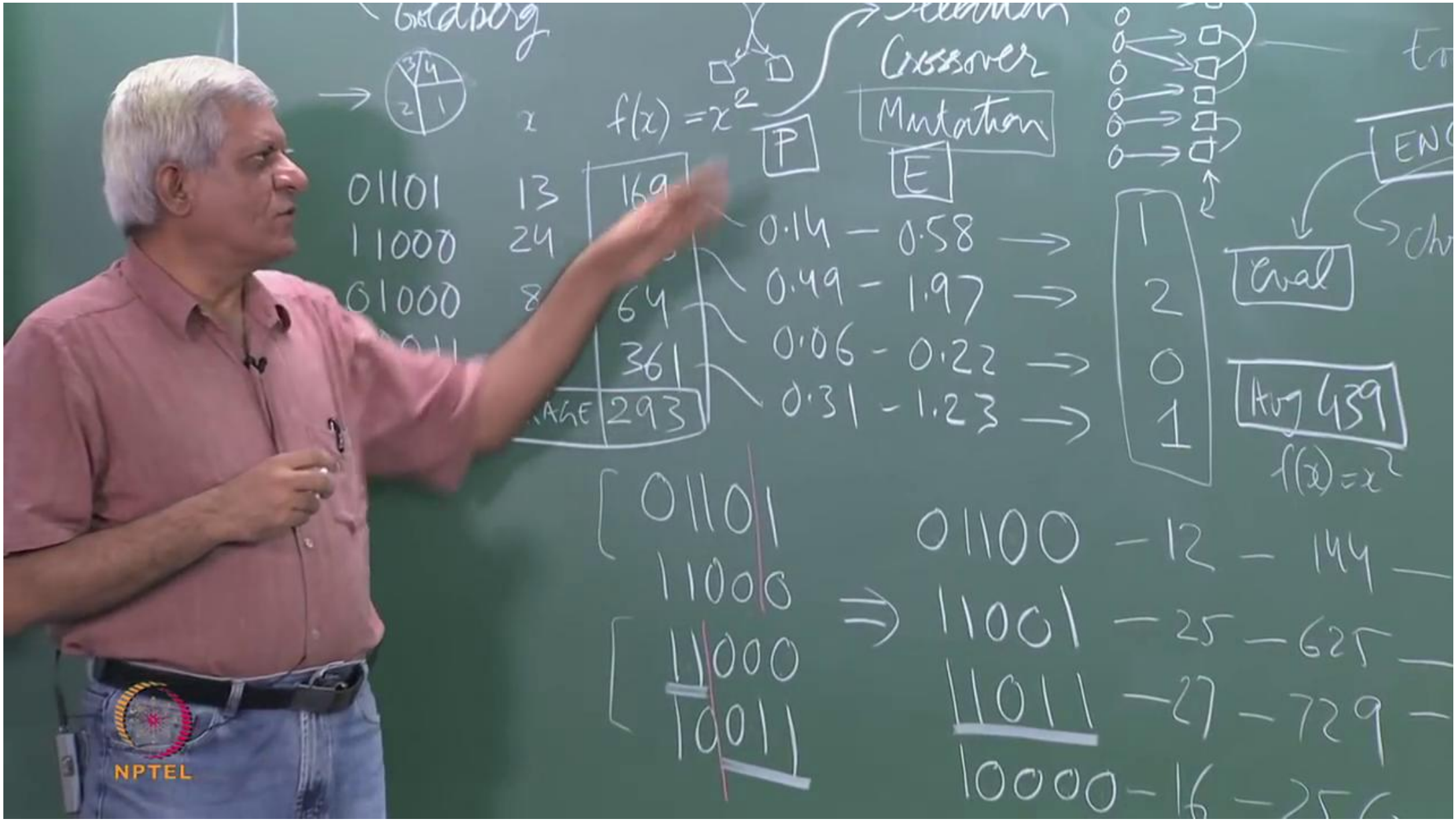

x
f(x) = x²
P
Mutation
E
13
169
24
576
8
64
19
361
RAGE
293
0.14 - 0.58
0.49 - 1.97
0.06 - 0.22
0.31 - 1.23
1
2
0
1
01100 - 12
11001 - 25
11011 - 27
10000 - 16
11000
10011
NPTEL

