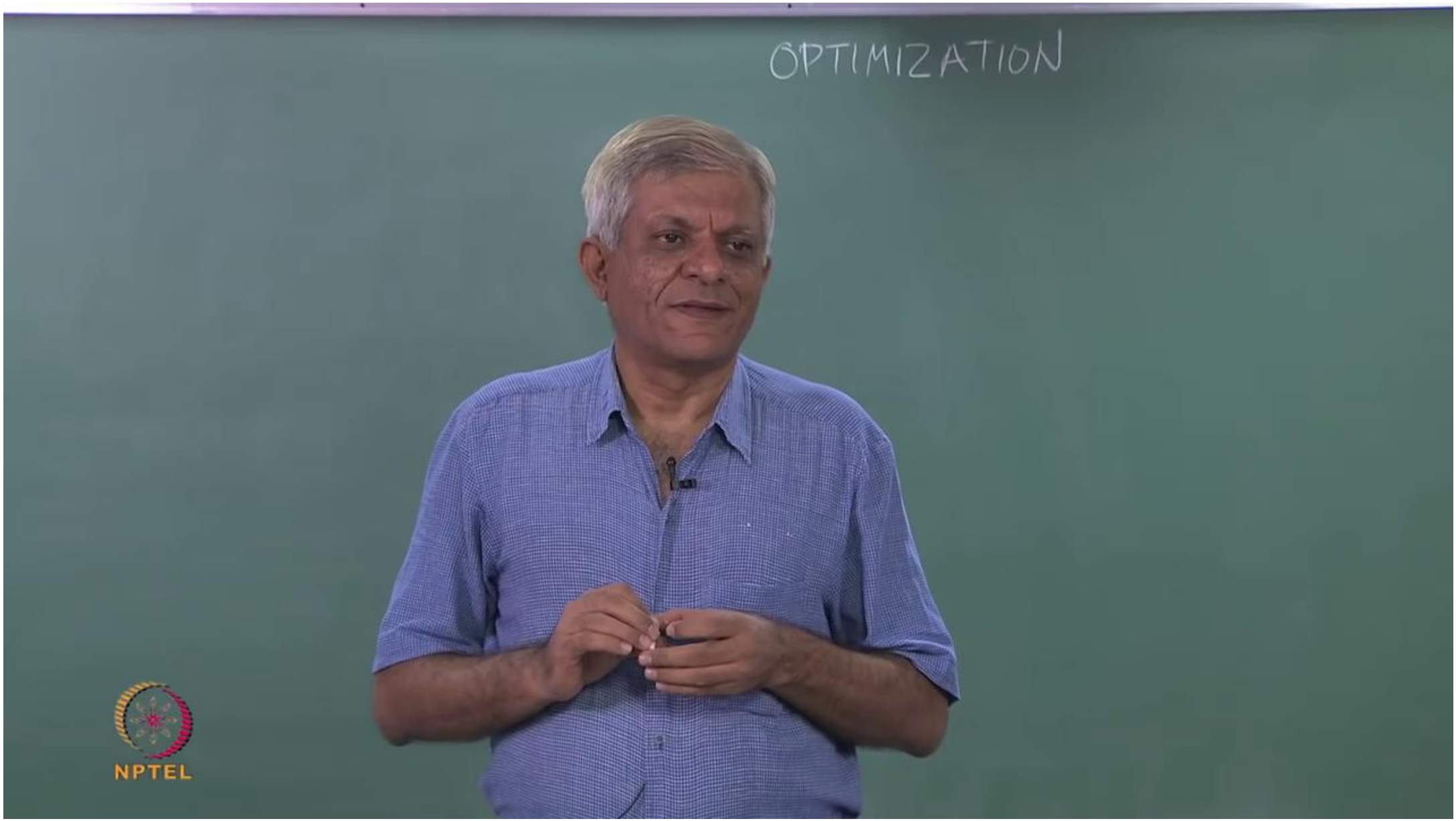
Video Lectures On

Artificial Intelligence

Lecture 15

Optimization II (Genetic Algorthms)

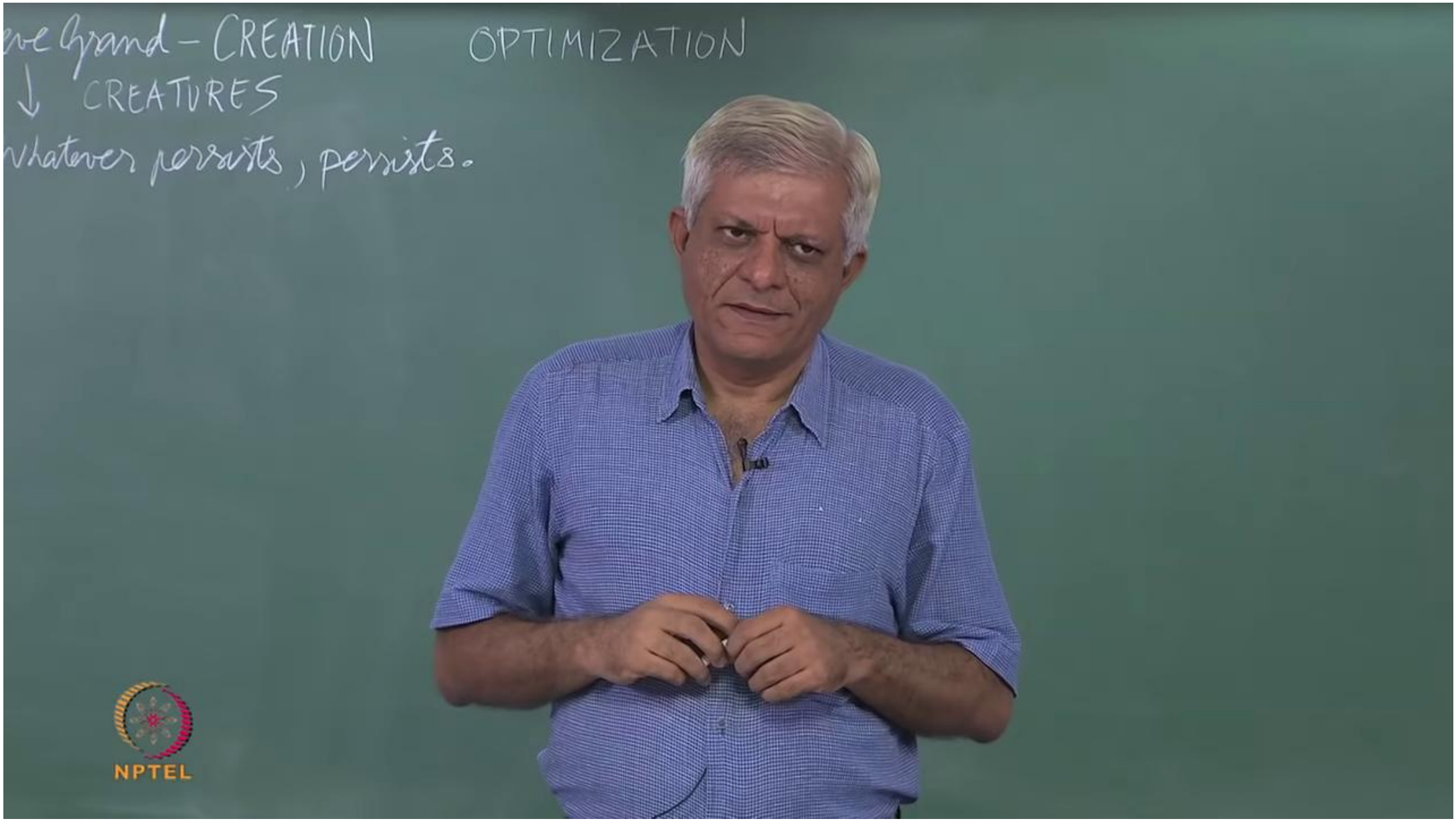
Prof. Deepak Khemani
Department of Computer Science
IIT Madras

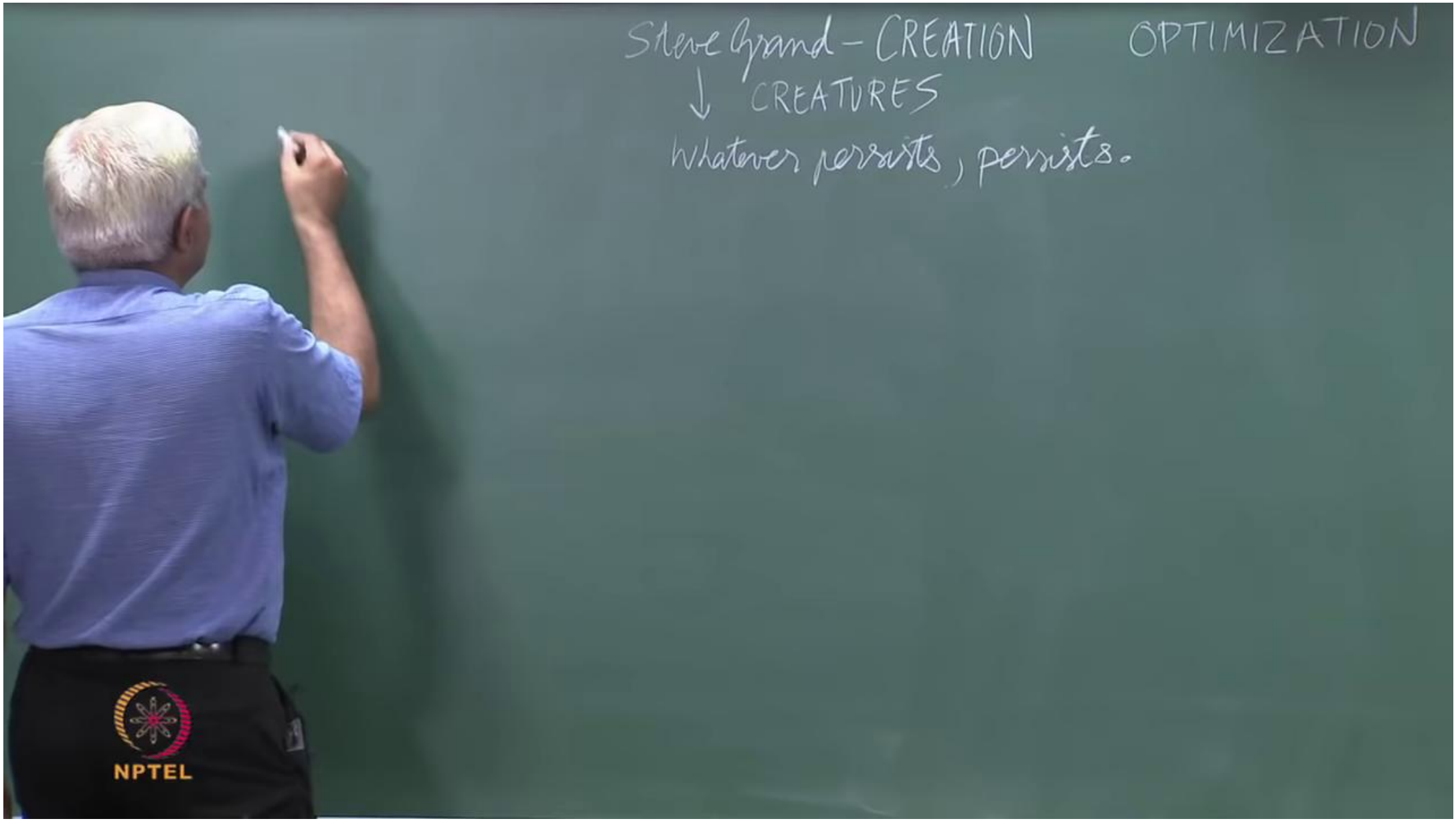

OPTIMIZATION
NPTEL

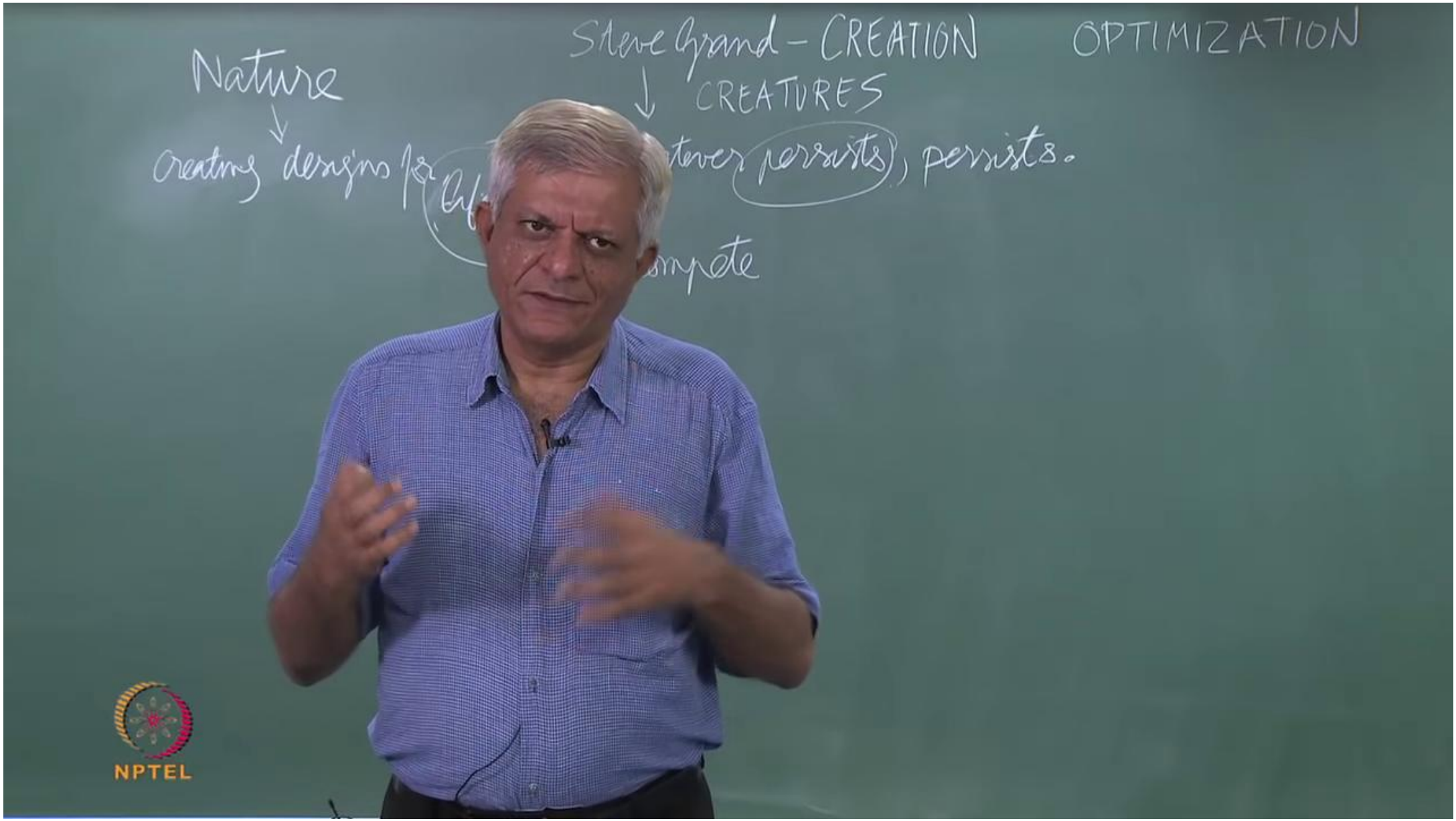

Steve Grand - CREATION
NPTEL

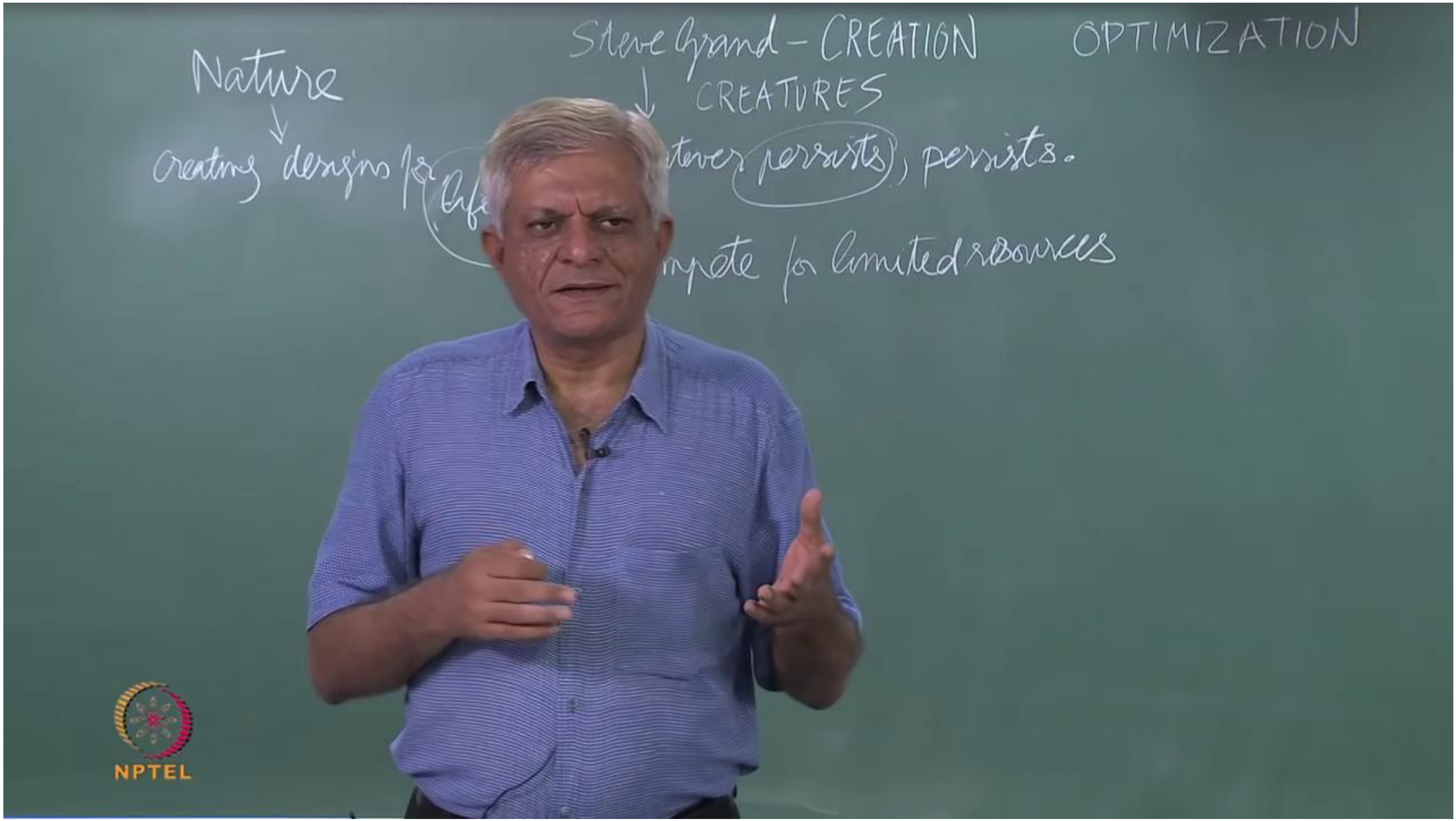

Steve Grand - CREATION
NPTEL


Steve Grand - CREATION
CREATURES
NPTEL


ve Grand – CREATION
OPTIMIZATION
↓ CREATURES
whatever persists, persists.
NPTEL


Steve Grand – CREATION
OPTIMIZATION
↓ CREATURES
Whatever persists, persists.
NPTEL


Nature
Steve Grand – CREATION
CREATURES
OPTIMIZATION
creating designs
persists
persists.
NPTEL


Nature
Steve Grand – CREATION
CREATURES
OPTIMIZATION
creating designs for
persists.
compete for limited resources
NPTEL

