Video Lectures On

Artificial Intelligence

Lecture 17

Population Based Methods II

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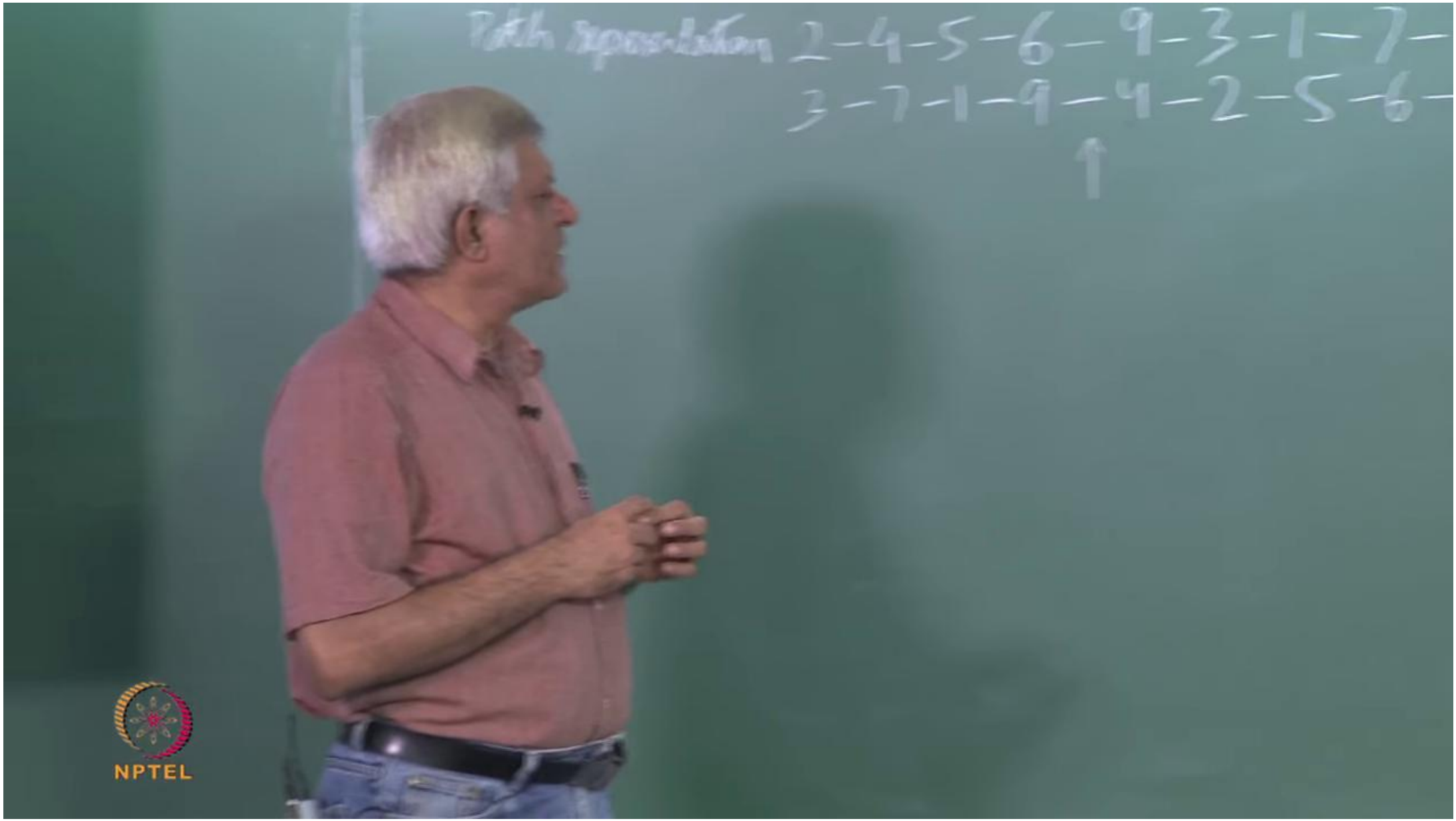
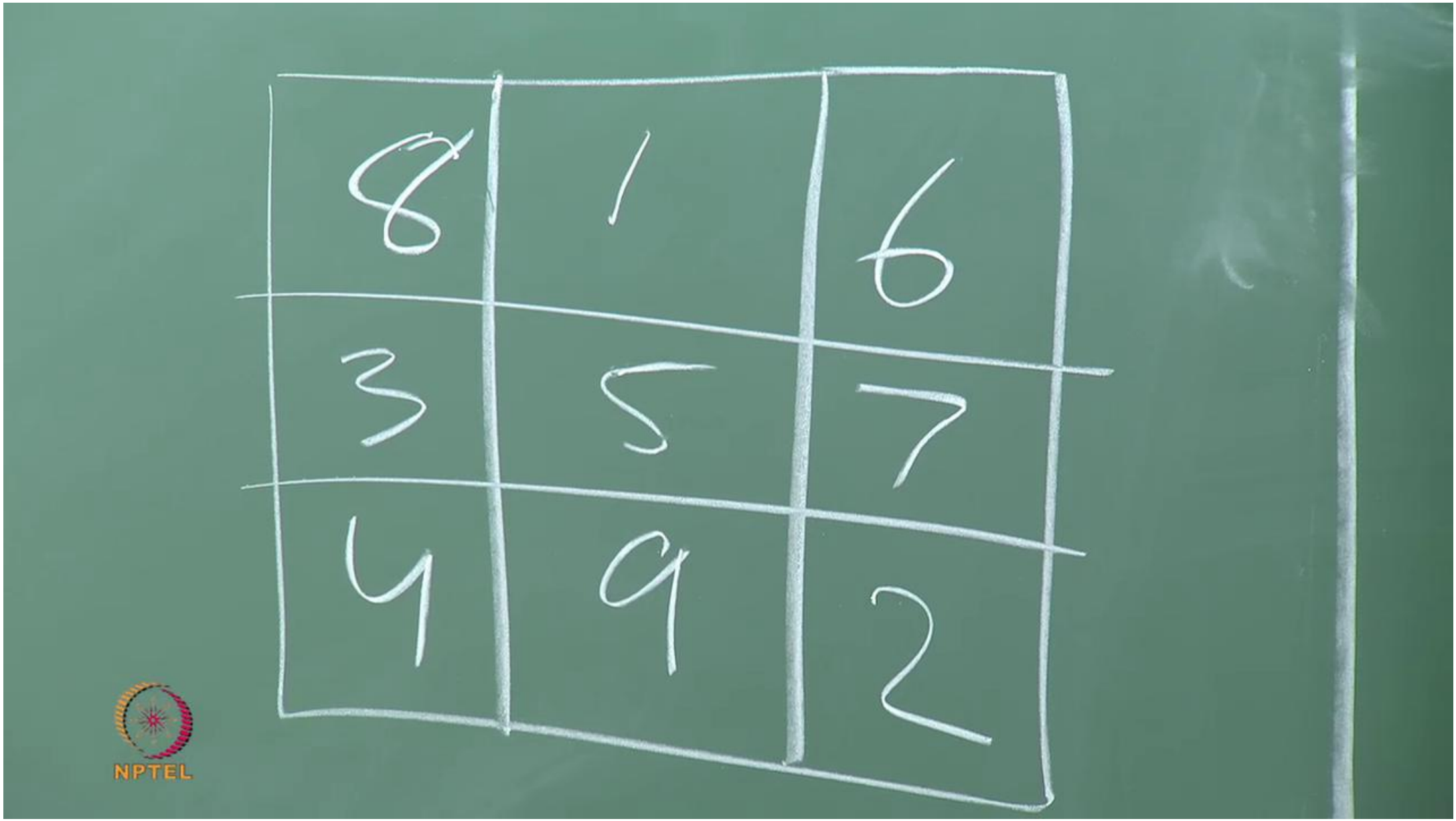
IIT Madras