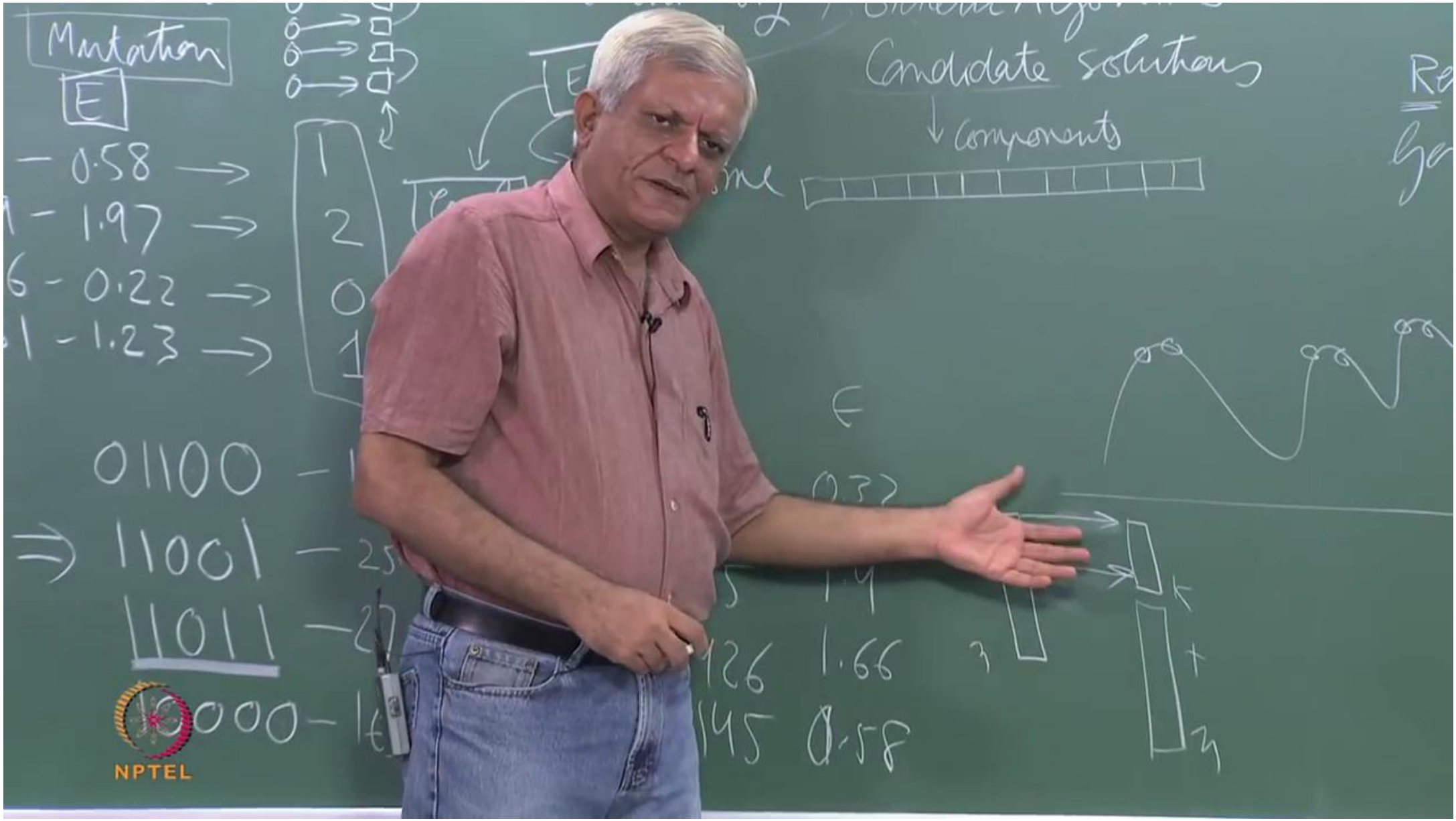


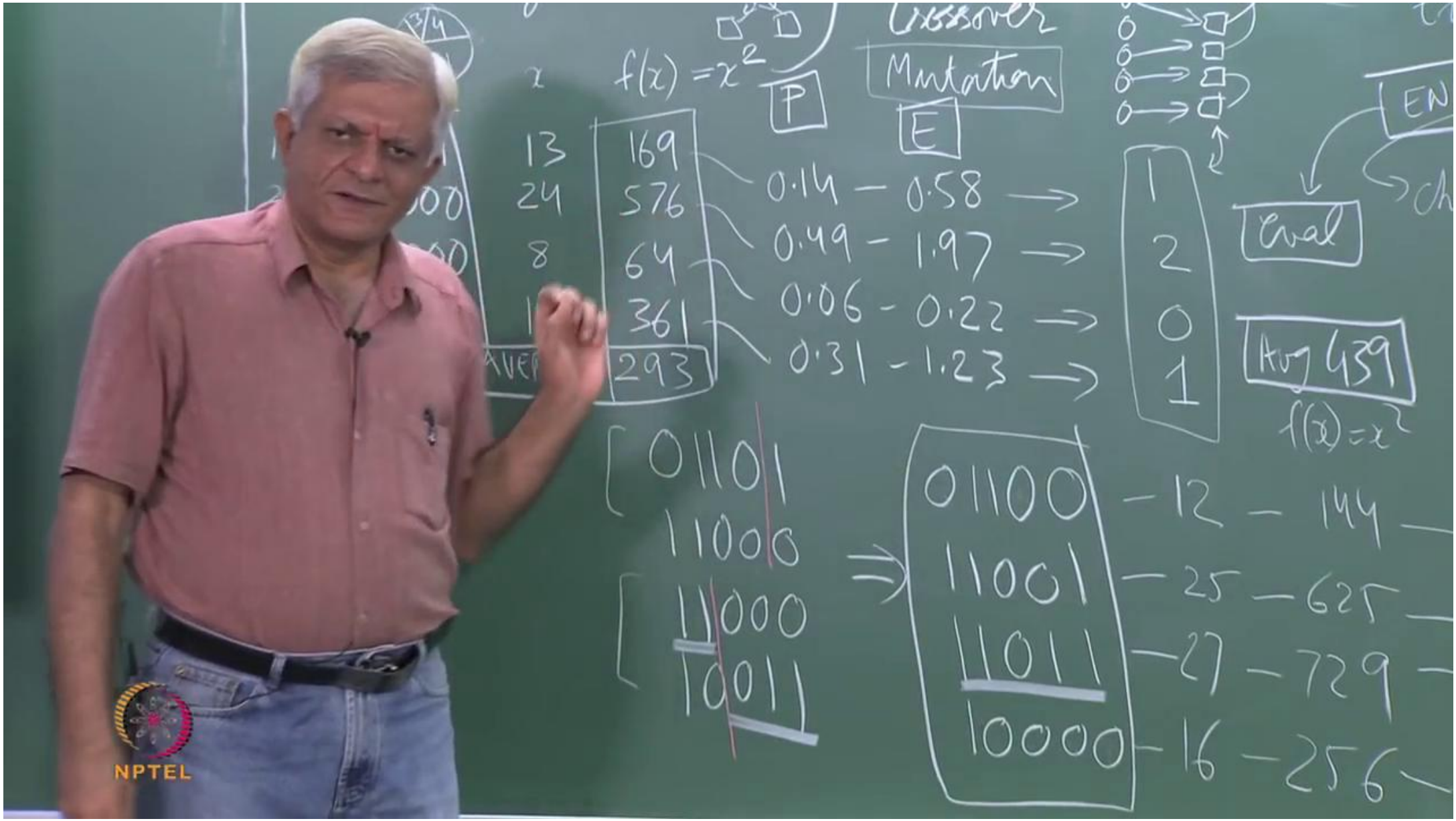
f(x) = x^2
ENCODE
Chromosom
1 01101 13 169
2 11000 24 576
3 01000 8 64
4 10011 19
AVERAGE
Avg 439
f(x) = x^2
P
144
625
729
10000 16 256
NPTEL


8 64
19 361
ERAGE 293
0.49 - 1.97 ⇒ 2
0.06 - 0.22 ⇒ 0
0.31 - 1.23 ⇒ 1
Avg 439
f(x) = x²
P
E
01101
11000
11000
10011
01100 - 12 - 144 - 0.08 0.32
⇒ 11001 - 25 - 625 - 0.35 1.4
11011 - 27 - 729 - 0.426 1.66
10000 - 16 - 256 - 0.145 0.58


Crossover
Mutation
E
Evolutionary
ENCODE
Chromosome
Eval
Avg 439
f(x)=x²
P
E
0.58
1.97
0.22
1100 - 12 - 144 - 0.08 0.32
11001 - 25 - 625 - 0.35 1.4
11011 - 27 - 729 - 0.426 1.66
10000 - 16 - 256 - 0.145 0.58
NPTEL


Goldberg
Crossover
Mutation
P
E
f(x) = x^2
01101 13 169
11000 24
01000 8 64
361
293
0.14 - 0.58
0.49 - 1.97
0.06 - 0.22
0.31 - 1.23
1
2
0
1
Eval
Avg 439
f(x) = x^2
01101
11000
11000
10011
01100 - 12 - 144
11001 - 25 - 625
11011 - 27 - 729
10000 - 16
NPTEL


Mutation
E
Candidate solutions
components
01100
11001
11011
1.66
0.58
NPTEL


x
f(x) = x²
13
24
8
169
576
64
361
293
P
Crossover
Mutation
E
0.14 - 0.58
0.49 - 1.97
0.06 - 0.22
0.31 - 1.23
1
2
0
1
Eval
Avg 459
f(x) = x²
01101
11000
11000
10011
01100
11001
11011
10000
- 12 - 144
- 25 - 625
- 27 - 729
- 16 - 256
NPTEL