Nature

↓

ting designs for Life forms

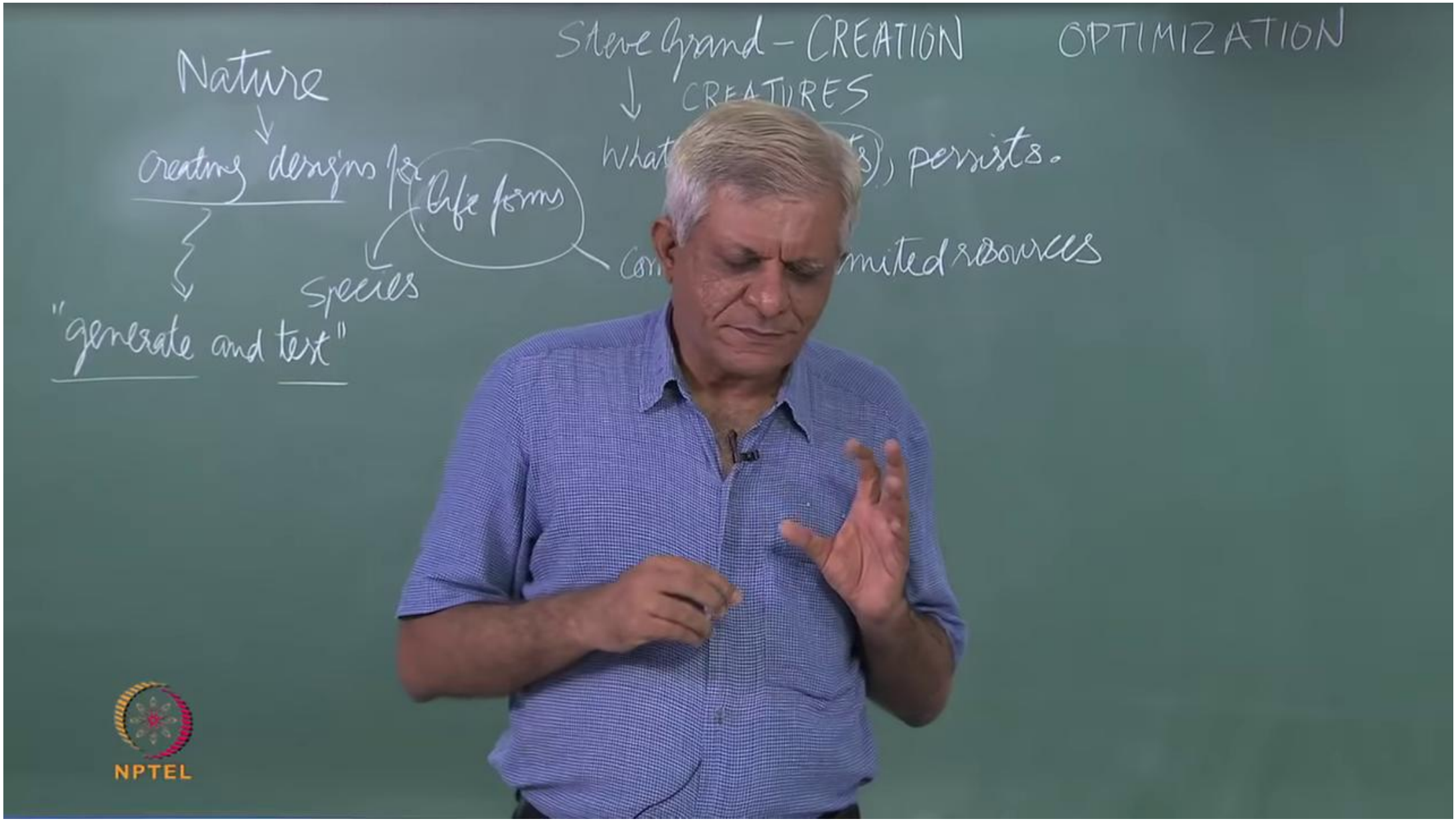
Species

Steve Grand – CREATION OPTIMIZATION

↓ CREATURES

Whatever persists, persists.

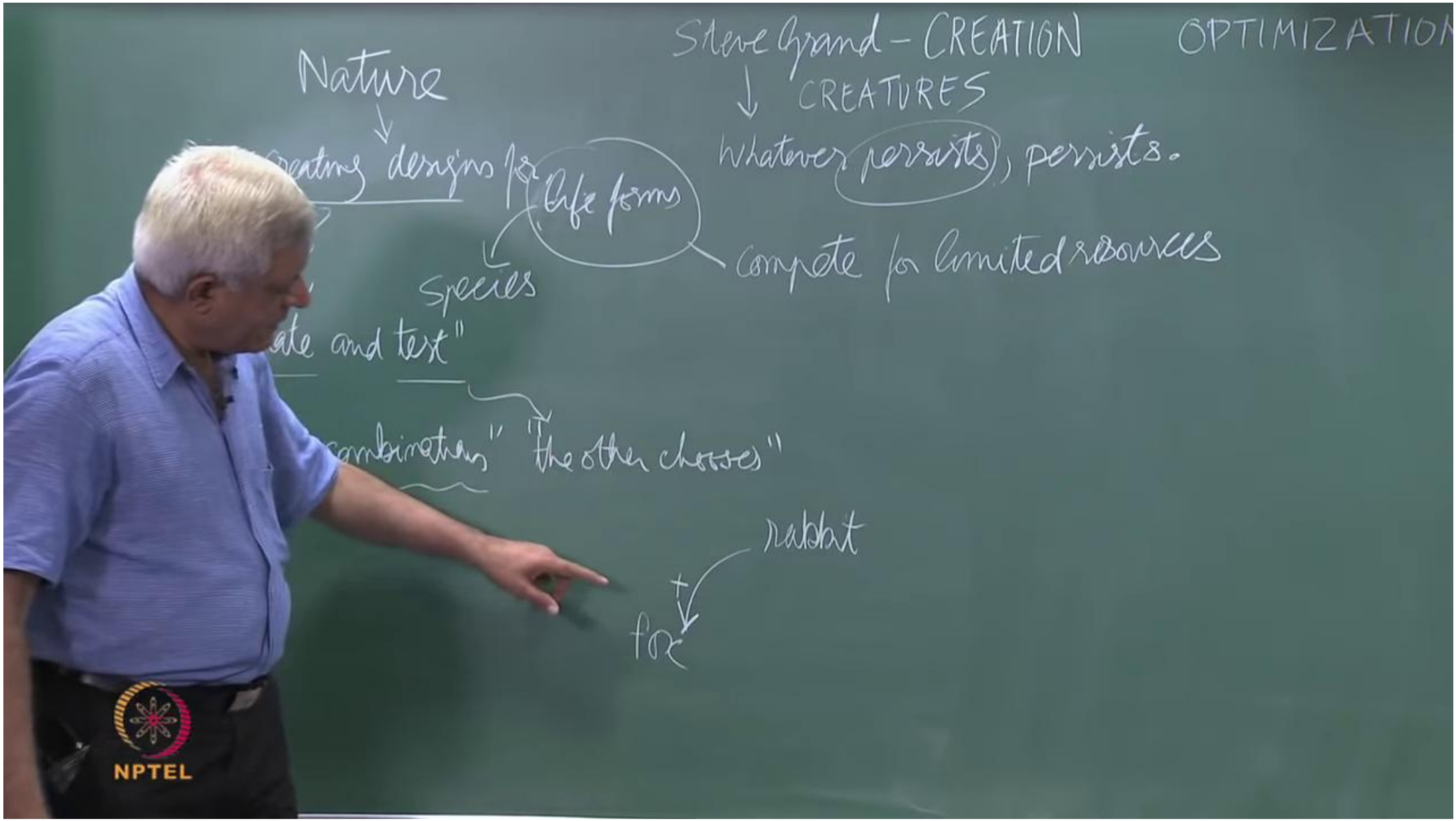
compete for limited resources

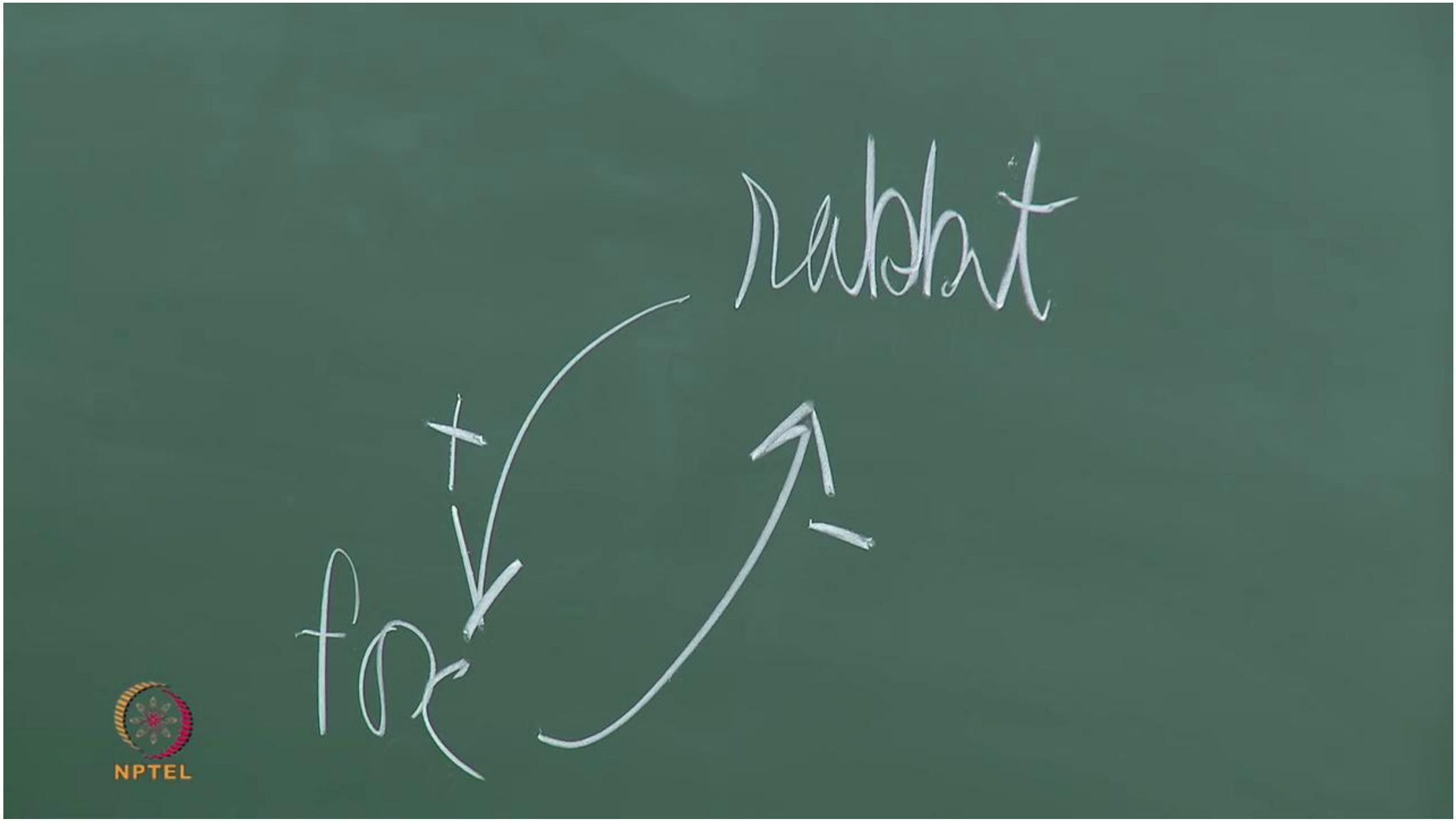

Nature
creating designs for
Life forms
species
"generate and test"
Steve Grand – CREATION
CREATURES
persists.
limited resources
OPTIMIZATION
NPTEL

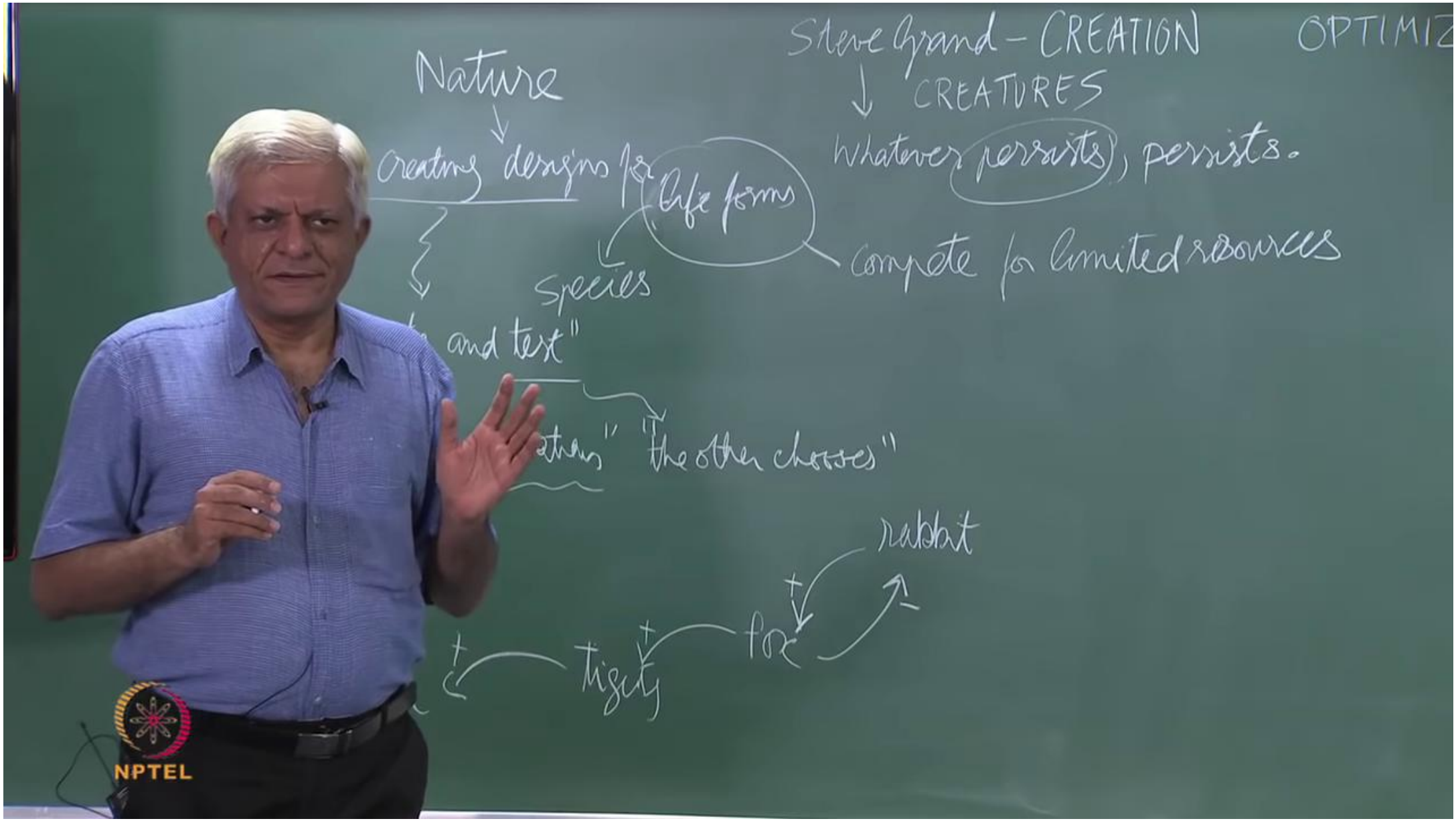
species

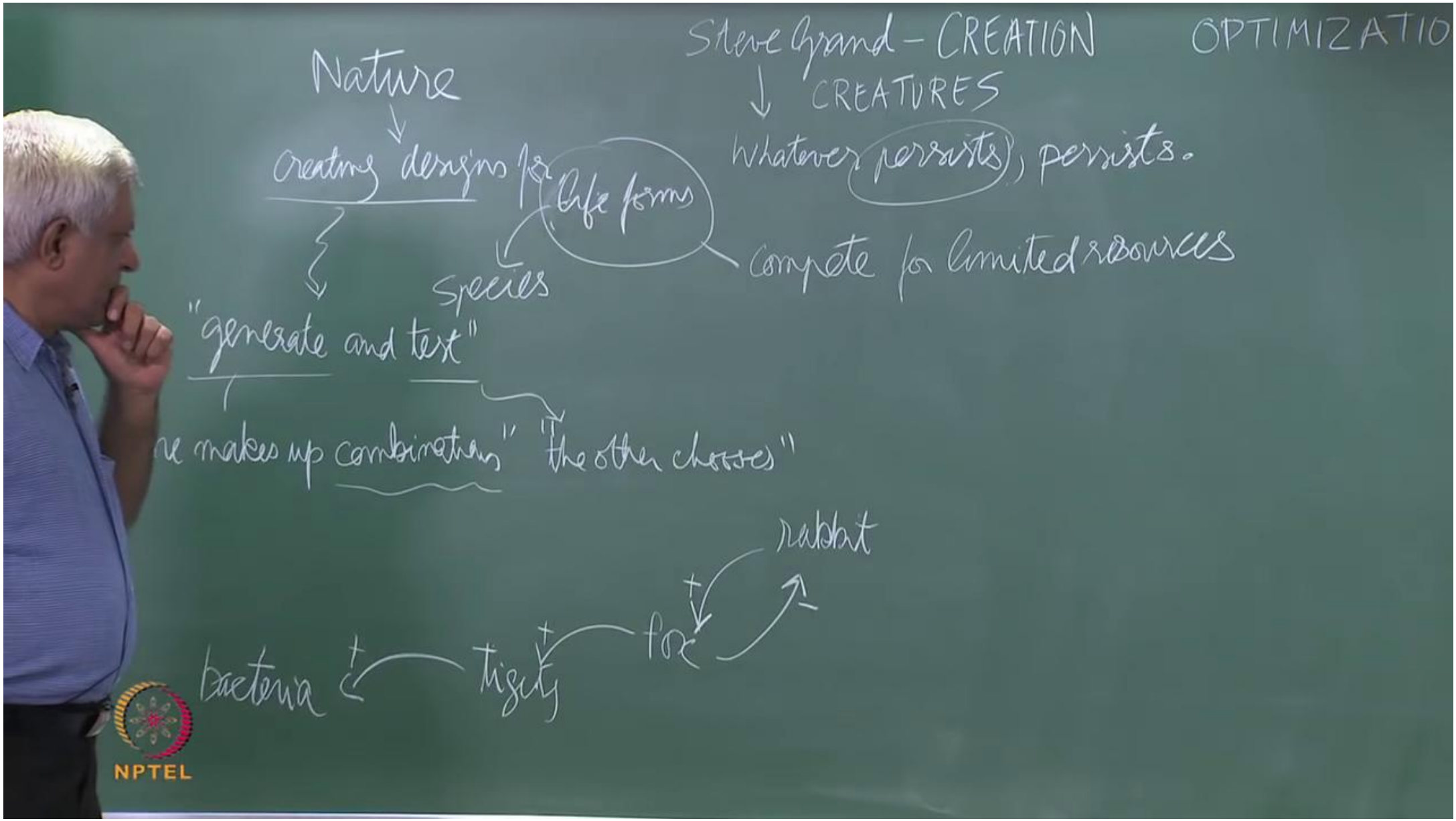
"generate and test"