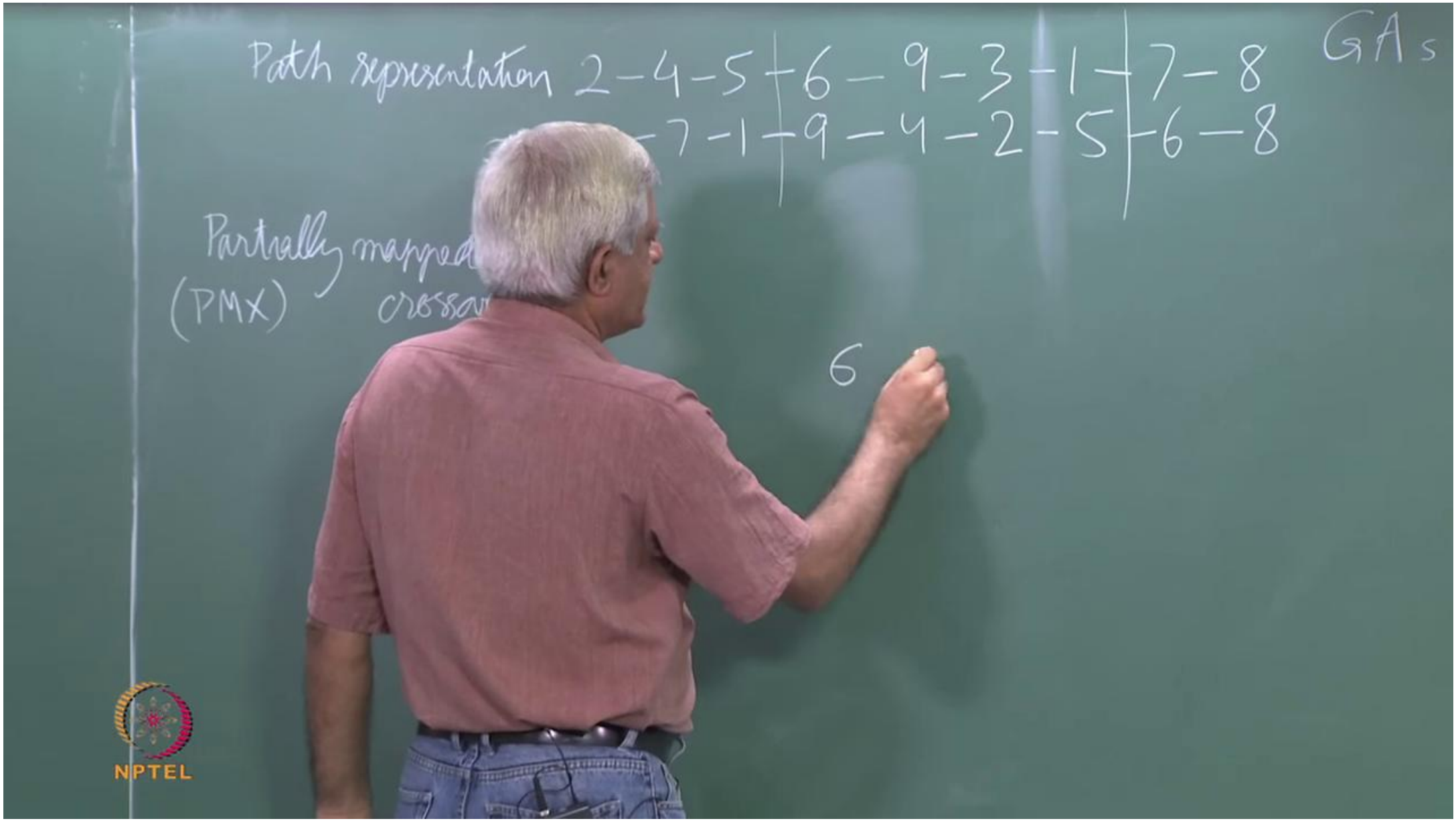
2-4-5-6-9-3-1-7-8

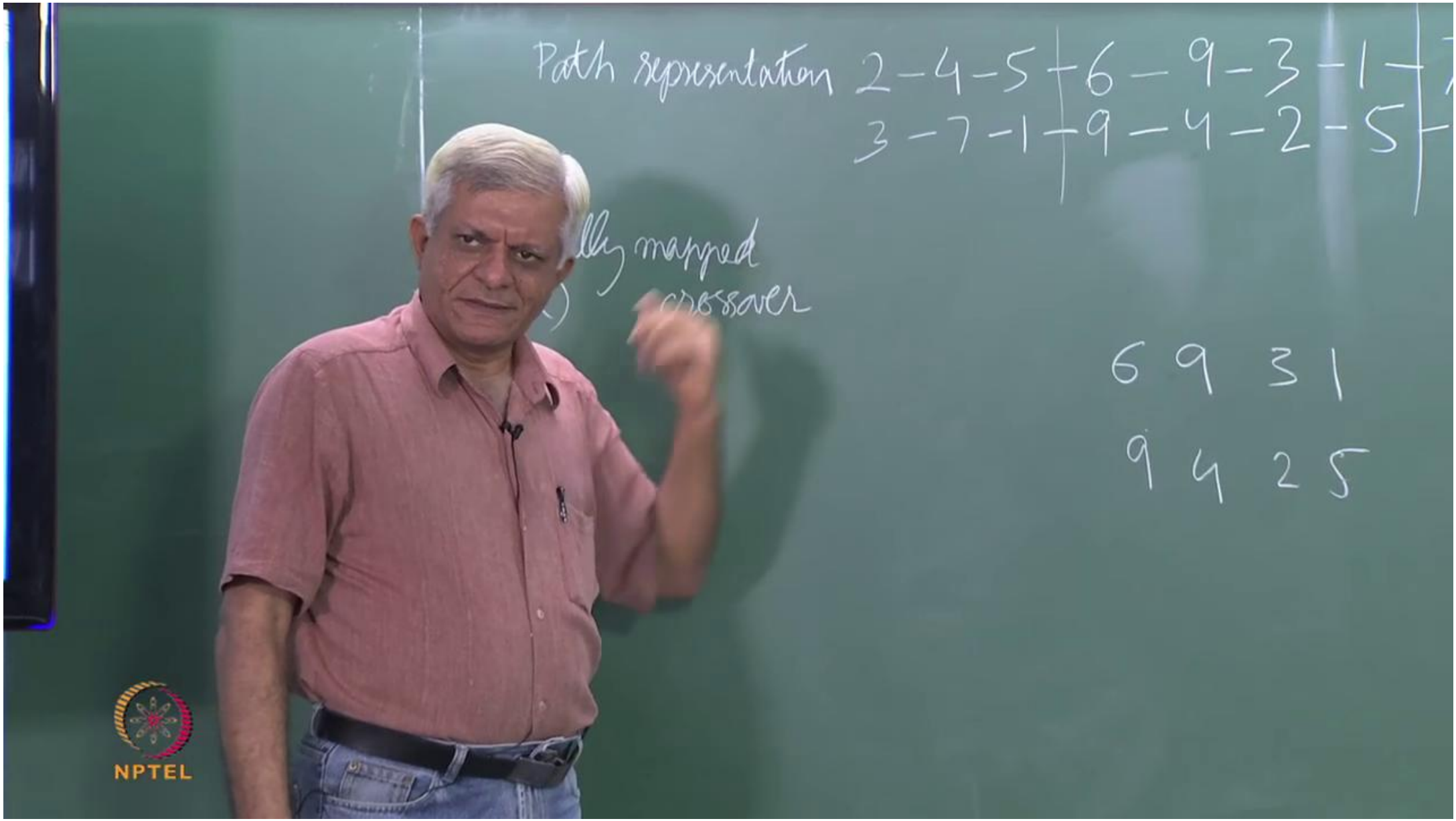
2-4-5-6-9-3-1-7-8