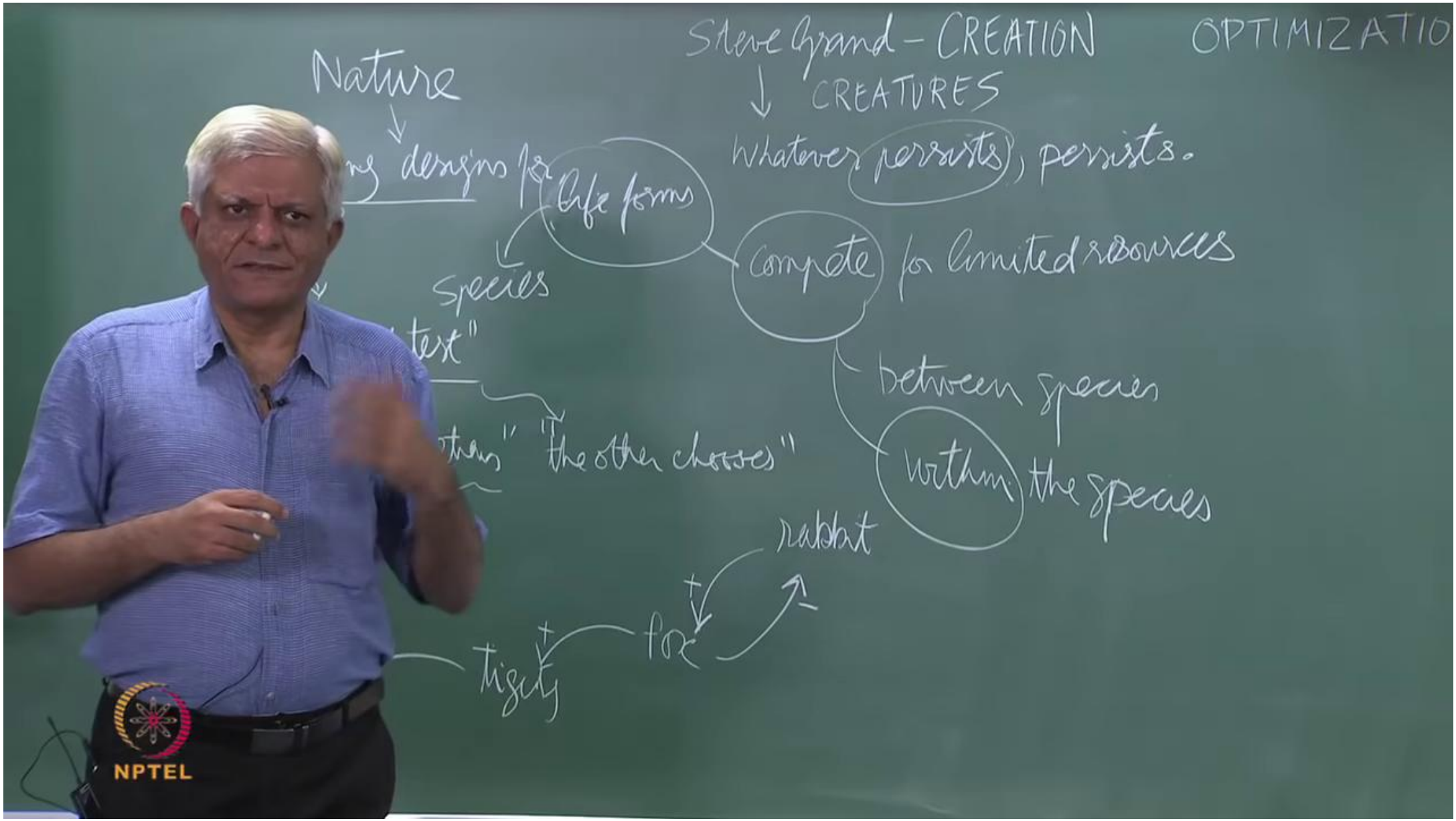
"one makes up combination" "the other chooses"

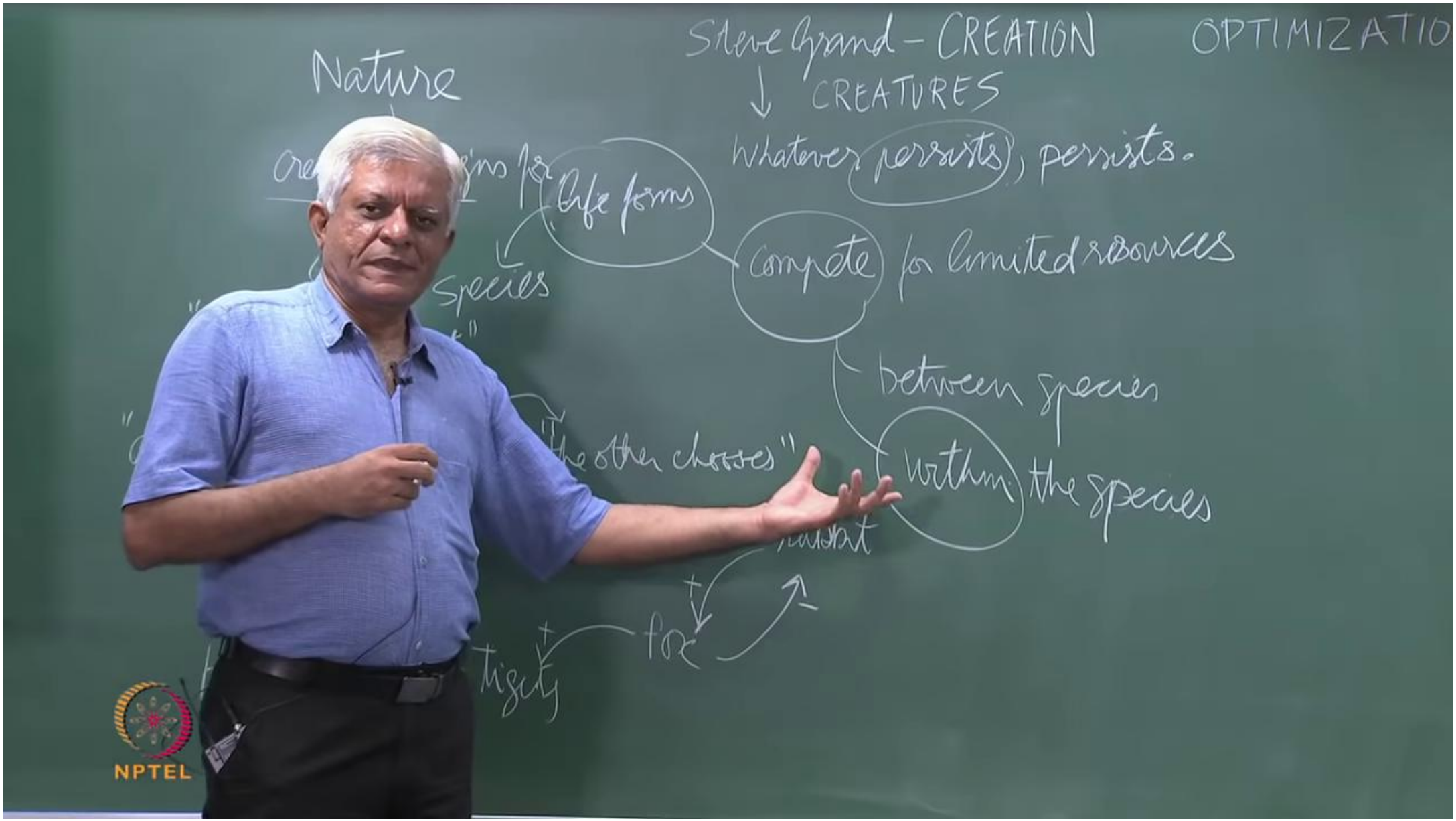

Nature
Steve Grand – CREATION
CREATURES
OPTIMIZATION
designs
Life forms
Whatever persists, persists.
compete for limited resources
species
and test"
combinations"
"the other chooses"
rabbit
for
NPTEL

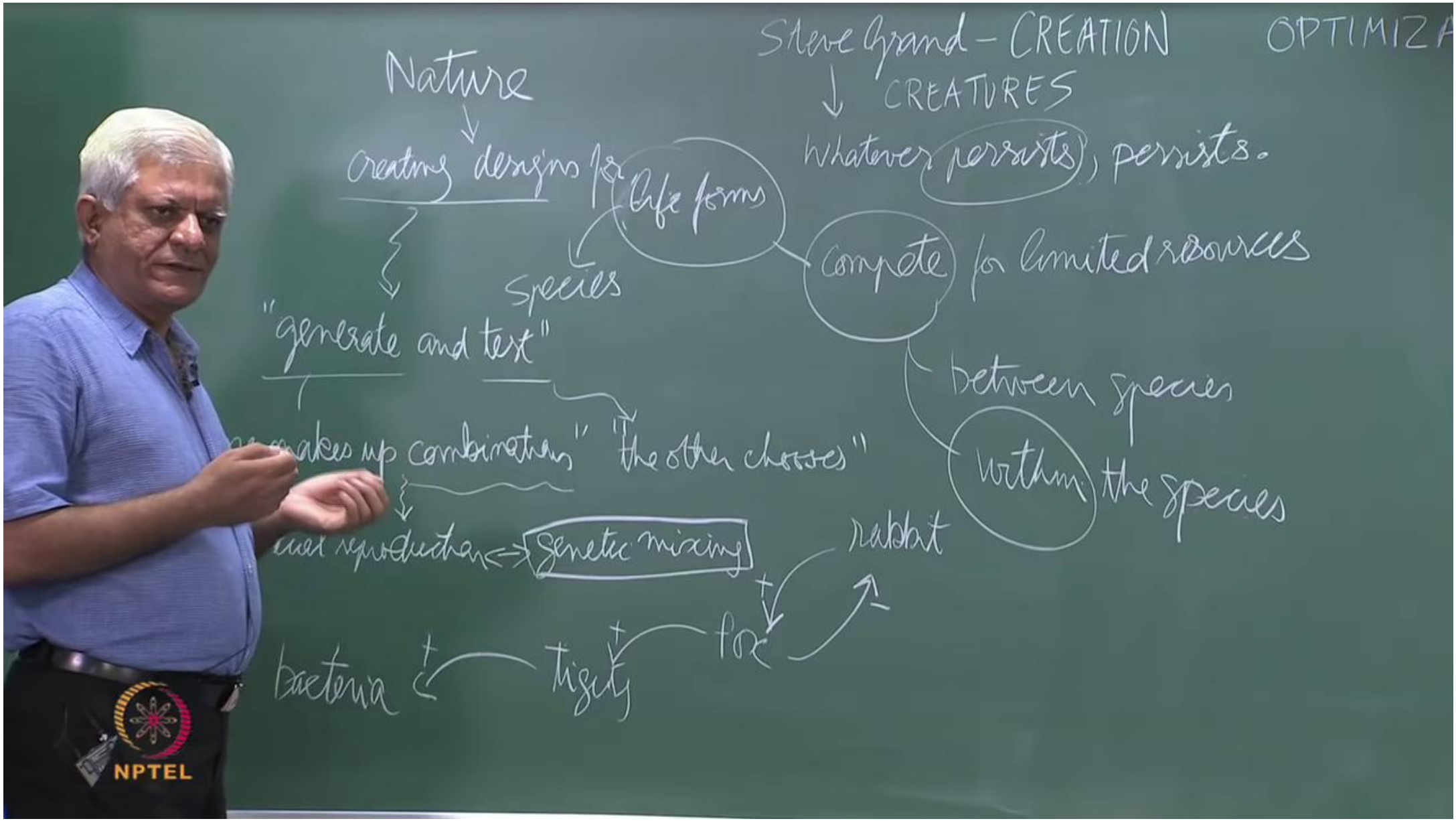

rabbit
for
+
-

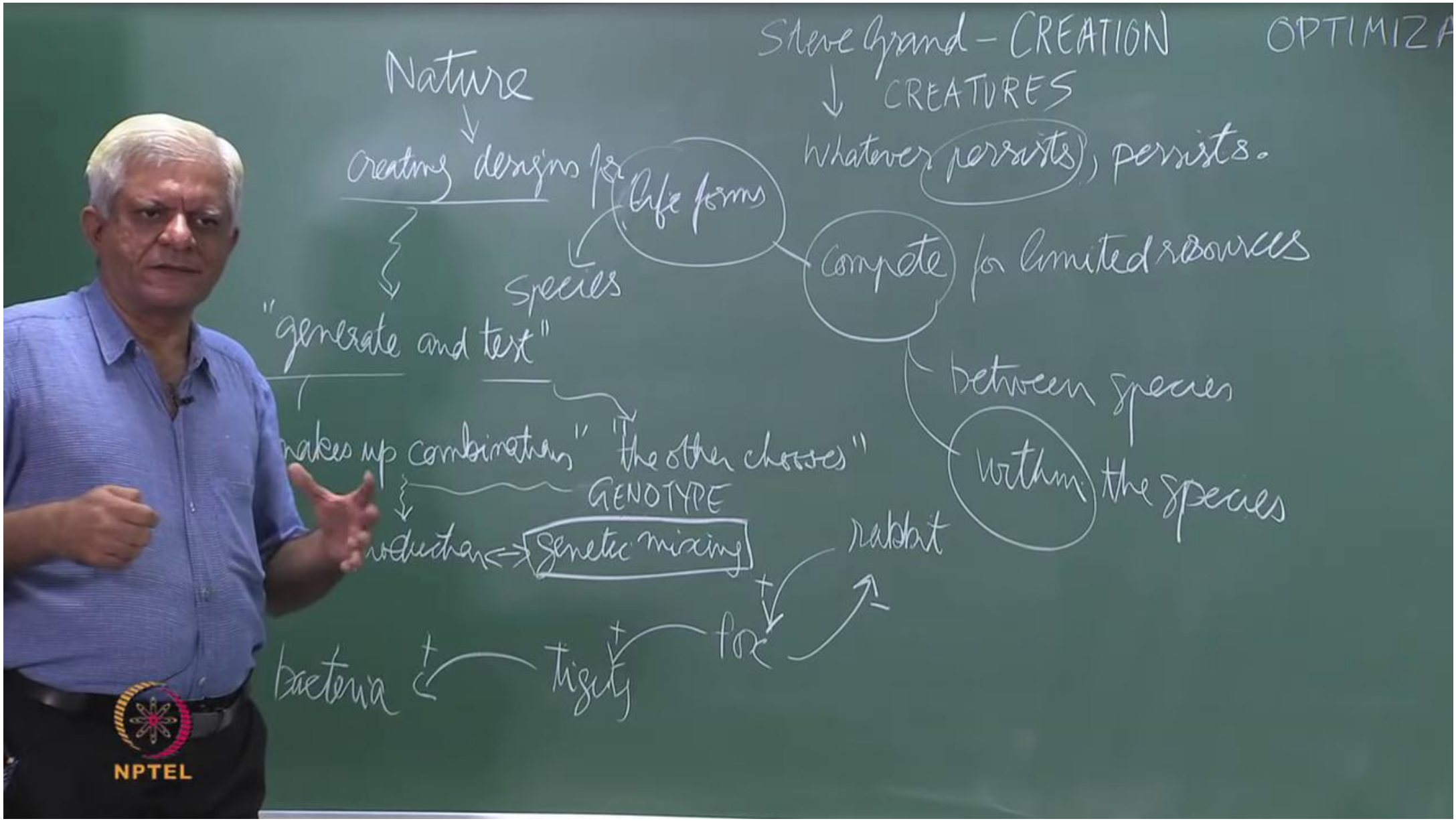

Steve Grand – CREATION
CREATURES
OPTIMIZ
Nature
creating designs for
Life forms
species
Whatever persists, persists.
compete for limited resources
and test"
"The other chooses"
rabbit
for
tiger
NPTEL

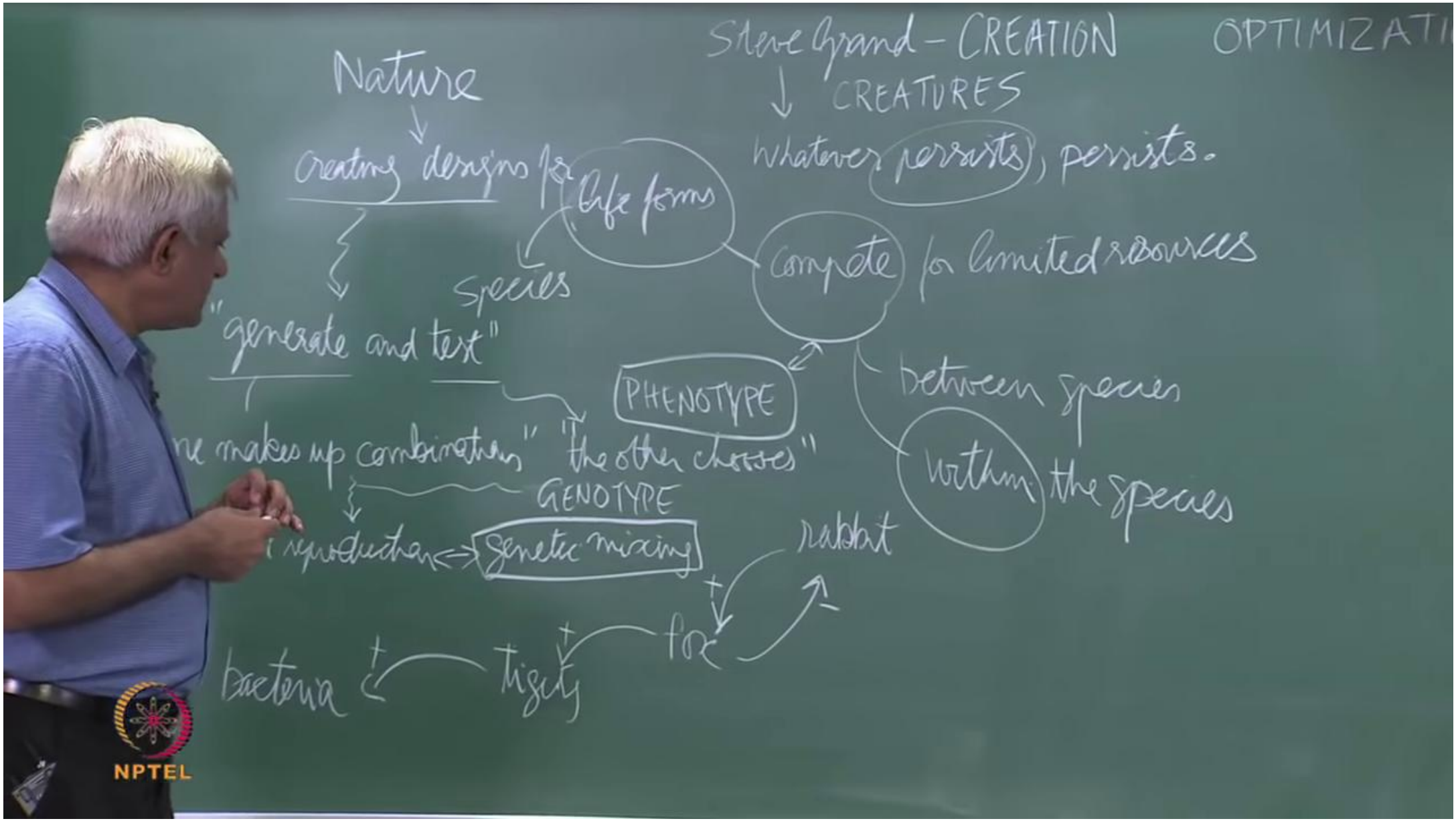

Nature
creating designs for
Life forms
species
"generate and test"
Steve Grand – CREATION
CREATURES
Whatever persists, persists.
compete for limited resources
OPTIMIZATIO
rabbit
fox
tiger
bacteria

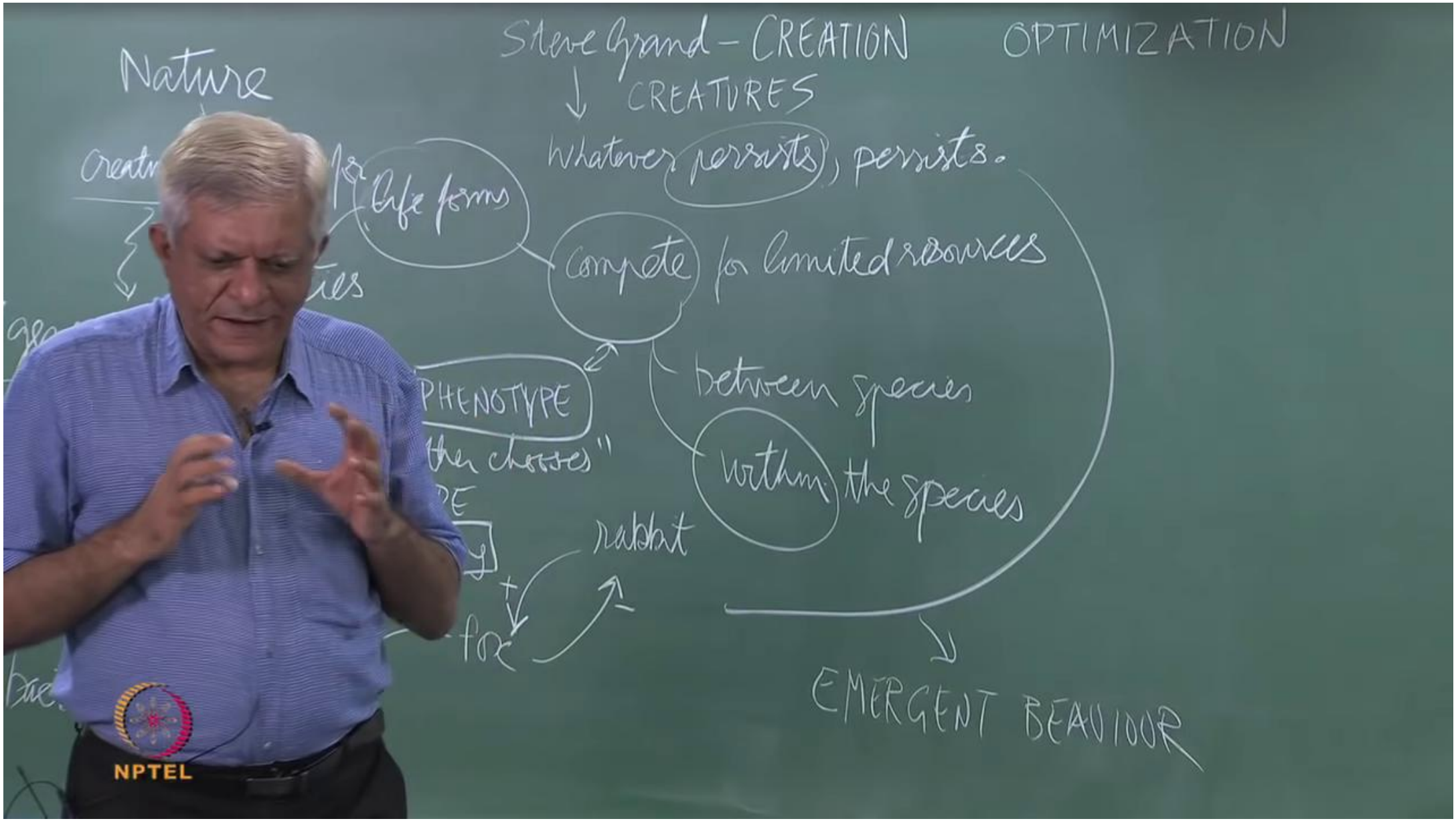

Nature
designs for
Steve Grand – CREATION
CREATURES
OPTIMIZATIO
Whatever persists, persists.
Life forms
compete for limited resources
species
test"
between species
within the species
"the other chooses"
rabbit
fox
tiger