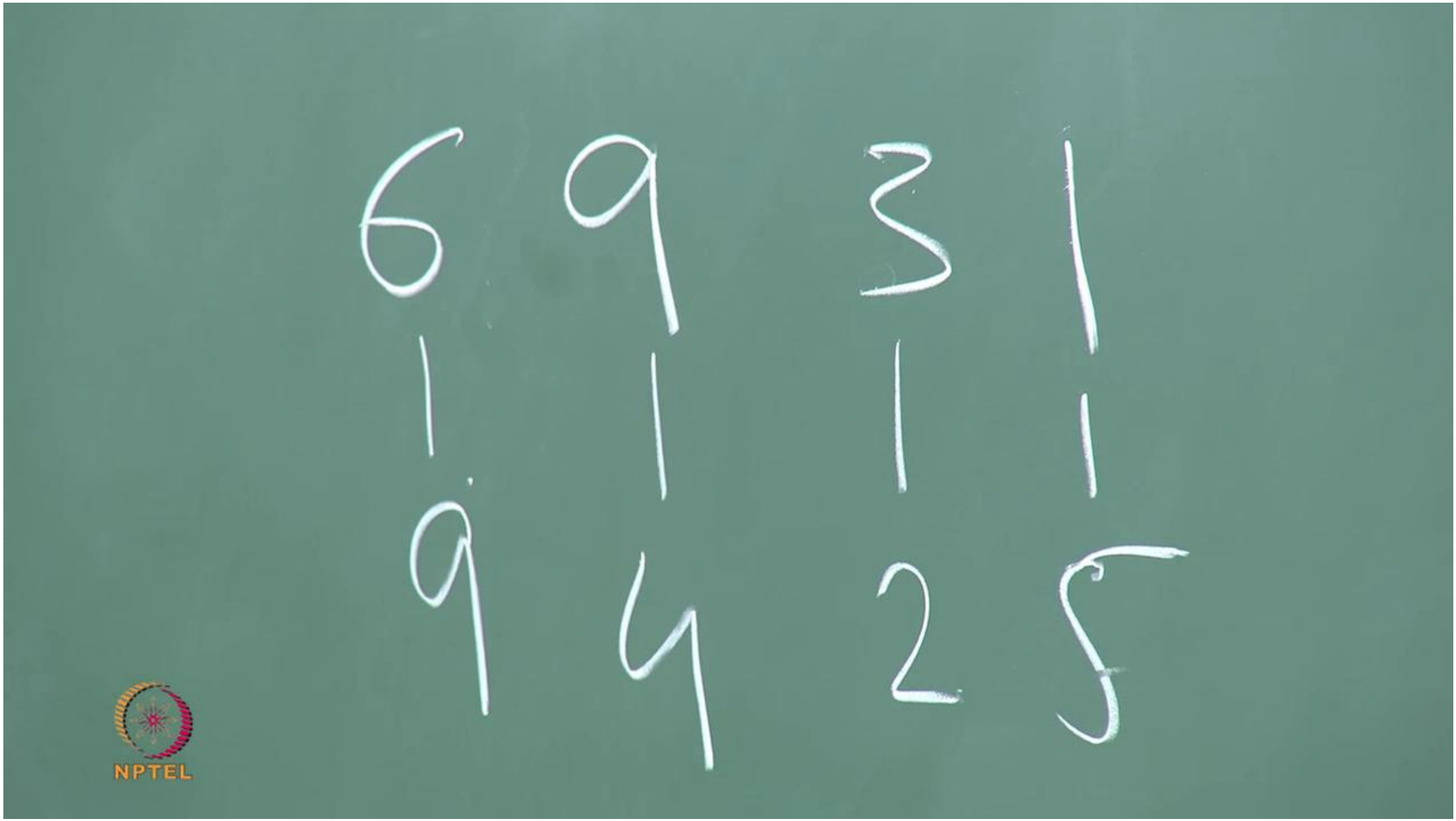
3-7-1-9-4-2-5-6-8

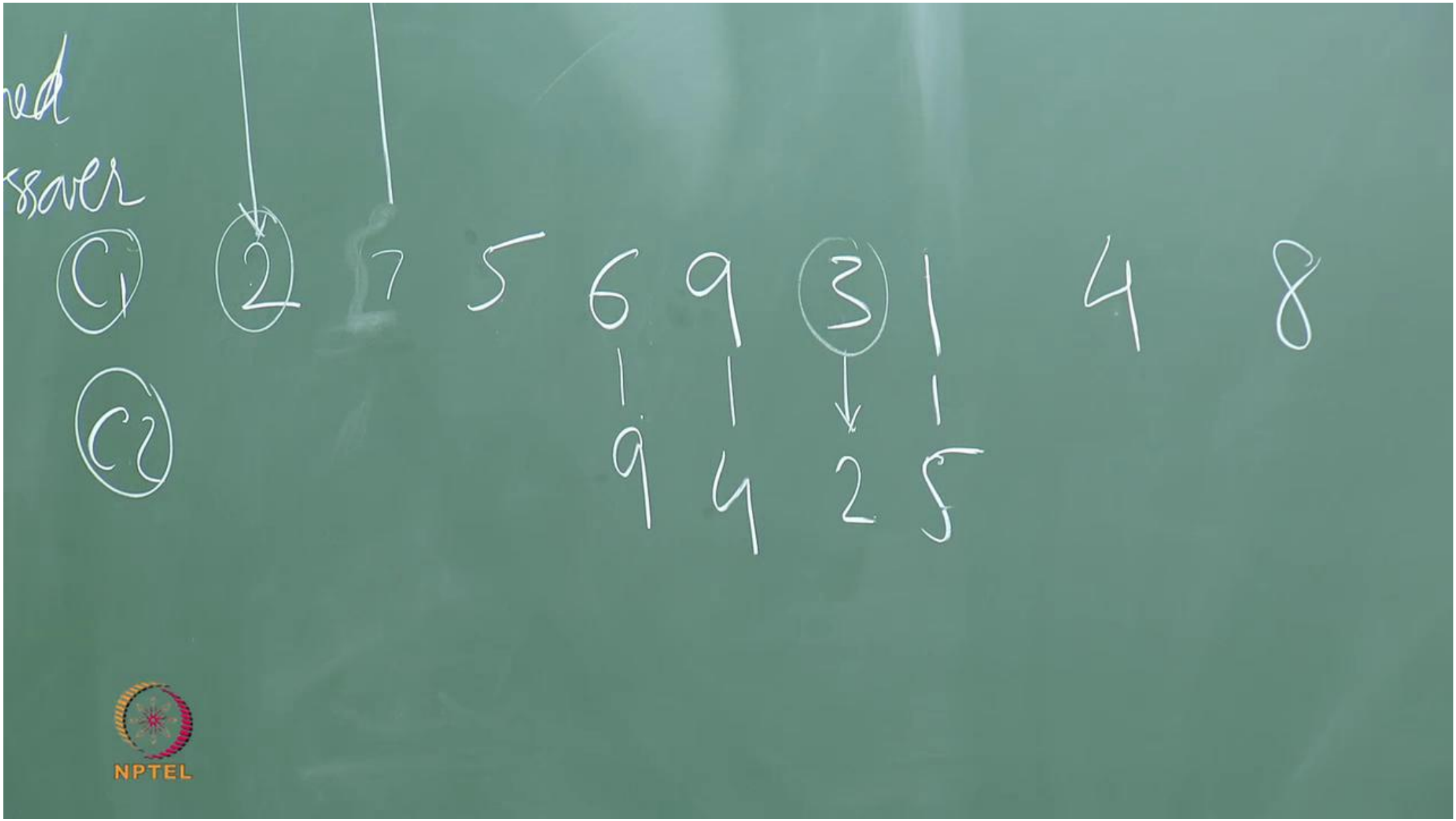

Path representation 2-4-5-6-9-3-1-7-
3-7-1-9-4-2-5-6-
NPTEL

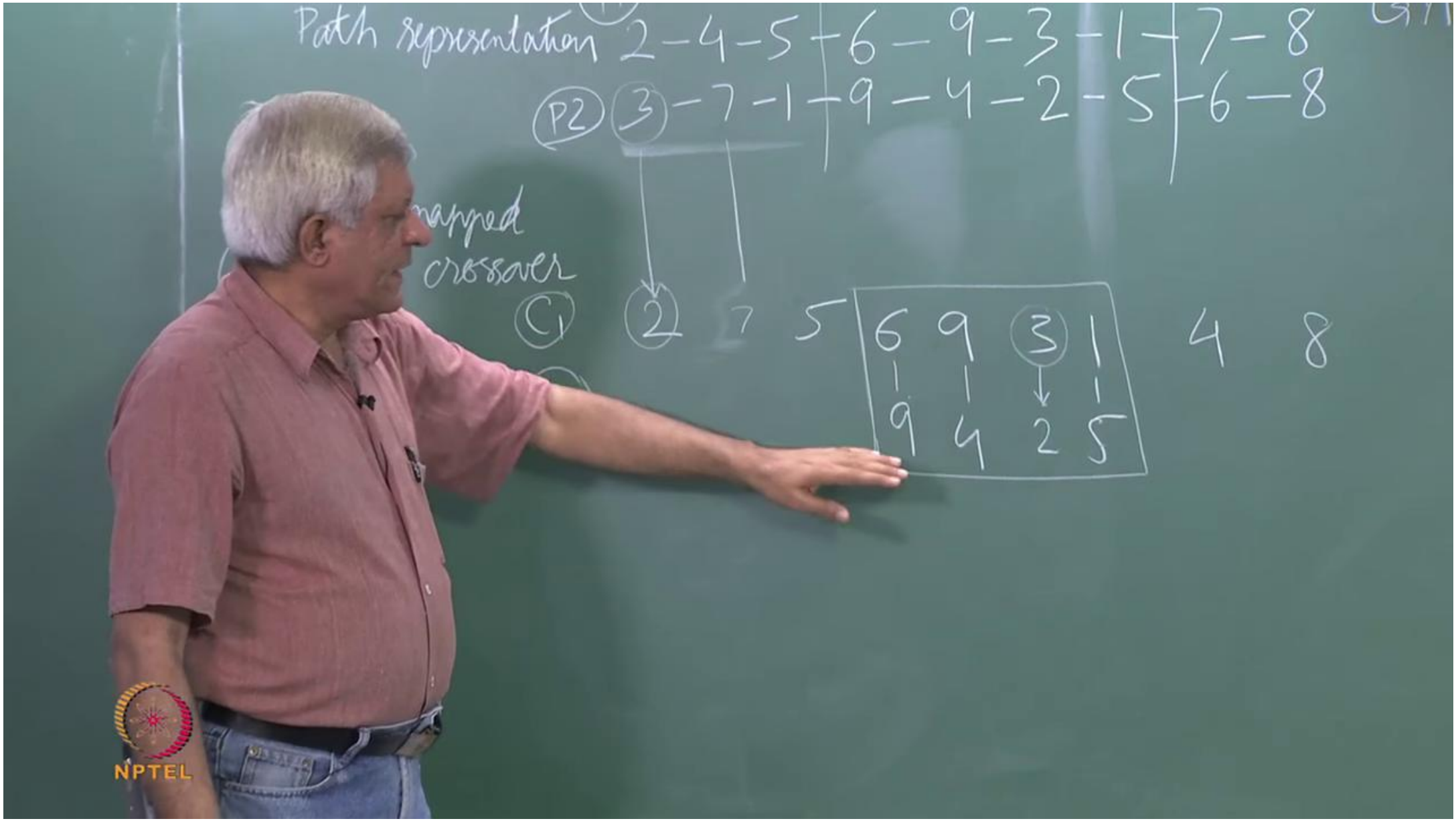

8 1 6
3 5 7
4 9 2