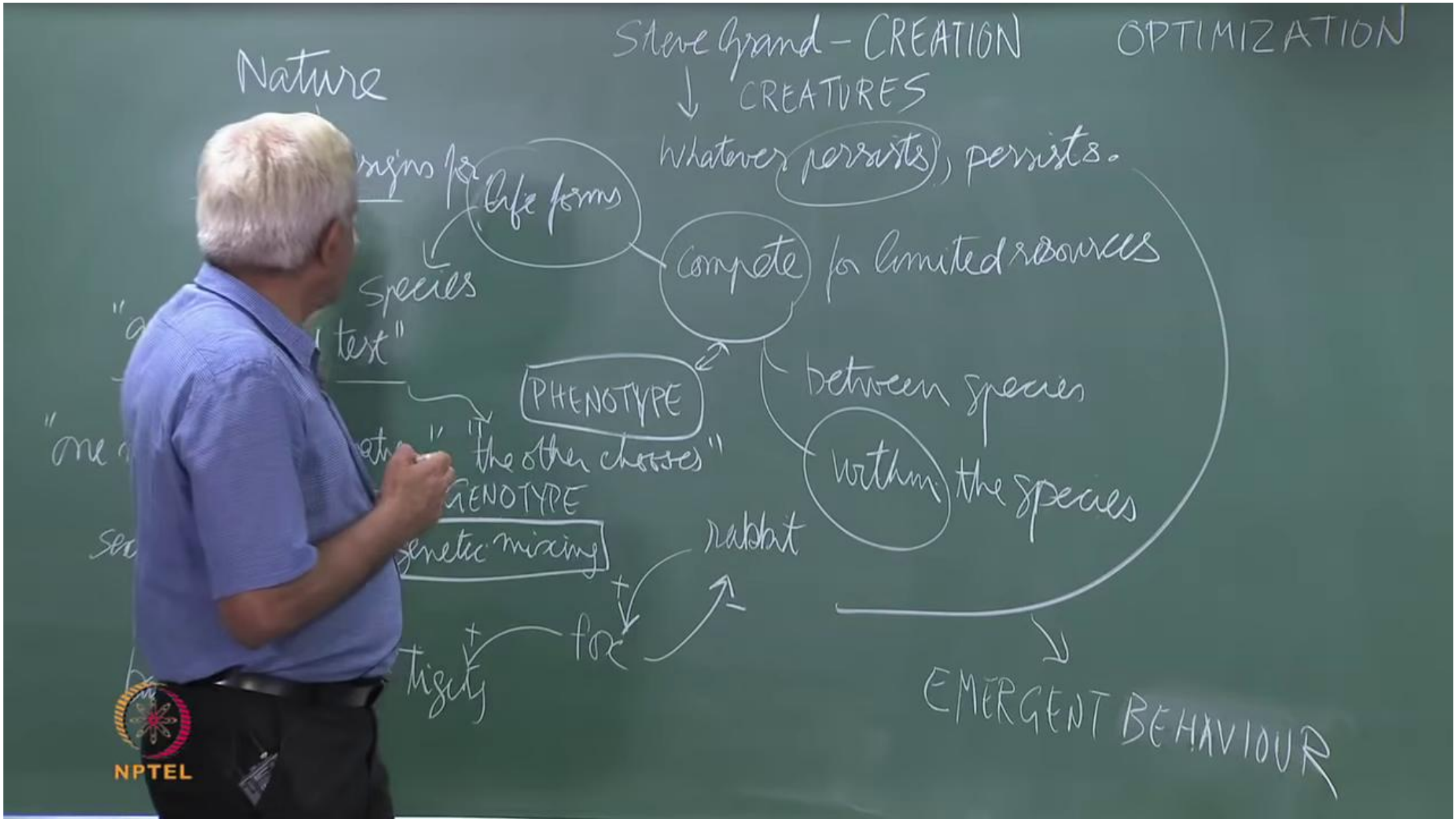

Nature
Steve Grand – CREATION
CREATURES
OPTIMIZATIO
Whatever persists, persists.
Life forms
compete for limited resources
species
between species
within the species
"the other chosses"
fitness
for

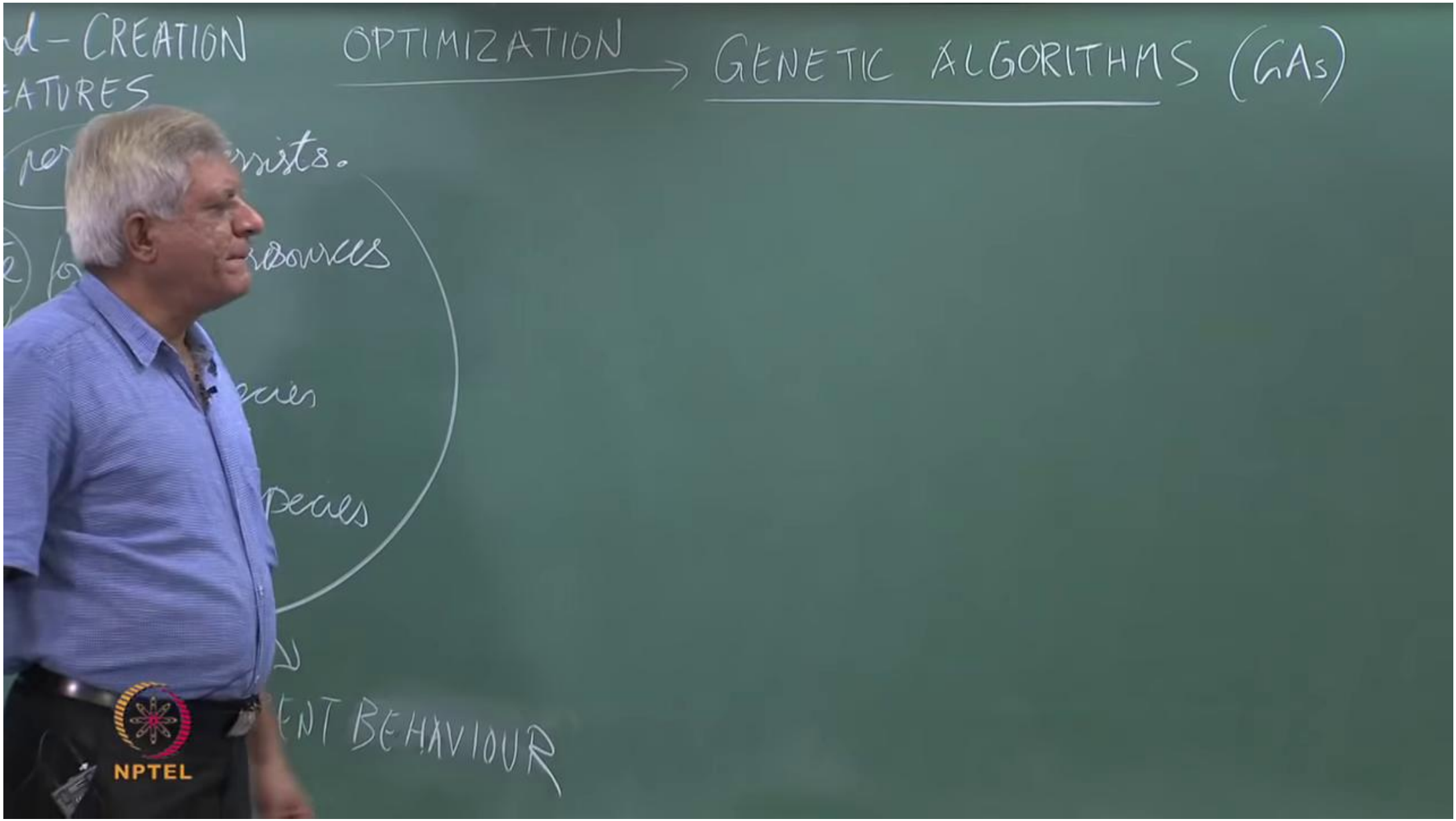

Nature
creating designs for
species
"generate and test"
"makes up combination"
"the other chooses"
sexual reproduction <=> Genetic mixing
bacteria
tissue
fox
rabbit
Steve Grand - CREATION
CREATURES
Whatever persists, persists.
Life forms
compete for limited resources
between species
within the species
OPTIMIZA
NPTEL

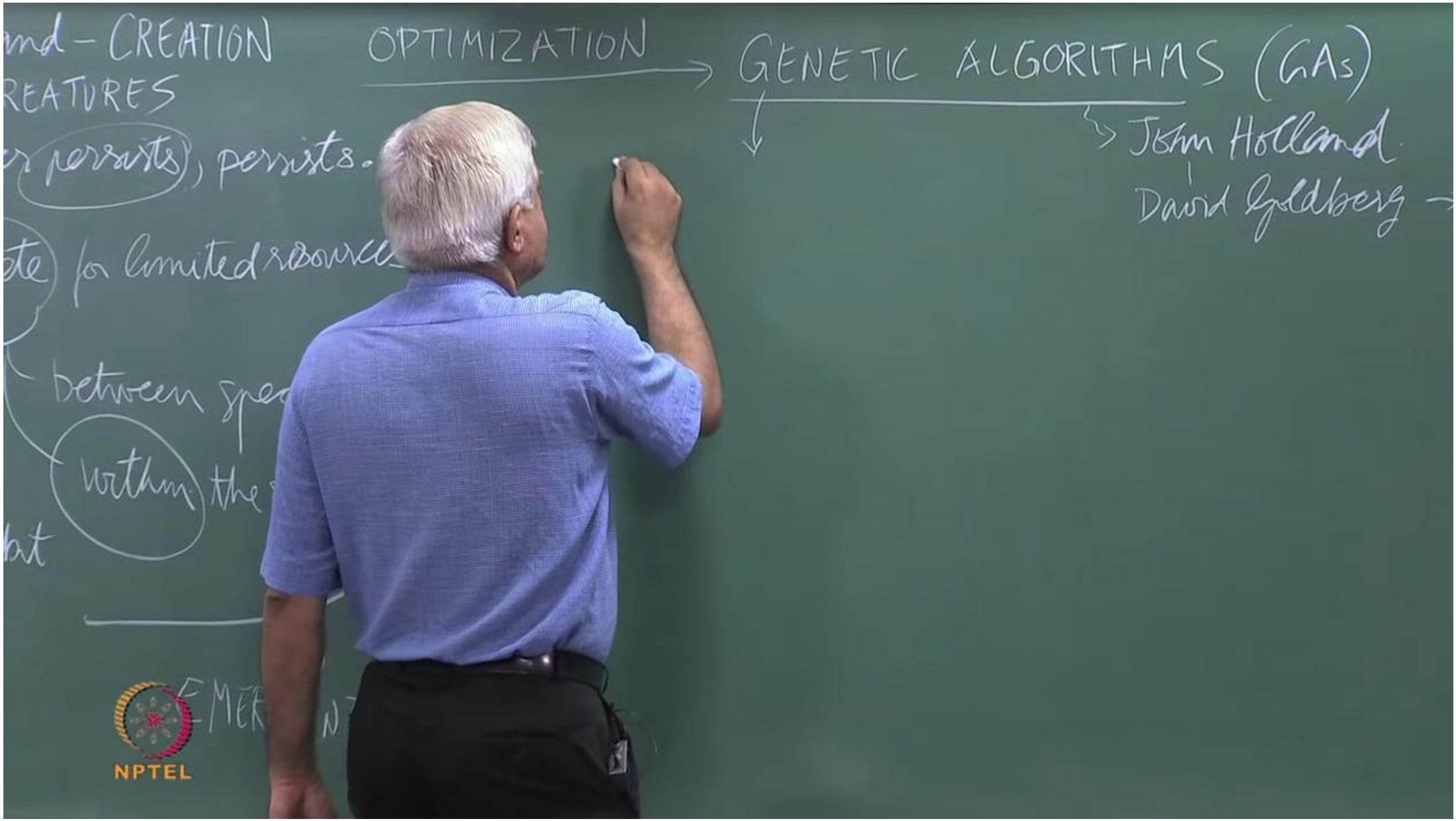

Nature
creating designs for
life forms
species
"generate and test"
makes up combinations
"the other chooses"
GENOTYPE
reduction <=> Genetic mixing
Steve Grand – CREATION
CREATURES
OPTIMIZA
Whatever persists, persists.
compete for limited resources
between species
within the species
bacteria
tissue
fox
rabbit
NPTEL

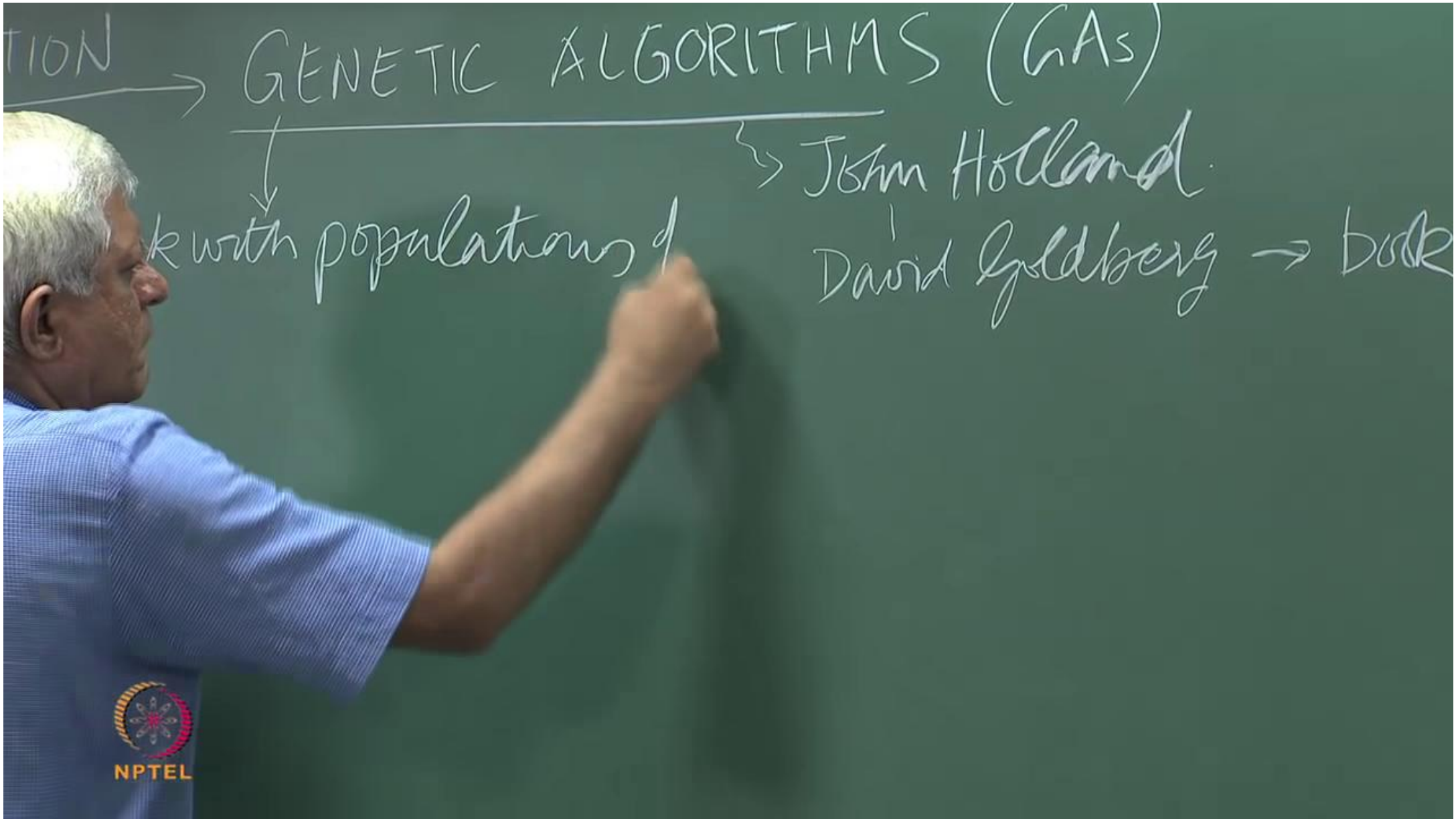

Nature
creating designs for
life forms
species
"generate and test"
PHENOTYPE
GENOTYPE
genetic mixing
Steve Grand - CREATION
CREATURES
whatever persists, persists.
compete for limited resources
between species
within the species
rabbit
fox
bacteria
tiger
OPTIMIZATI


Nature
Steve Grand – CREATION
CREATURES
OPTIMIZATION
Whatever persists, persists.
Life forms
compete for limited resources
between species
within the species
PHENOTYPE
rabbit
for
EMERGENT BEAVIOUR
NPTEL


Steve Grand – CREATION
OPTIMIZATION
Nature
CREATURES
whatever persists, persists.
Life forms
compete for limited resources
Species
PHENOTYPE
between species
within the species
"the other chooses"
GENOTYPE
genetic mixing
rabbit
fox
tiger
EMERGENT BEHAVIOUR
NPTEL


d - CREATION
EATURES
OPTIMIZATION
GENETIC ALGORITHMS (GAs)
ENT BEHAVIOUR
NPTEL


nd - CREATION
REATURES
OPTIMIZATION
GENETIC ALGORITHMS (GAs)
John Holland
David Goldberg
persists
persists.
te for limited resource
between spe
within the
hat
EMER
NPTEL

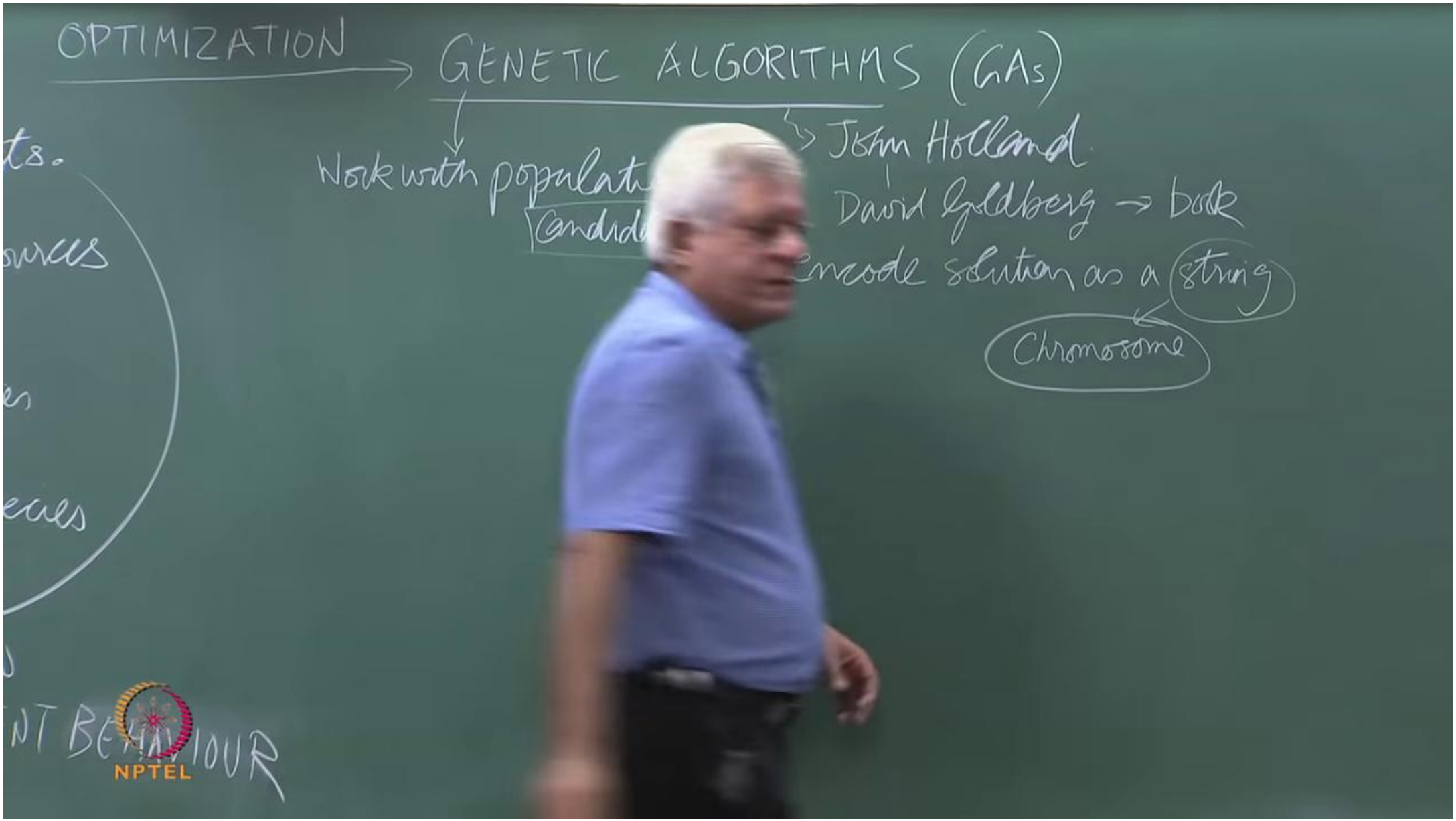

TION
GENETIC ALGORITHMS (GAs)
John Holland
David Goldberg
NPTEL

TION → GENETIC ALGORITHMS (GAs)

↓ Work with populations of candidates

↘ John Holland.