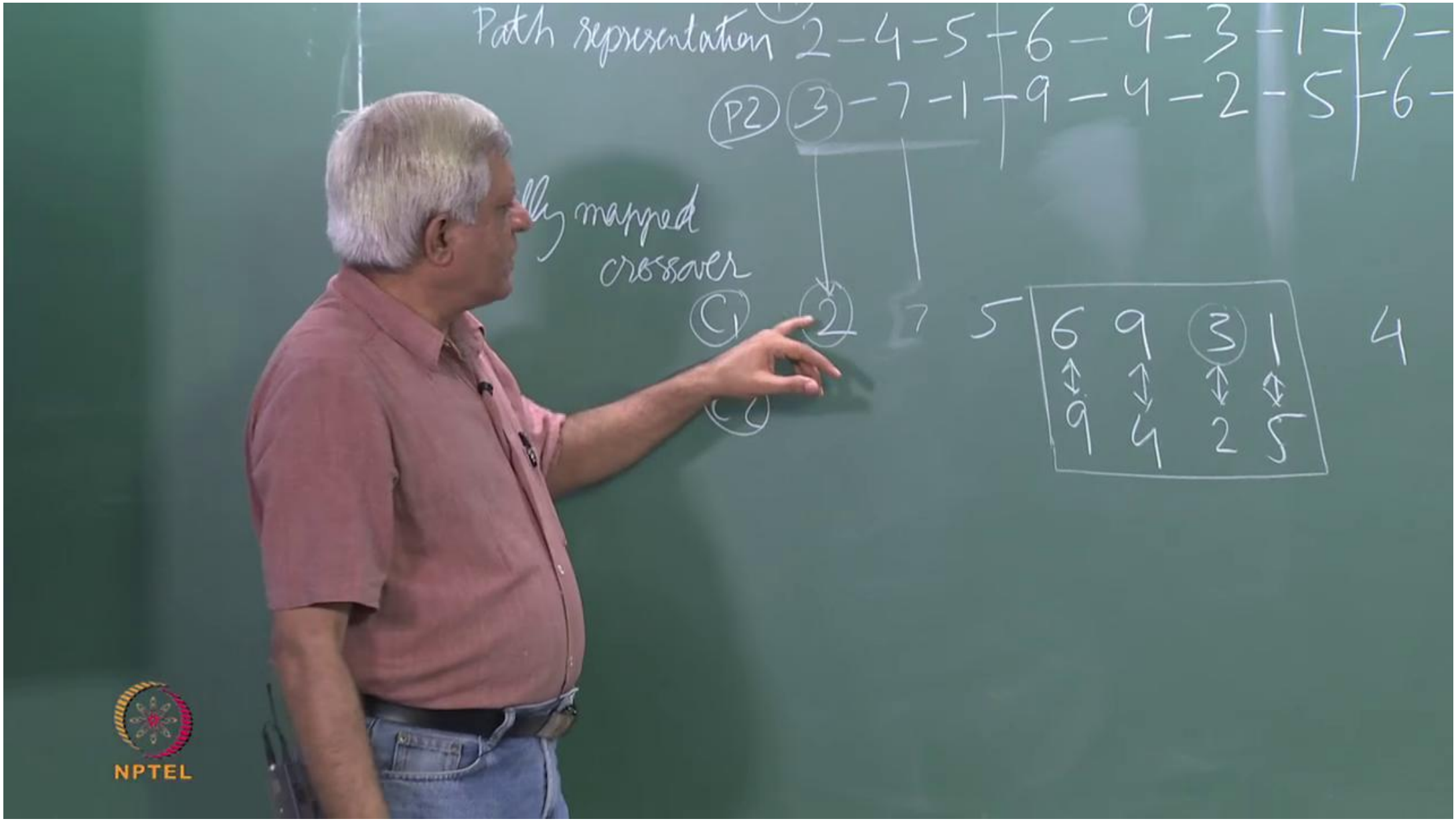

GAs
Path representation 2-4-5-6-9-3-1-7-8
-7-1-9-4-2-5-6-8
Partially mapped
(PMX)
6
NPTEL