David Goldberg → book


OPTIMIZATION
GENETIC ALGORITHMS (GAs)
John Holland
David Goldberg → book
Work with
encode solution as a string
Chromosome
NPTEL

ON → GENETIC ALGORITHMS (GAs)

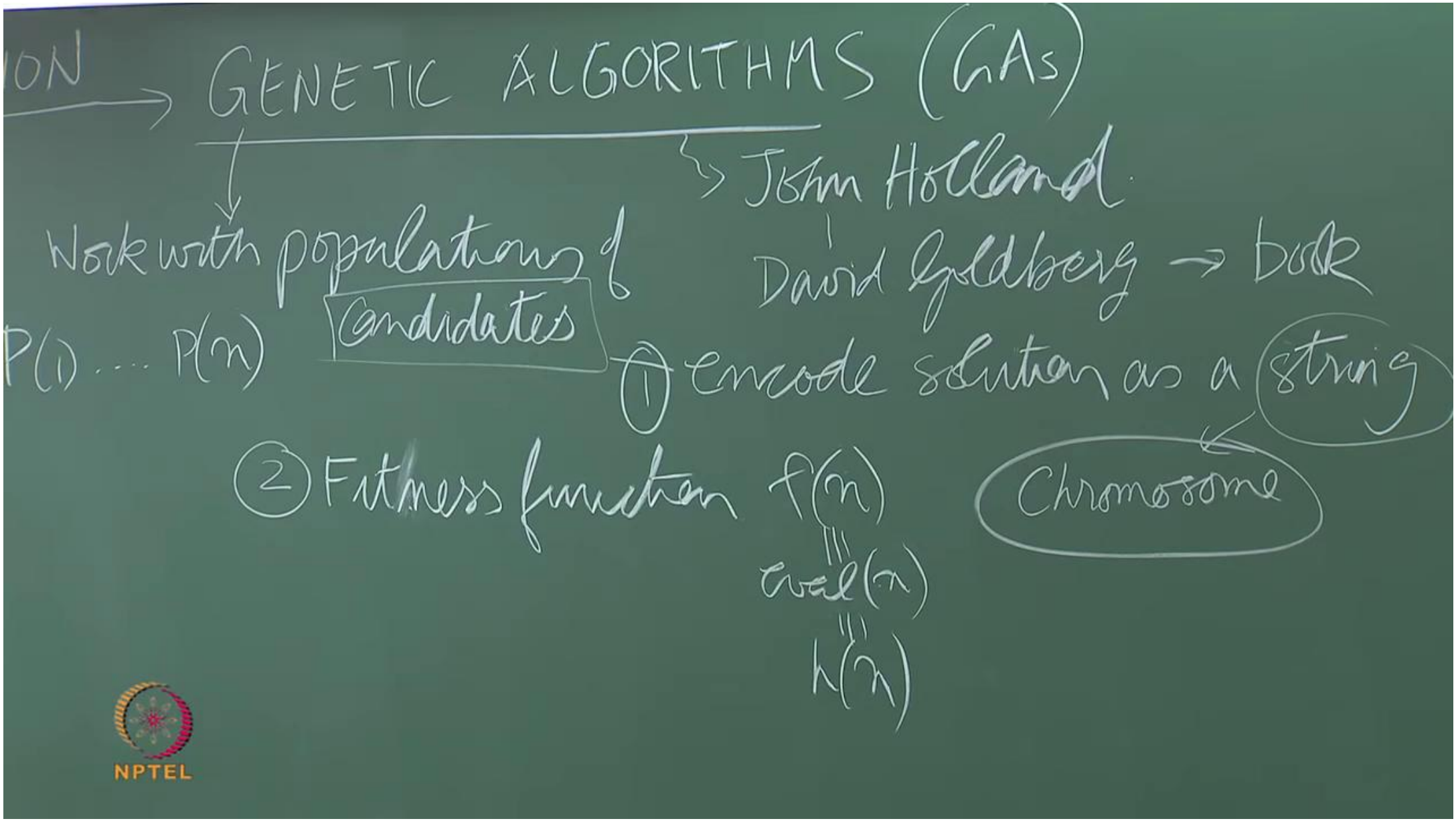
↳ John Holland.

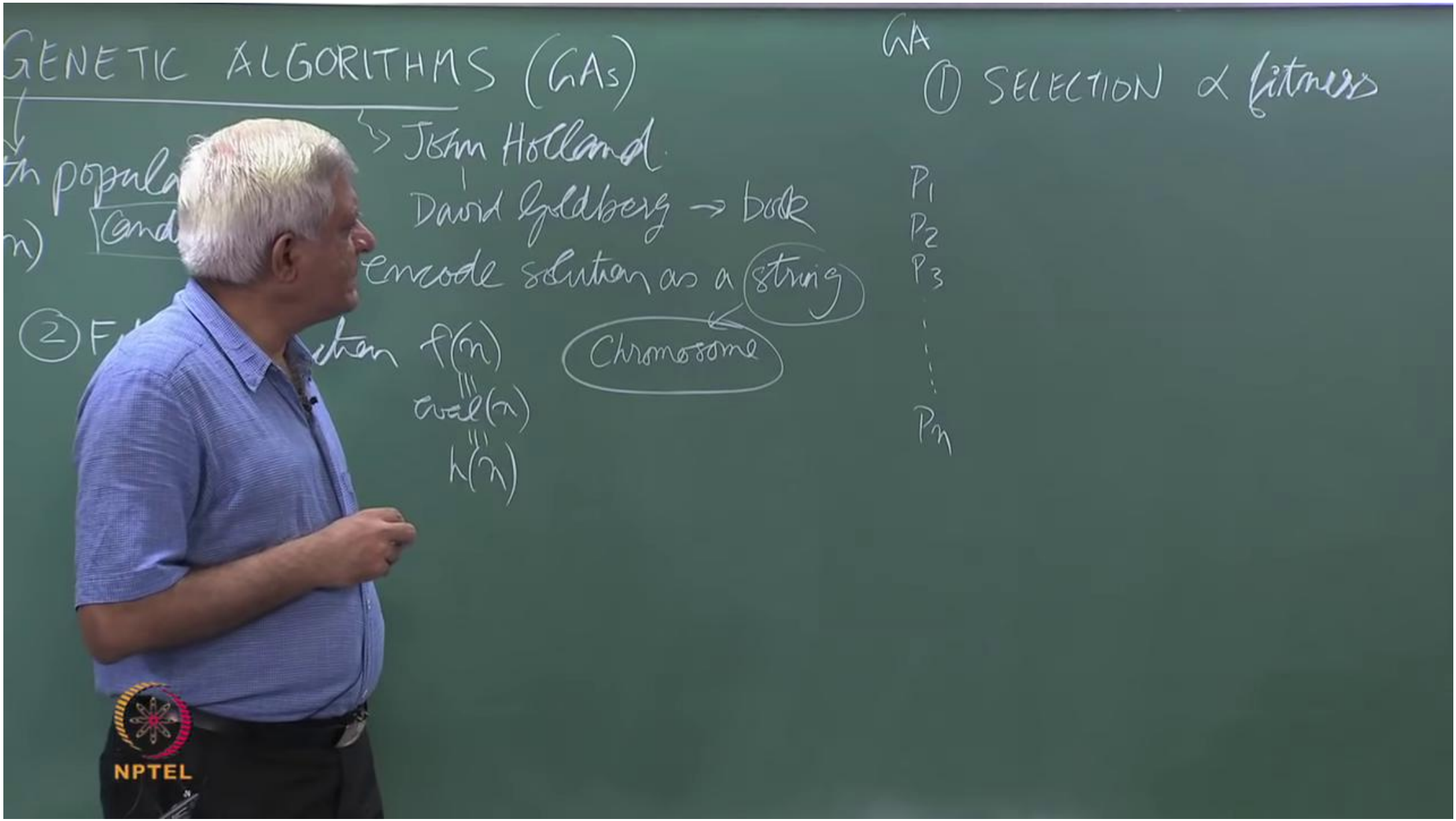
↳ David Goldberg → book

Work with populations of candidates

encode solution as a string

Chromosome

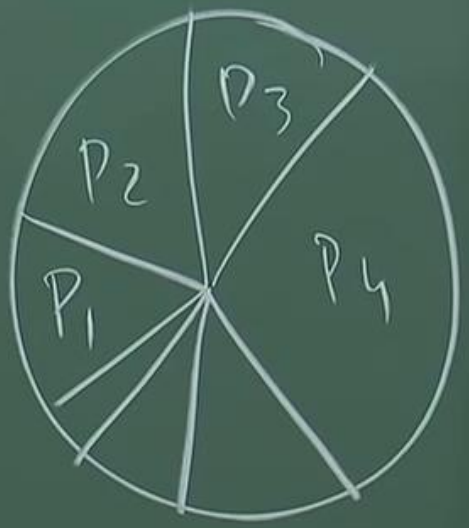

ION
GENETIC ALGORITHMS (GAs)
John Holland
David Goldberg → book
Work with populations of candidates
P(1) .... P(n)
① encode solution as a string
Chromosome
② Fitness function f(n)
eval(n)
h(n)
NPTEL


GENETIC ALGORITHMS (GAs)
John Holland
David Goldberg → book
encode solution as a string
Chromosome
f(n)
eval(n)
h(n)
GA
① SELECTION α fitness
P1
P2
P3
Pn
NPTEL