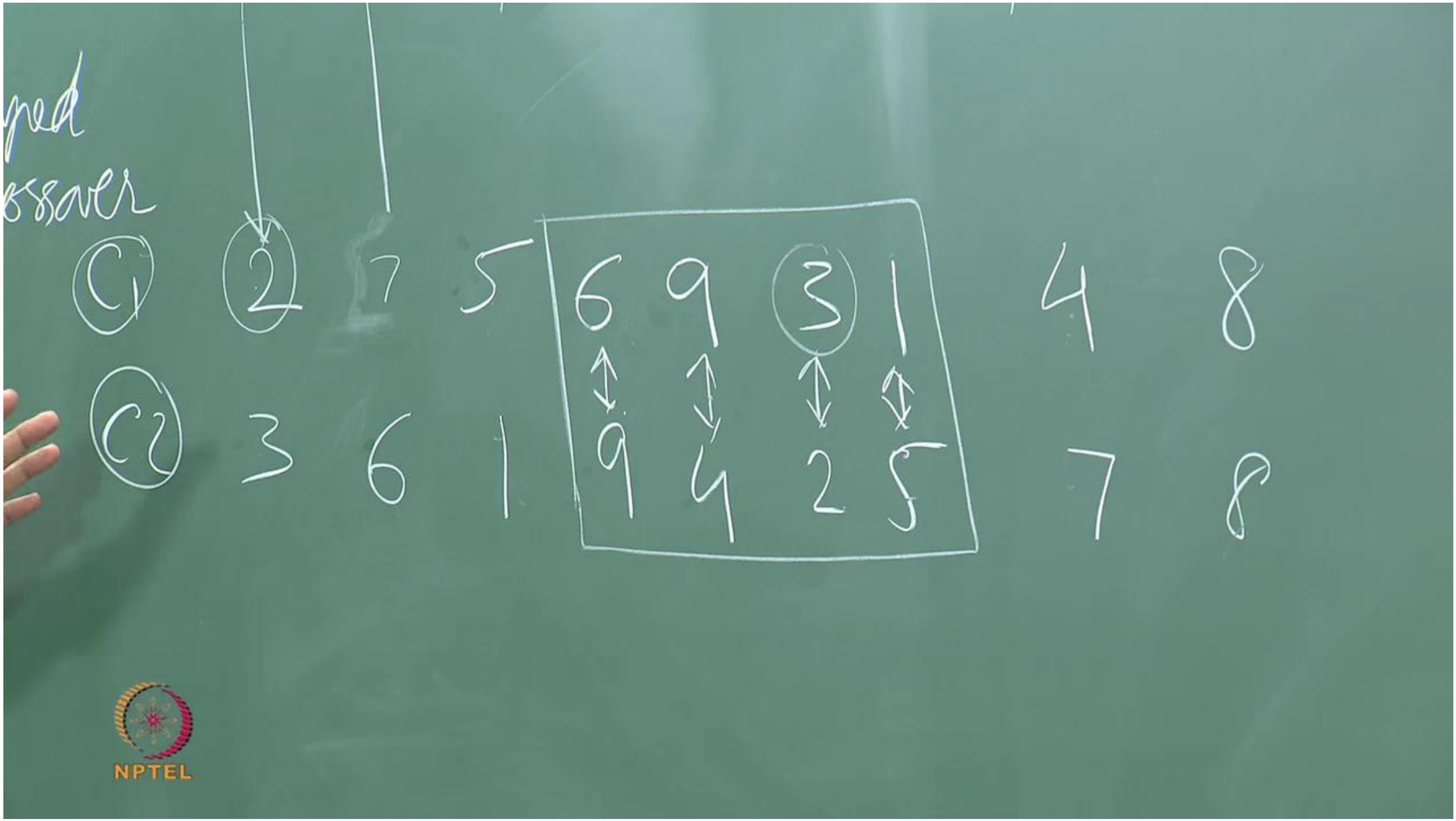

Path representation 2-4-5 | 6-9-3-1 |
3-7-1 | 9-4-2-5 |
6 9 3 1
9 4 2 5
NPTEL


6 9 3 1
- - - -
9 4 2 5


ed
ssaver
C1
2 7 5 6 9 3 1 4 8
C2
9 4 2 5


Path representation 2-4-5-6-9-3-1-7-8
P2 3-7-1-9-4-2-5-6-8
mapped
crossover
C1 2 7 5 6 9 3 1 4 8
9 4 2 5
NPTEL


Path representation 2-4-5-6-9-3-1-7-
P2 3-7-1-9-4-2-5-6-
mapped
crossover
2
7
5
6 9 3 1
9 4 2 5
4
NPTEL