GA

① SELECTION α fitness

P_1
P_2
P_3
.....
P_N

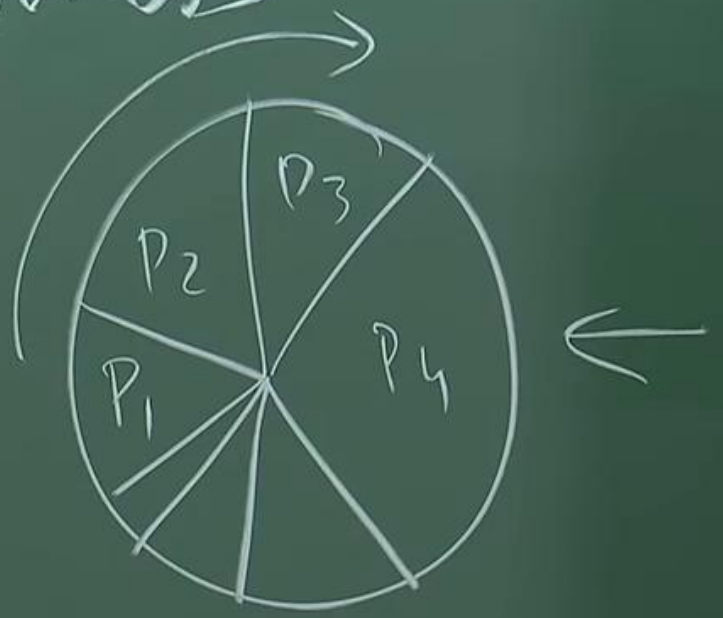


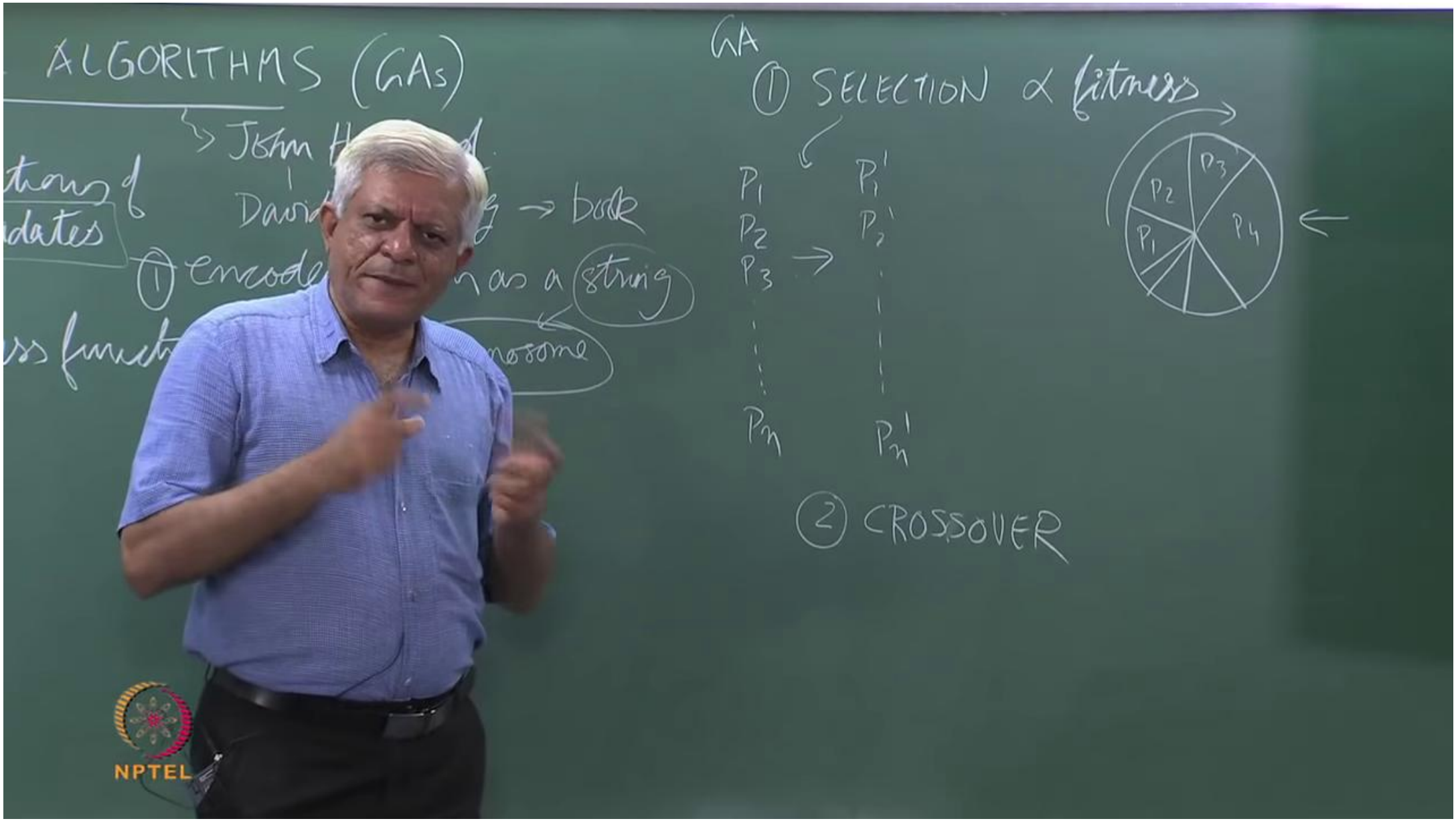
GA

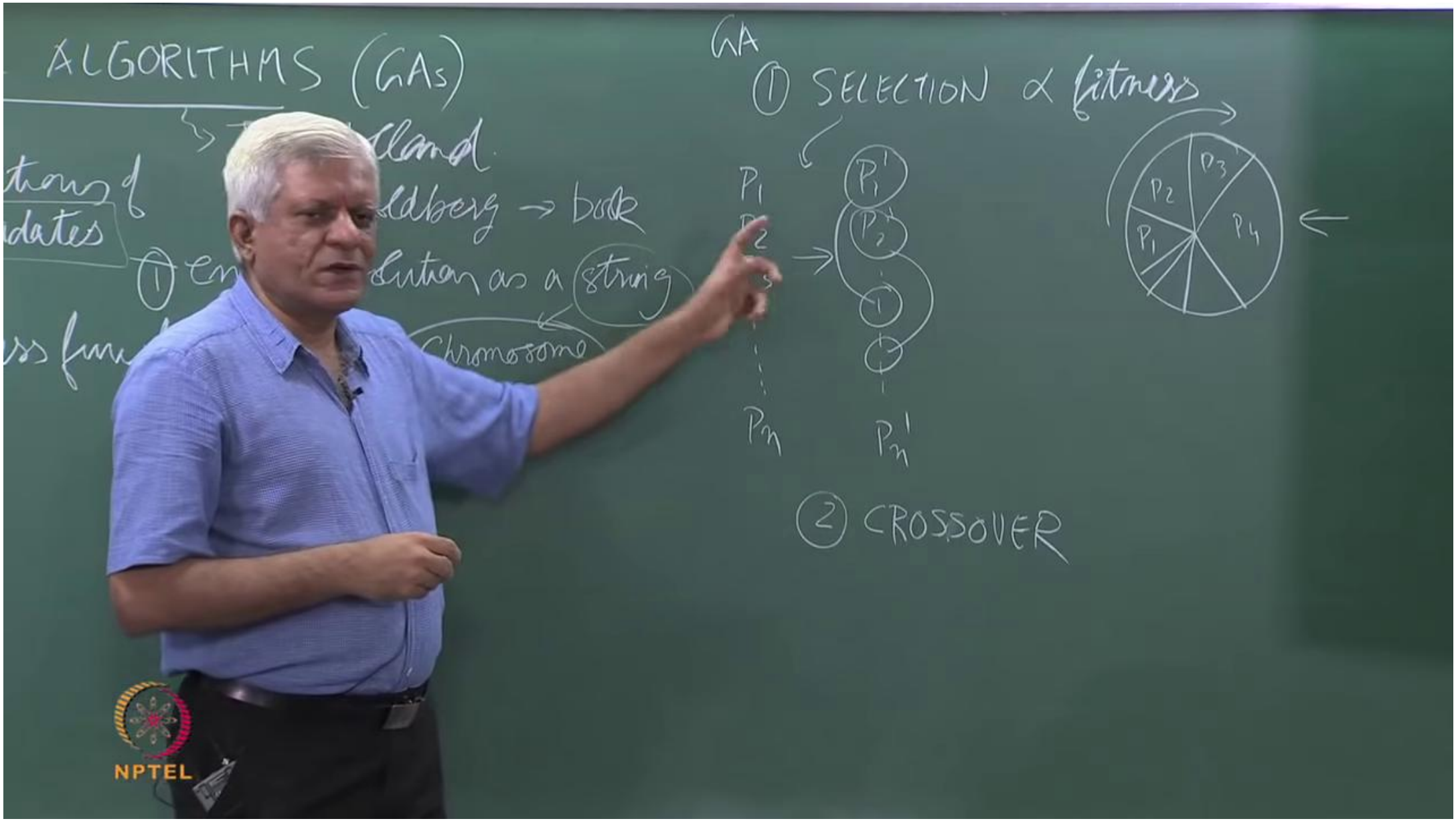
① SELECTION α fitness

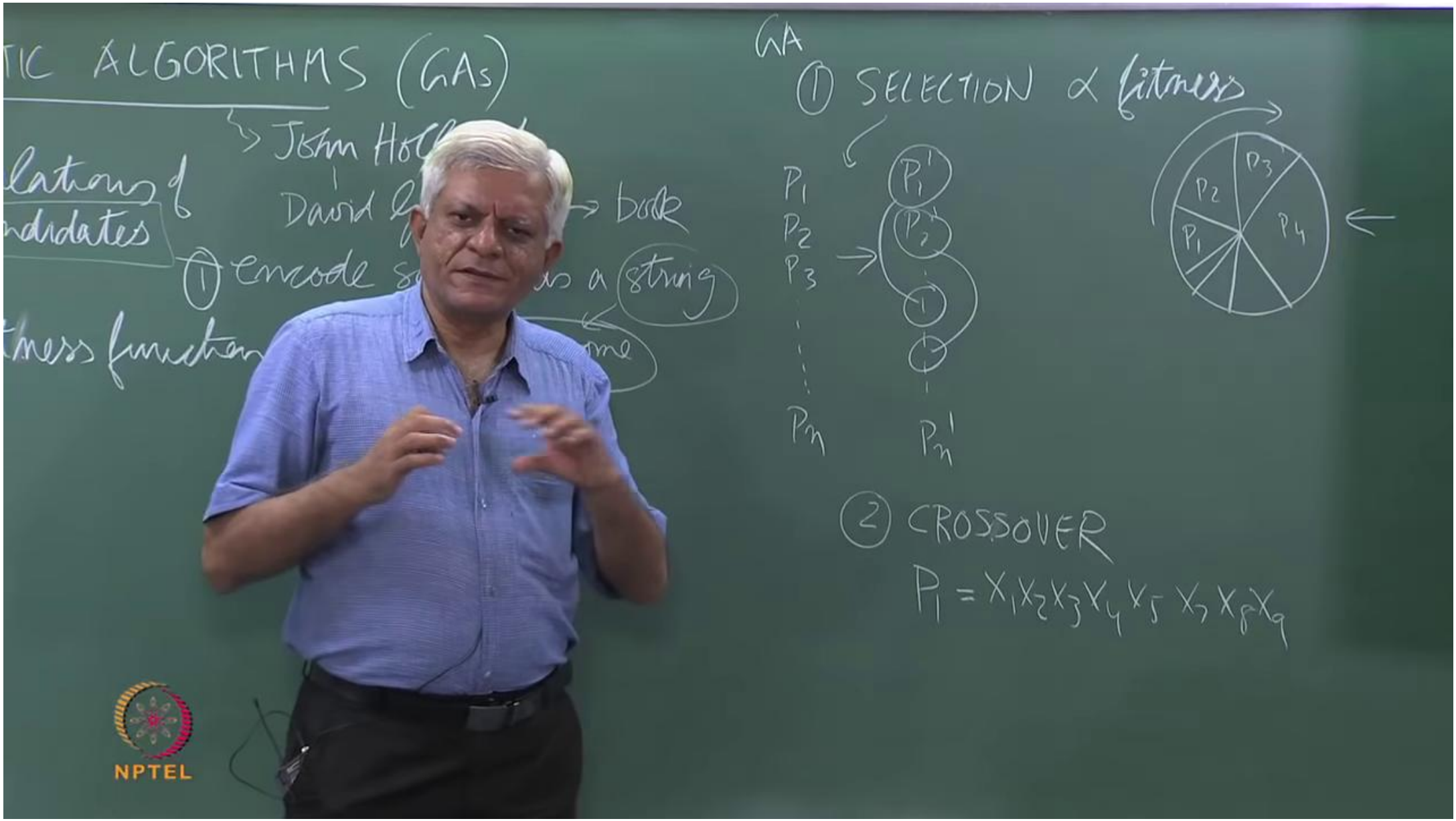
P_1
P_2
P_3
P_n

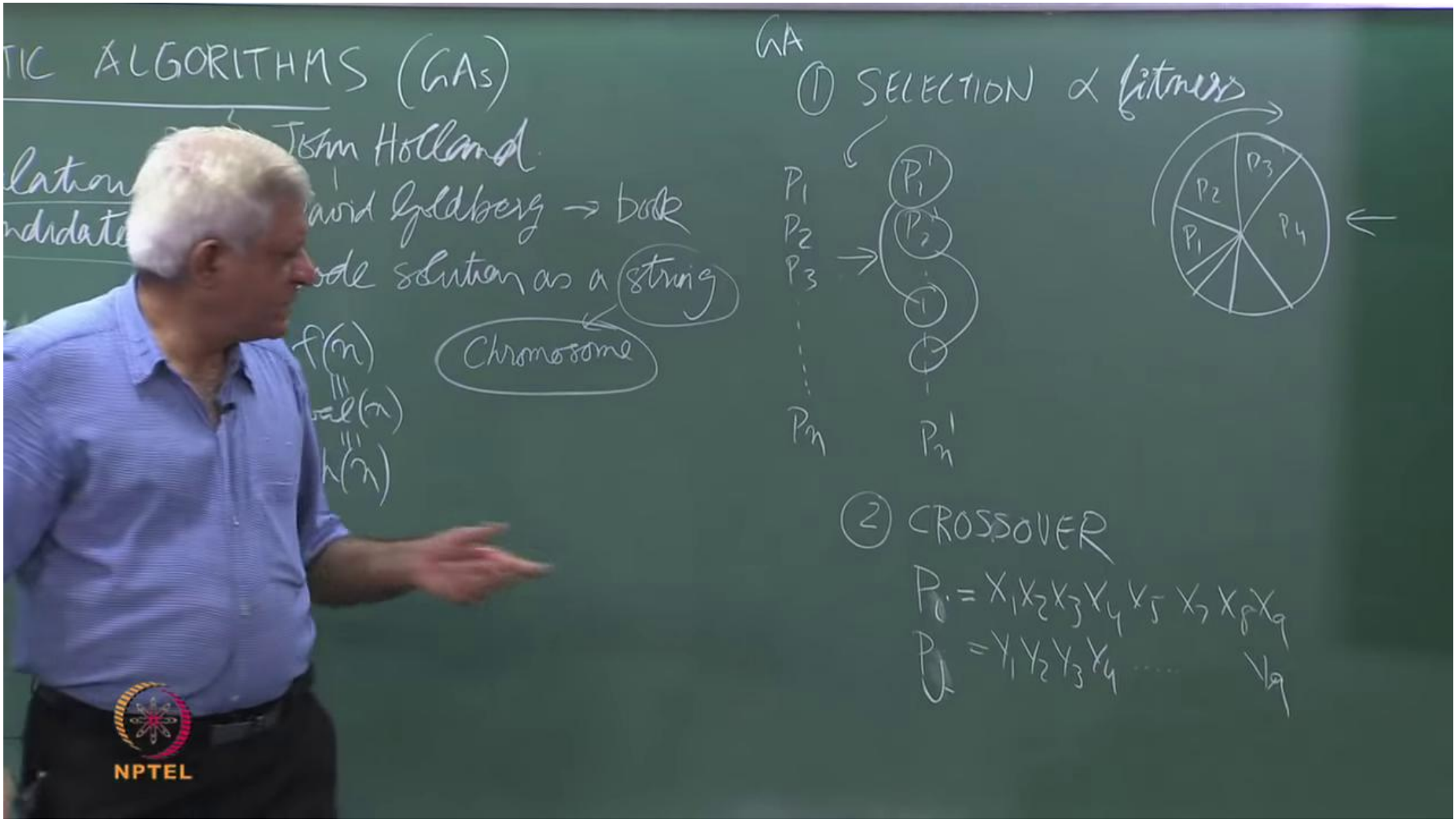
P_1'
P_2'
P_n'




ALGORITHMS (GAs)
GA
① SELECTION α fitness
P1
P2
P3
Pn
P1'
P2'
Pn'
P4
P3
P2
P1
② CROSSOVER
NPTEL


ALGORITHMS (GAs)
GA
① SELECTION α fitness
P1
Pn
P1'
Pn'
P1
P2
P3
P4
② CROSSOVER
NPTEL


TIC ALGORITHMS (GAs)
John Ho
David
book
① encode
as a string
GA
① SELECTION α fitness
P1
P2
P3
Pn
P1'
P2'
P3'
Pn'
P3
P2
P1
P4
② CROSSOVER
P1 = X1X2X3X4X5 X6X7X8
NPTEL


TIC ALGORITHMS (GAs)
John Holland
David Goldberg → book
ode solution as a string
Chromosome
f(n)
GA
① SELECTION α fitness
P1
P2
P3
Pn
P1'
P2'
Pn'
P3
P2
P1
P4
② CROSSOVER
NPTEL

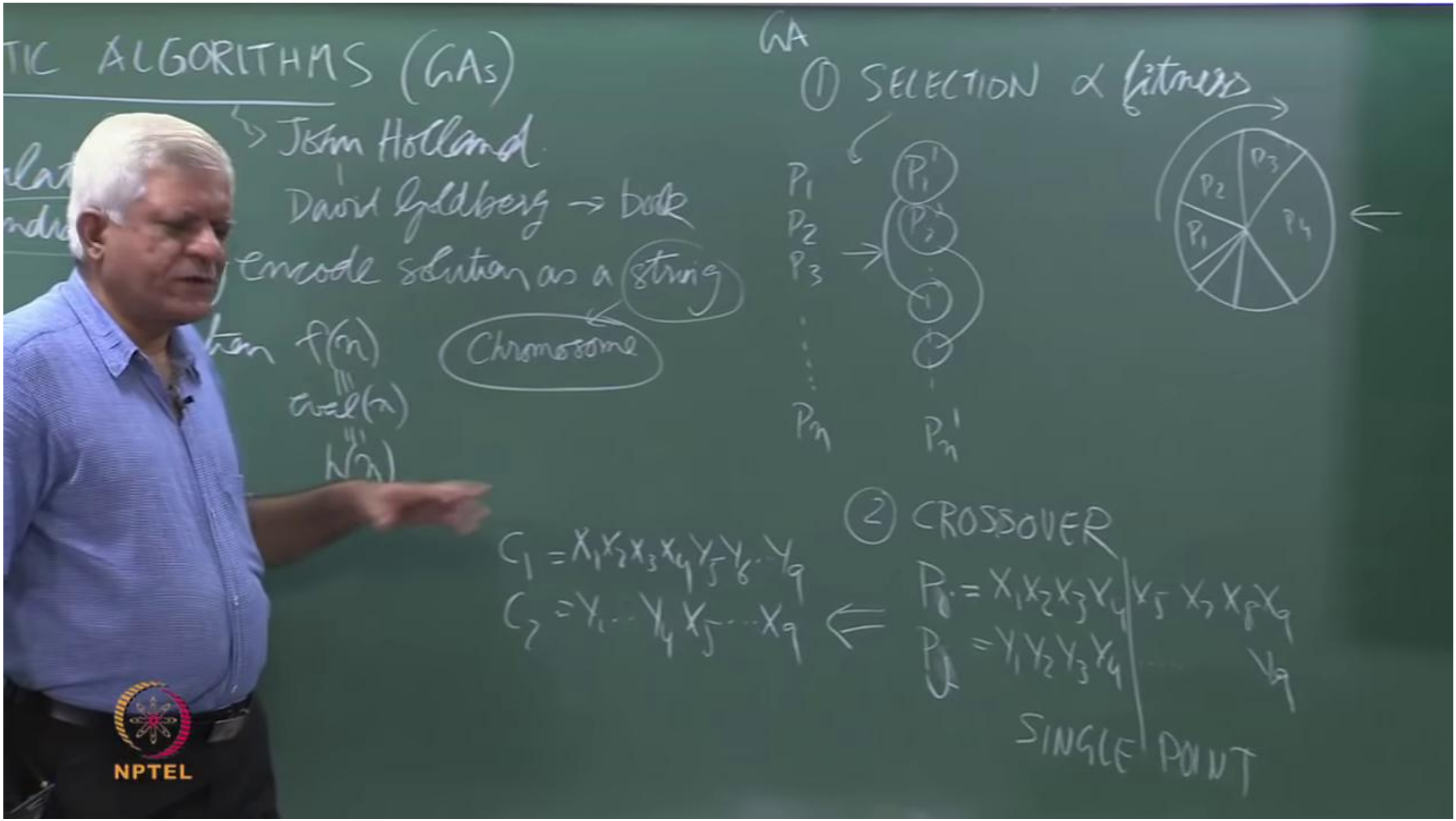
(2) CROSSOVER

$P_i = X_1 X_2 X_3 X_4 \mid X_5 X_6 X_7 X_8 X_9$

$P_j = Y_1 Y_2 Y_3 Y_4 \mid \ldots\ldots \; Y_9$

$$C_1 = X_1 X_2 X_3 X_4 Y_5 Y_6 \cdots Y_9$$

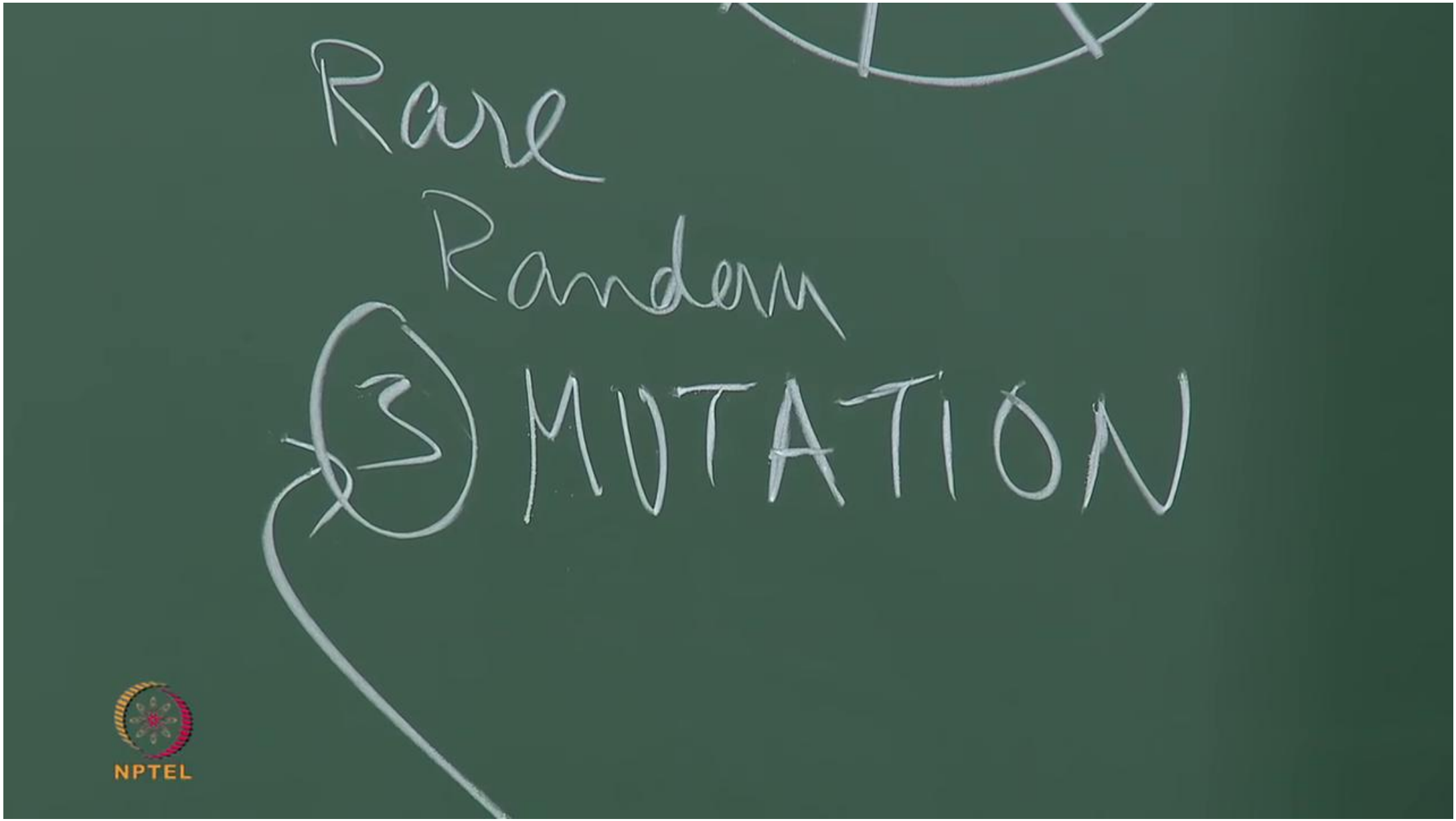
$$C_2 = Y_1 \cdots Y_4 X_5 \cdots X_9$$

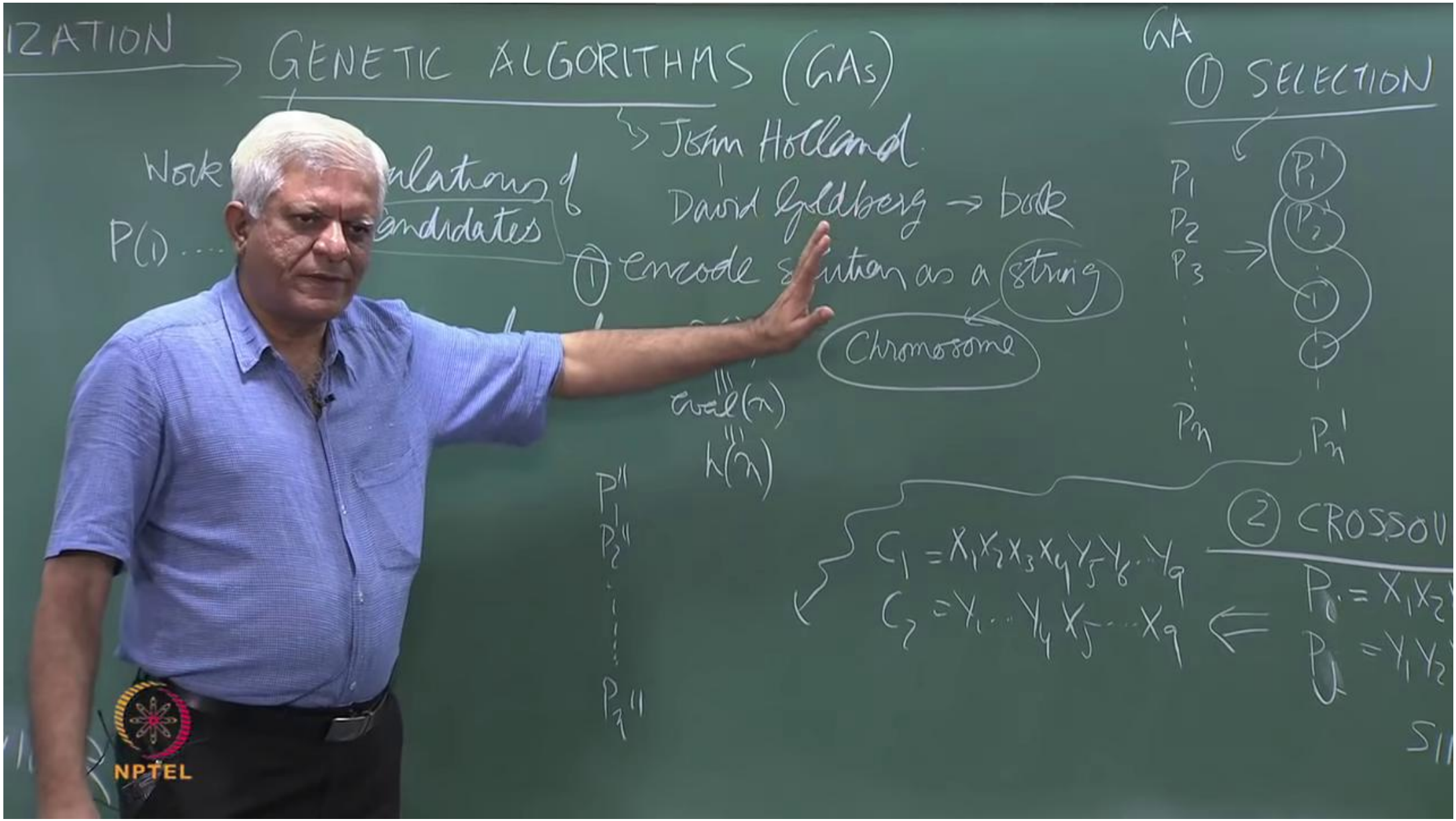

TIC ALGORITHMS (GAs)
John Holland
David Goldberg → book
encode solution as a string
Chromosome
GA
① SELECTION α fitness
P1
P2
P3
Pn
P1'
P2'
Pn'
P3
P2
P1
P4
② CROSSOVER
C1 = X1X2X3X4Y5Y6...Y9
C2 = Y1...Y4X5...X9
P1 = X1X2X3X4 | X5X7X8X9
P2 = Y1Y2Y3Y4 | Y9
SINGLE POINT