ped
ssaver
2
7
5
6
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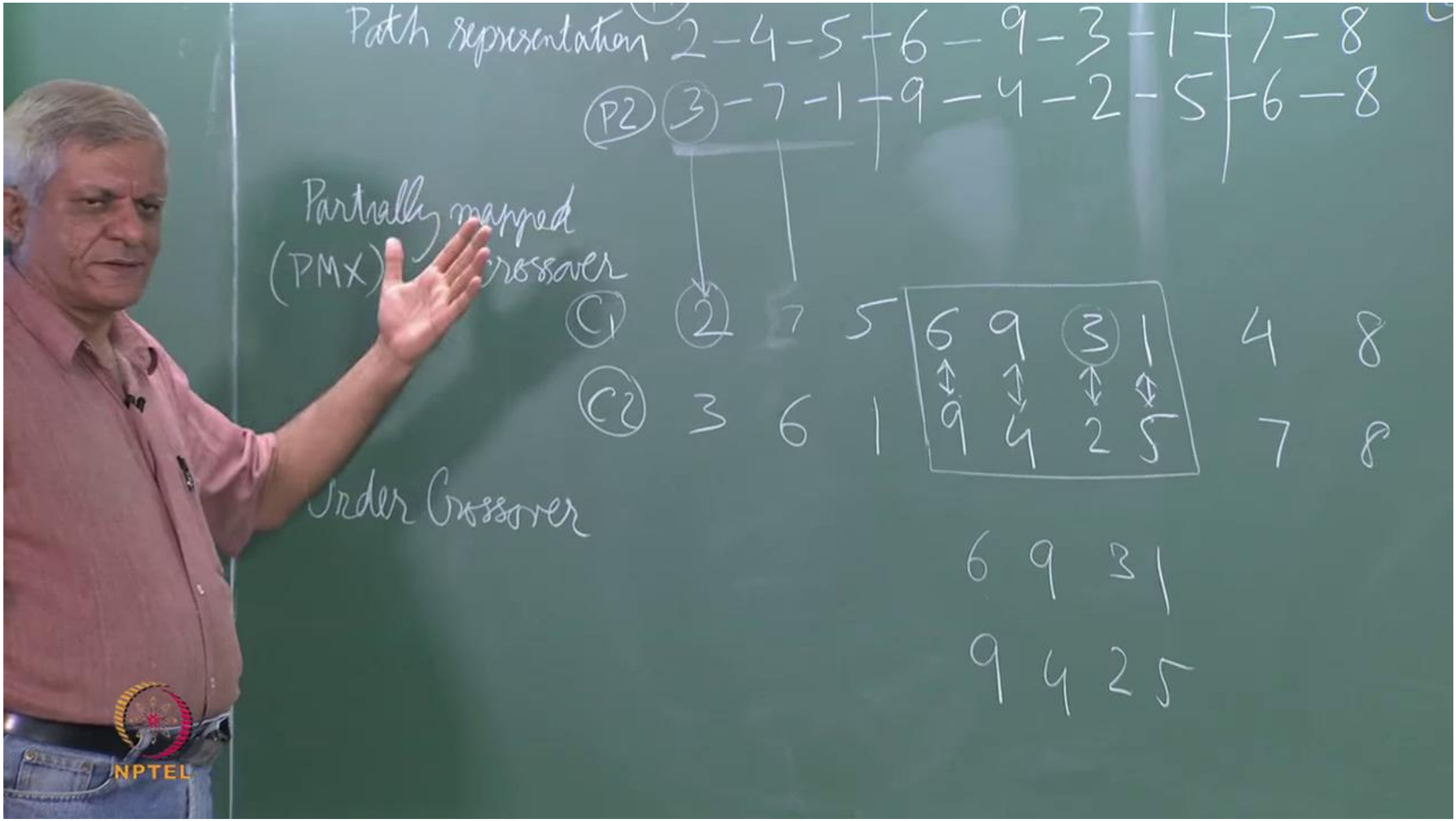
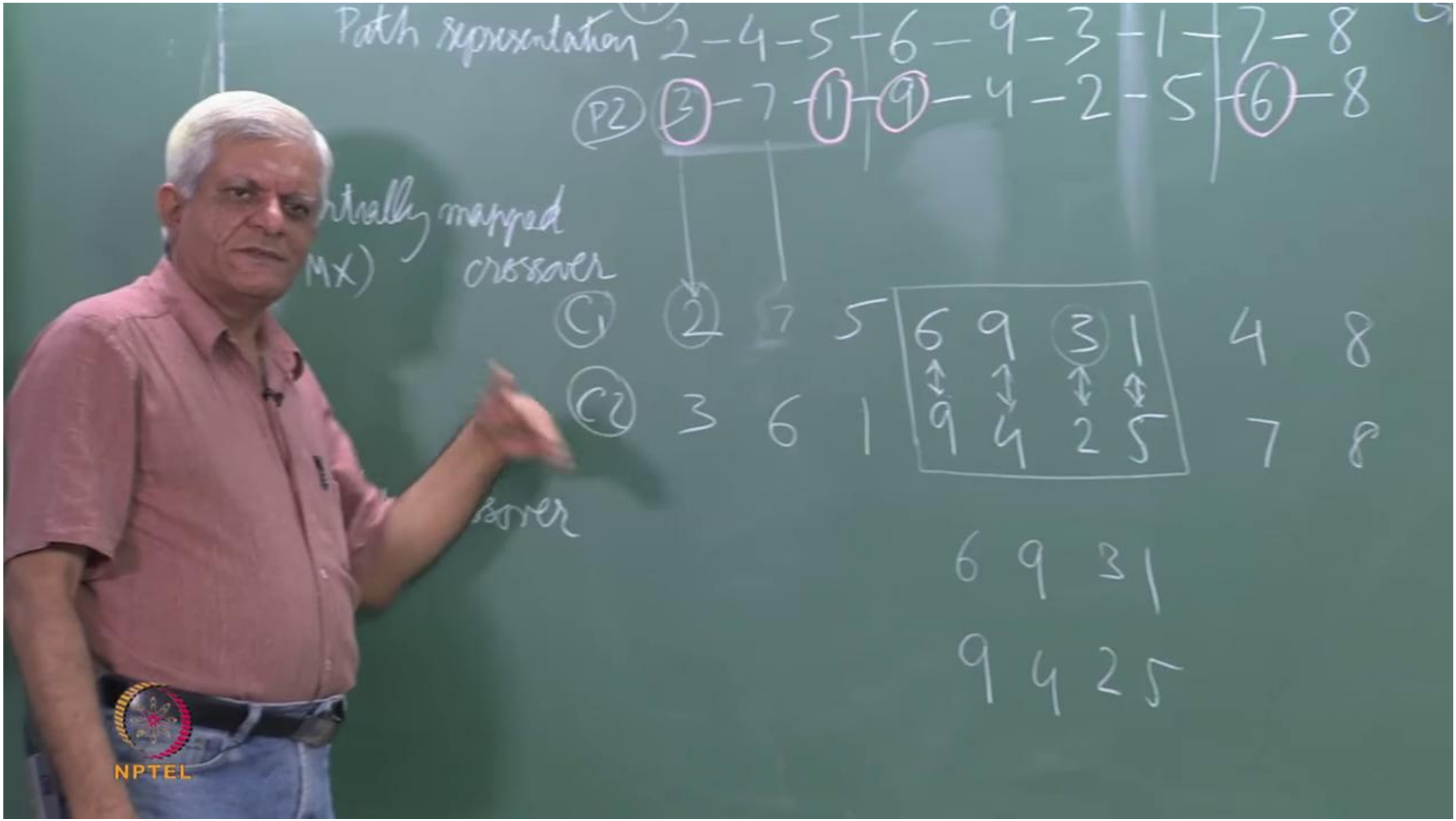
3
1
4
8
3
6
1
9
4
2
5
7
8
NPTEL


Path representation 2-4-5-6-9-3-1-7-8
P2 3-7-1-9-4-2-5-6-8
Partially mapped
(PMX) Crossover
C1 2 7 5 6 9 3 1 4 8
C2 3 6 1 9 4 2 5 7 8
Order Crossover
6 9 3 1
9 4 2 5
NPTEL


Path representation 2-4-5-6-9-3-1-7-8
P2 3-7-1-9-4-2-5-6-8
rtially mapped
MX) crossover
C1 2 7 5
C2 3 6 1
6 9 3 1
9 4 2 5
4 8
7 8
6 9 3 1
9 4 2 5
NPTEL