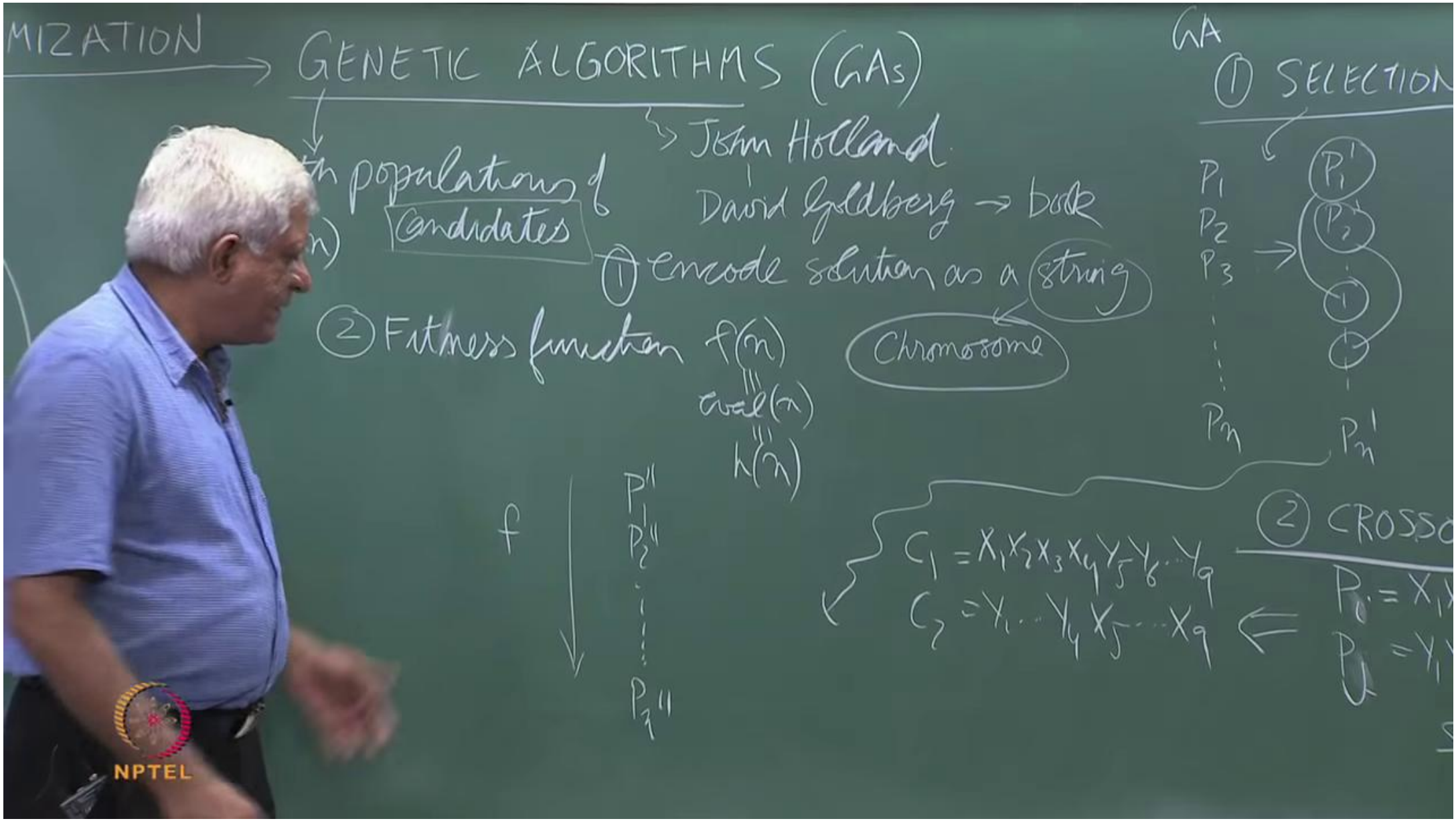
$P_1 = X_1 X_2 X_3 X_4 | X_5 X_6 X_7 X_8 X_9$

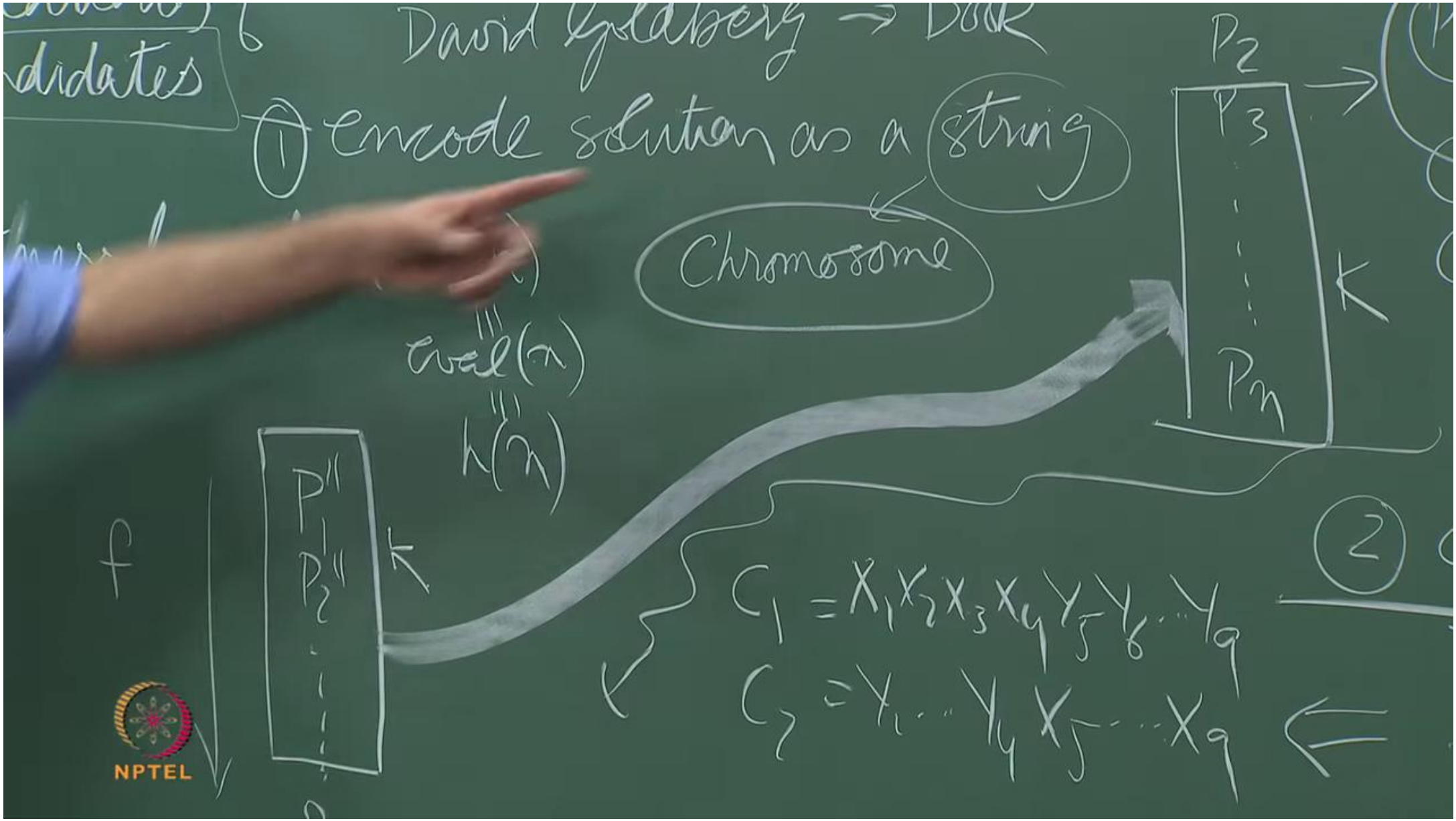
$P_2 = Y_1 Y_2 Y_3 Y_4 \ldots\ldots Y_9$

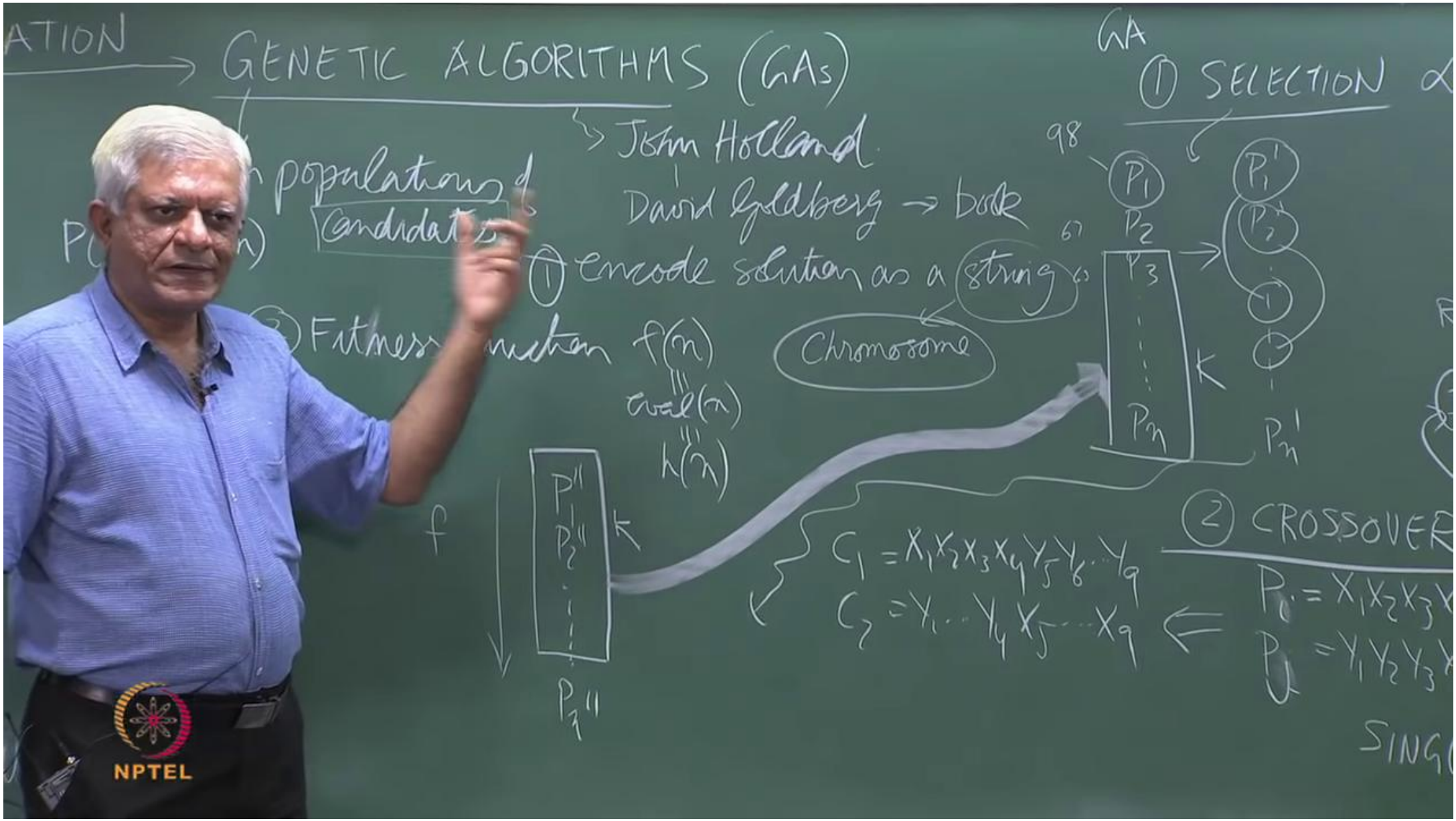
SINGLE POINT

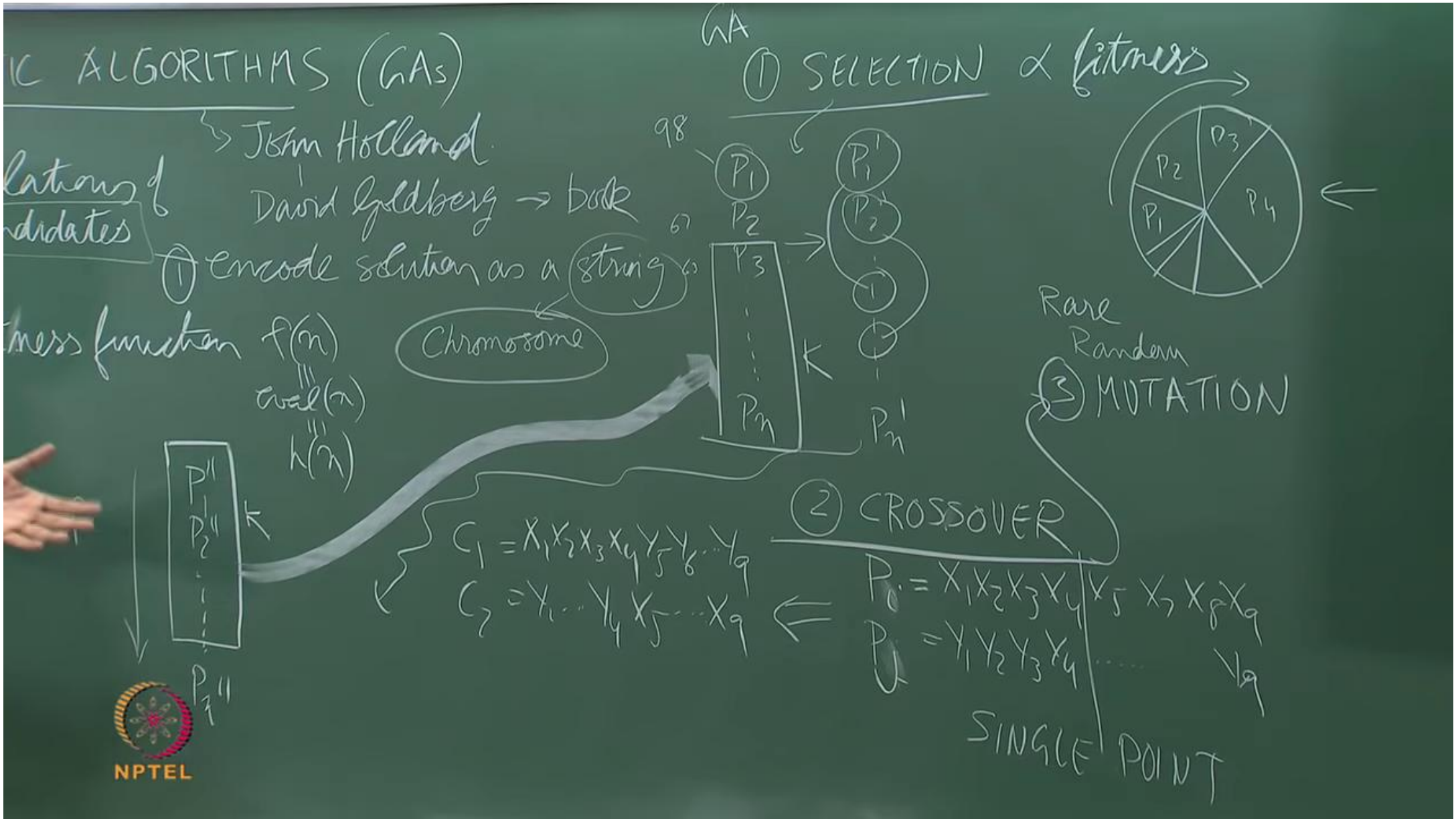

Rare
Random
3 MUTATION

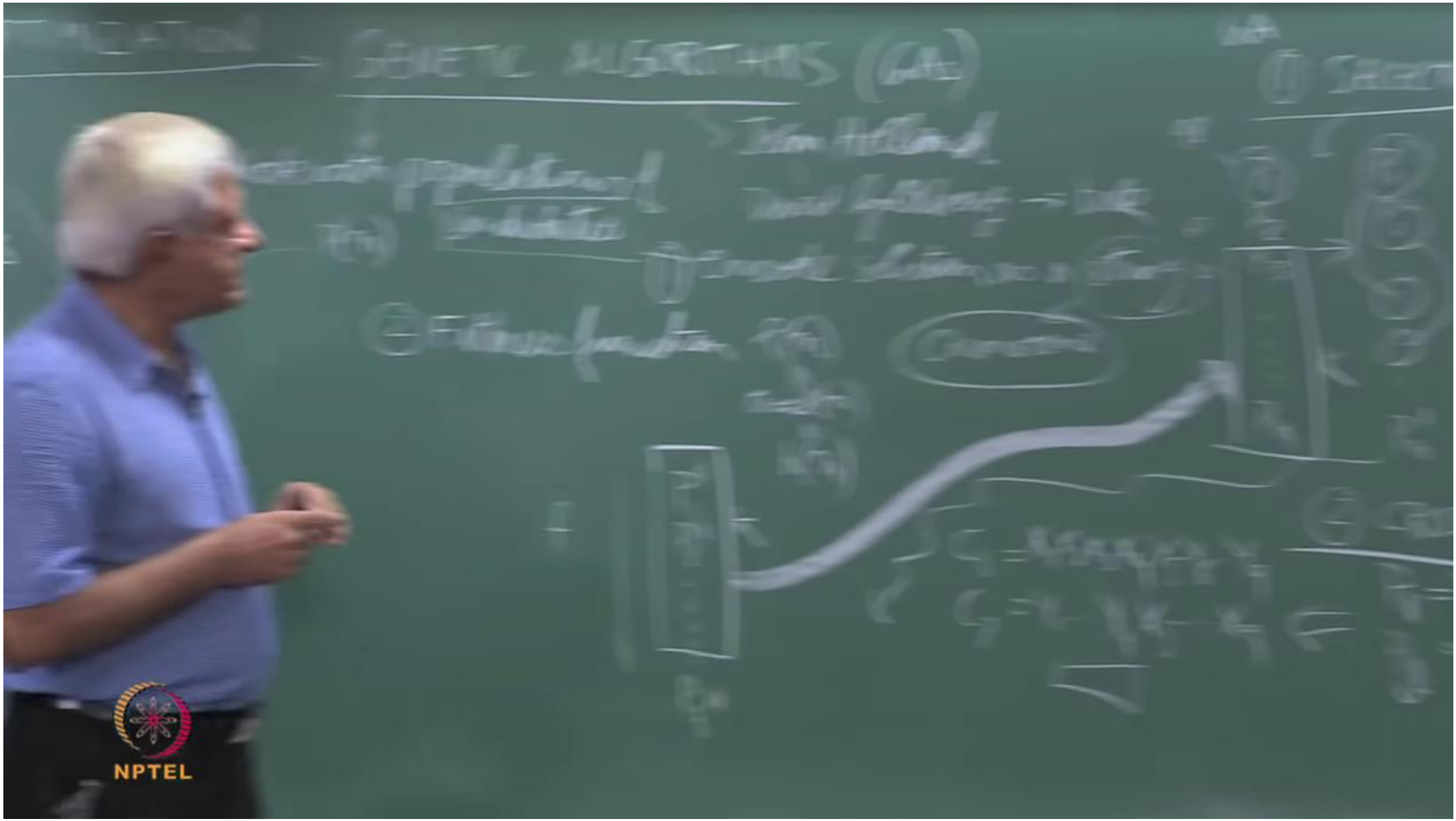

IZATION
GENETIC ALGORITHMS (GAs)
John Holland
David Goldberg → book
GA
① SELECTION
② CROSSOV
Chromosome
NPTEL


MIZATION
GENETIC ALGORITHMS (GAs)
John Holland
David Goldberg → book
populations of
candidates
① encode solution as a string
Chromosome
② Fitness function f(n)
GA
① SELECTION
② CROSSO
NPTEL


didates
David Goldberg → Book
① encode solution as a string
Chromosome
P2
P3
Pn
K
P1
P2
K
f
② NPTEL


ATION
GENETIC ALGORITHMS (GAs)
John Holland
David Goldberg → book
populations of
candidates
encode solution as a string
Chromosome
Fitness function f(n)
GA
① SELECTION
98
60
60
K
② CROSSOVER
NPTEL


GA
IC ALGORITHMS (GAs)
John Holland
David Goldberg → book
① SELECTION ∝ fitness
encode solution as a string
Chromosome
Rare
Random
③ MUTATION
② CROSSOVER
SINGLE POINT
NPTEL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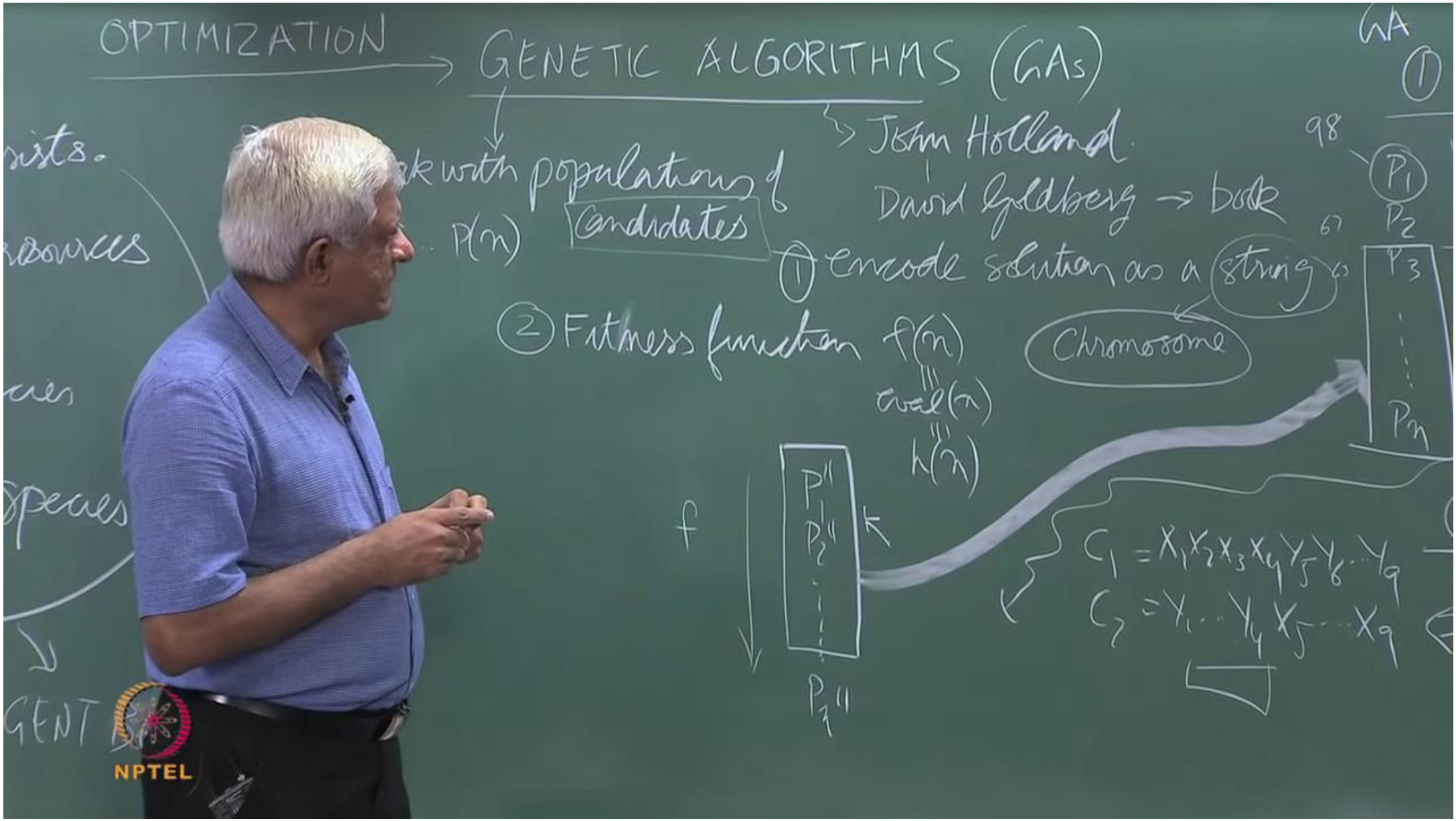
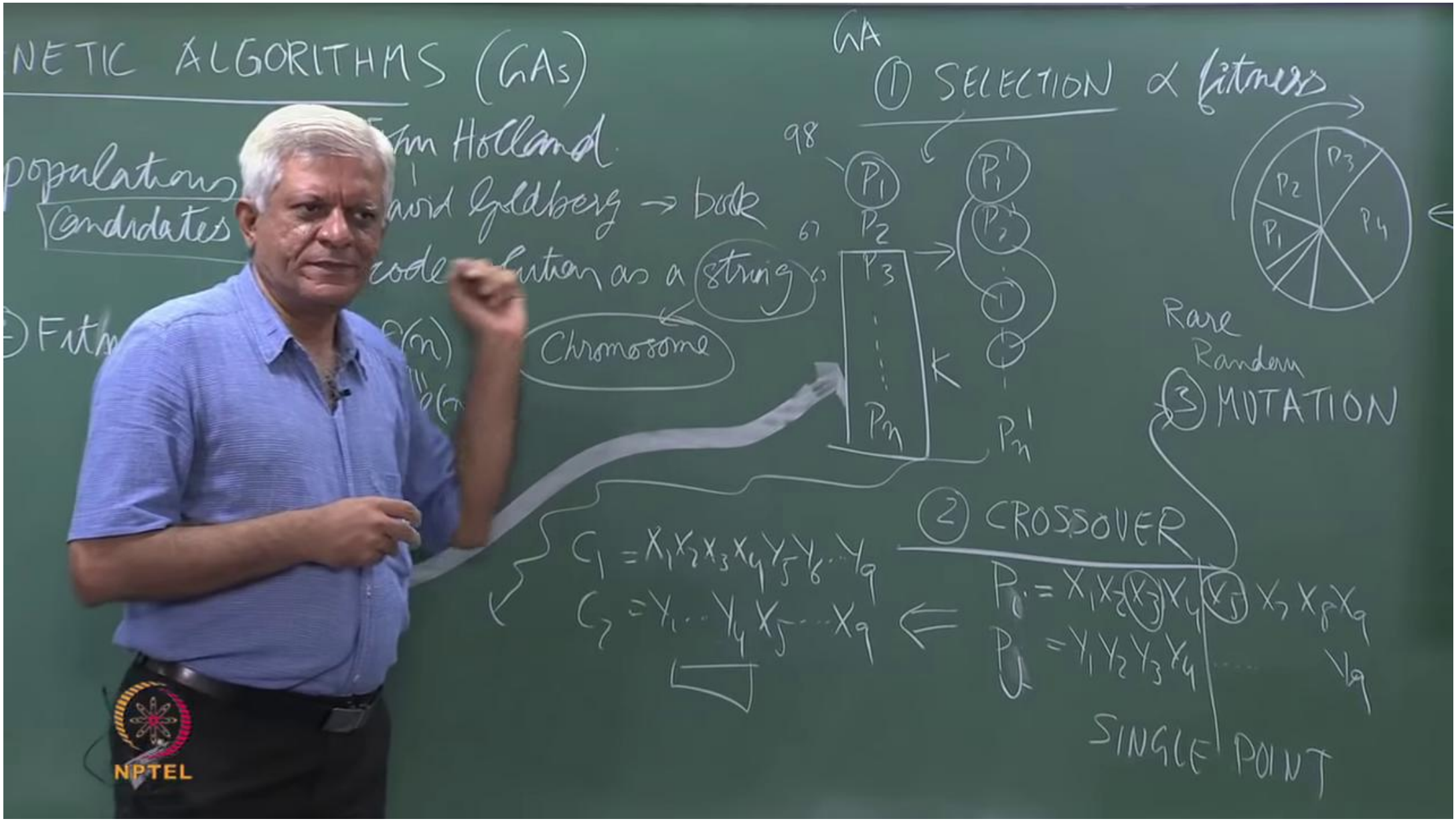
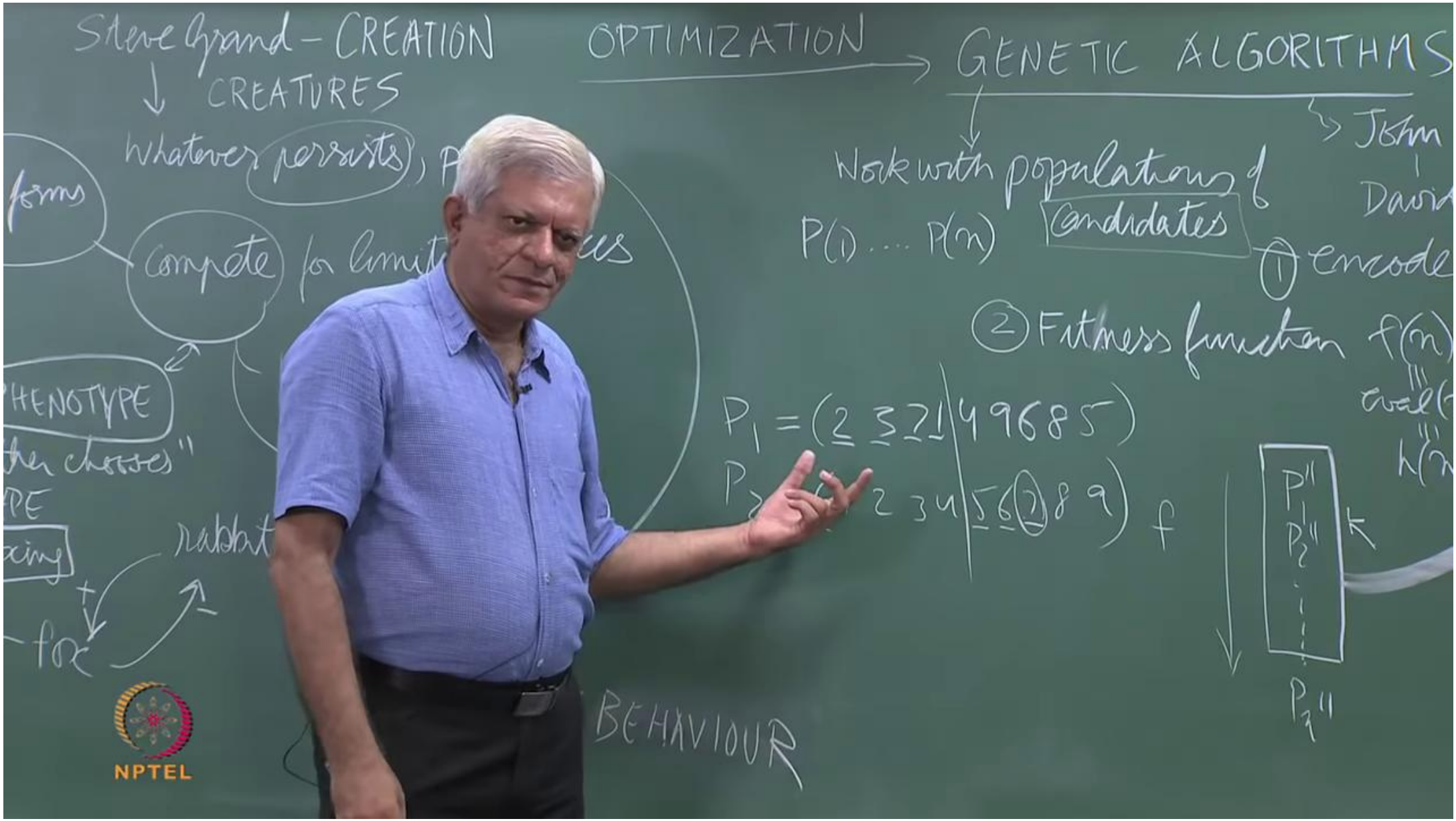
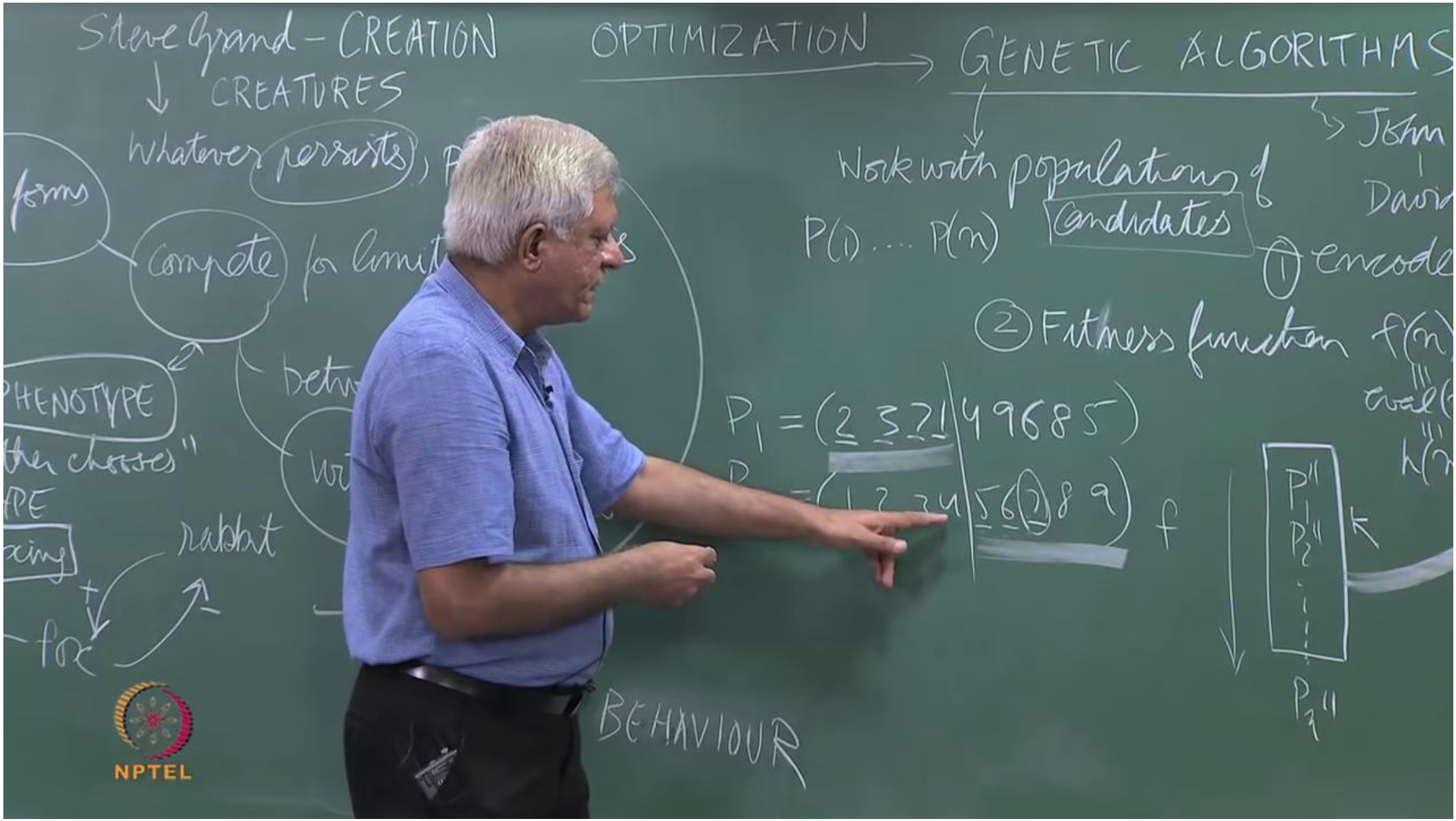

OPTIMIZATION
GENETIC ALGORITHMS (GAs)
John Holland
David Goldberg → book
GA
1
98
P1
P2
P3
Pn
population of candidates
P(n)
1 encode solution as a string
Chromosome
2 Fitness function
f(n)
eval(n)
h(n)
f
P1''
P2''
Pn''
C1 = X1X2X3X4Y5Y6 ... Y9
C2 = Y1 ... Y4X5 ... X9
NPTEL

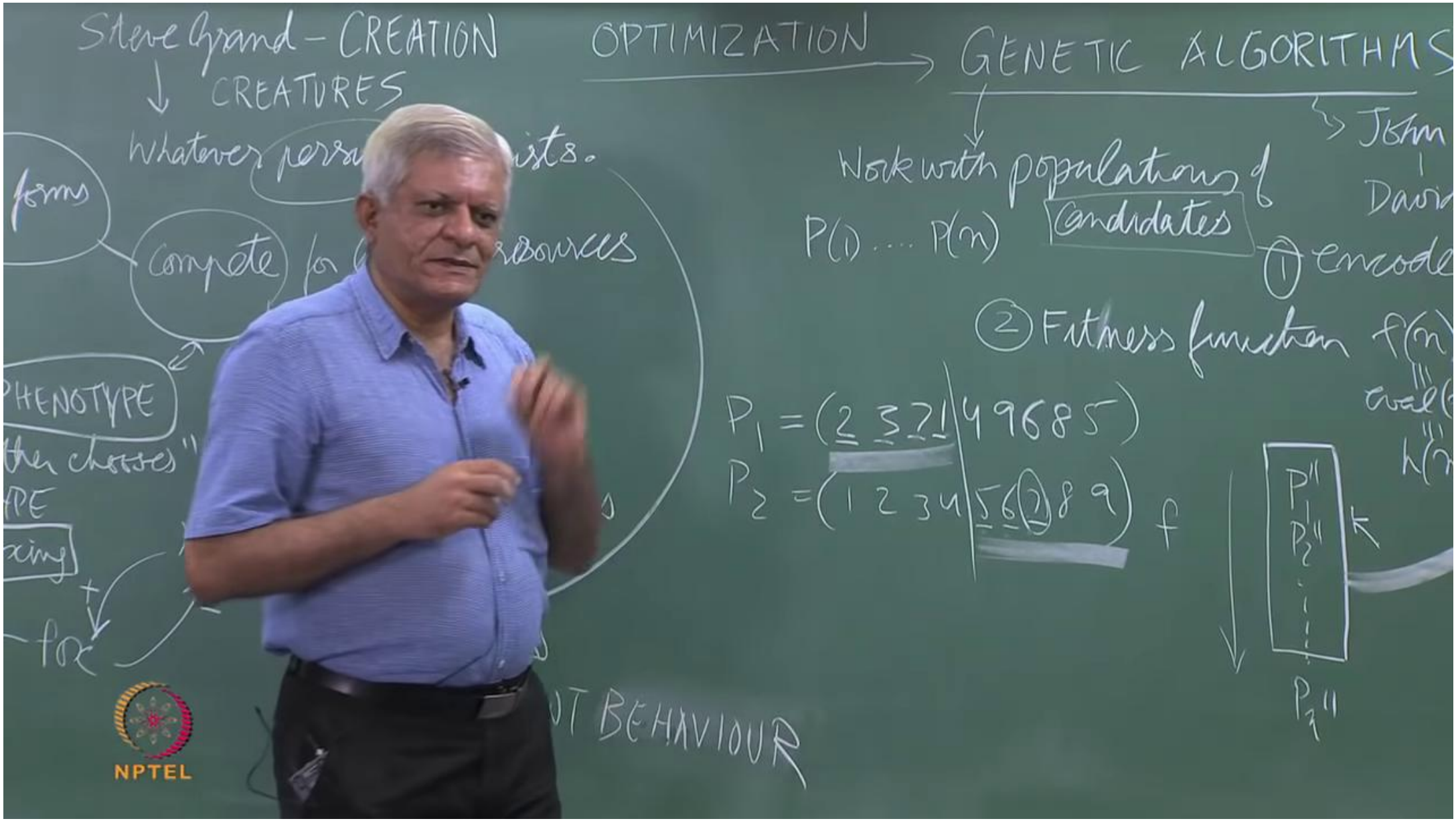

NETIC ALGORITHMS (GAs)
populations
candidates
Chromosome
GA
① SELECTION α fitness
98
67
K
Rare
Random
③ MUTATION
② CROSSOVER
SINGLE POINT
NPTEL

$$P_1 = (2\ 3\ 7\ 1\ 4\ 9\ 6\ 8\ 5)$$

$$P_2 = (1\ 2\ 3\ 4\ 5\ 6\ 7\ 8\ 9)$$


Steve Grand – CREATION
CREATURES
OPTIMIZATION
GENETIC ALGORITHMS
Whatever persists,
forms
compete
PHENOTYPE
rabbit
BEHAVIOUR
Work with populations of
candidates
P(1) .... P(n)
John
David
encode
Fitness function
NPTEL


Steve Grand – CREATION
CREATURES
OPTIMIZATION
GENETIC ALGORITHMS
Whatever persists,
Work with populations of
candidates
P(1) ... P(n)
John
Dav
① encode
② Fitness function f(n)
forms
compete for limit
PHENOTYPE
other choices"
rabbit
fox
BEHAVIOUR
NPTEL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PHENOTYPE
NPTEL