6 9 31 7 4258

9 4 25

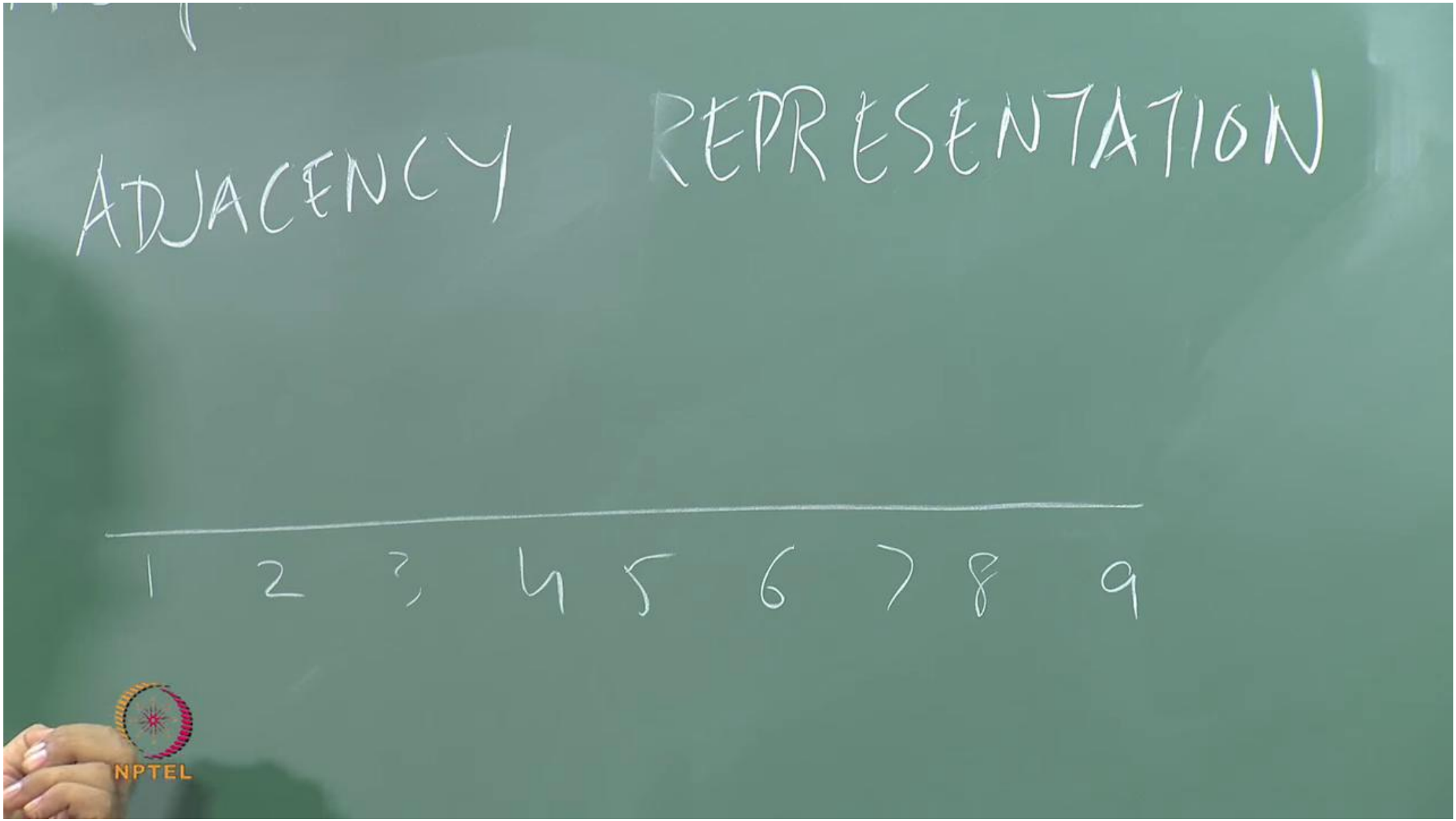
As for FST

ORDINAL REPRESENTATION

ADJACENCY REPRESENTATION

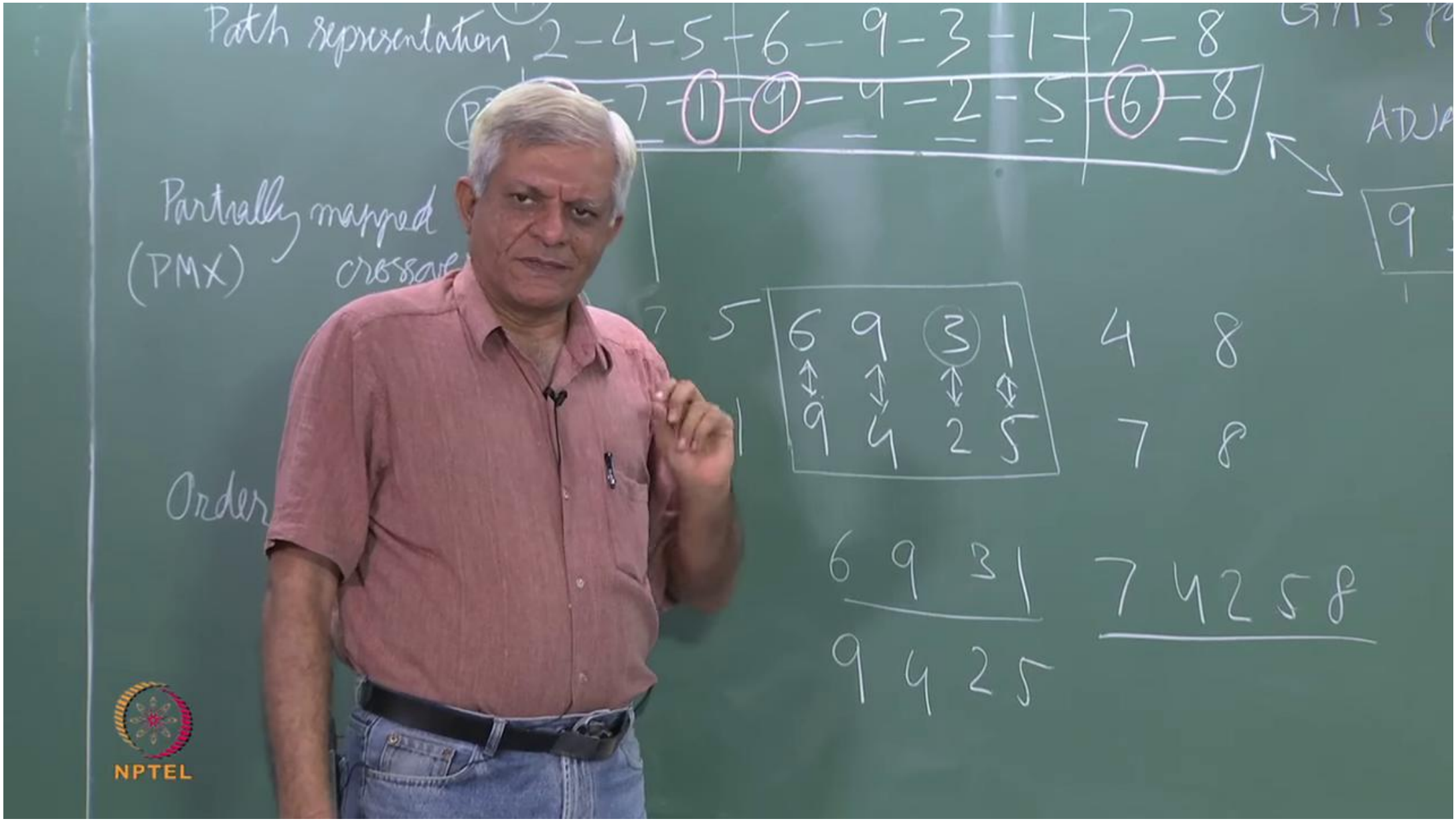
ADJACENCY REPRESENTATION

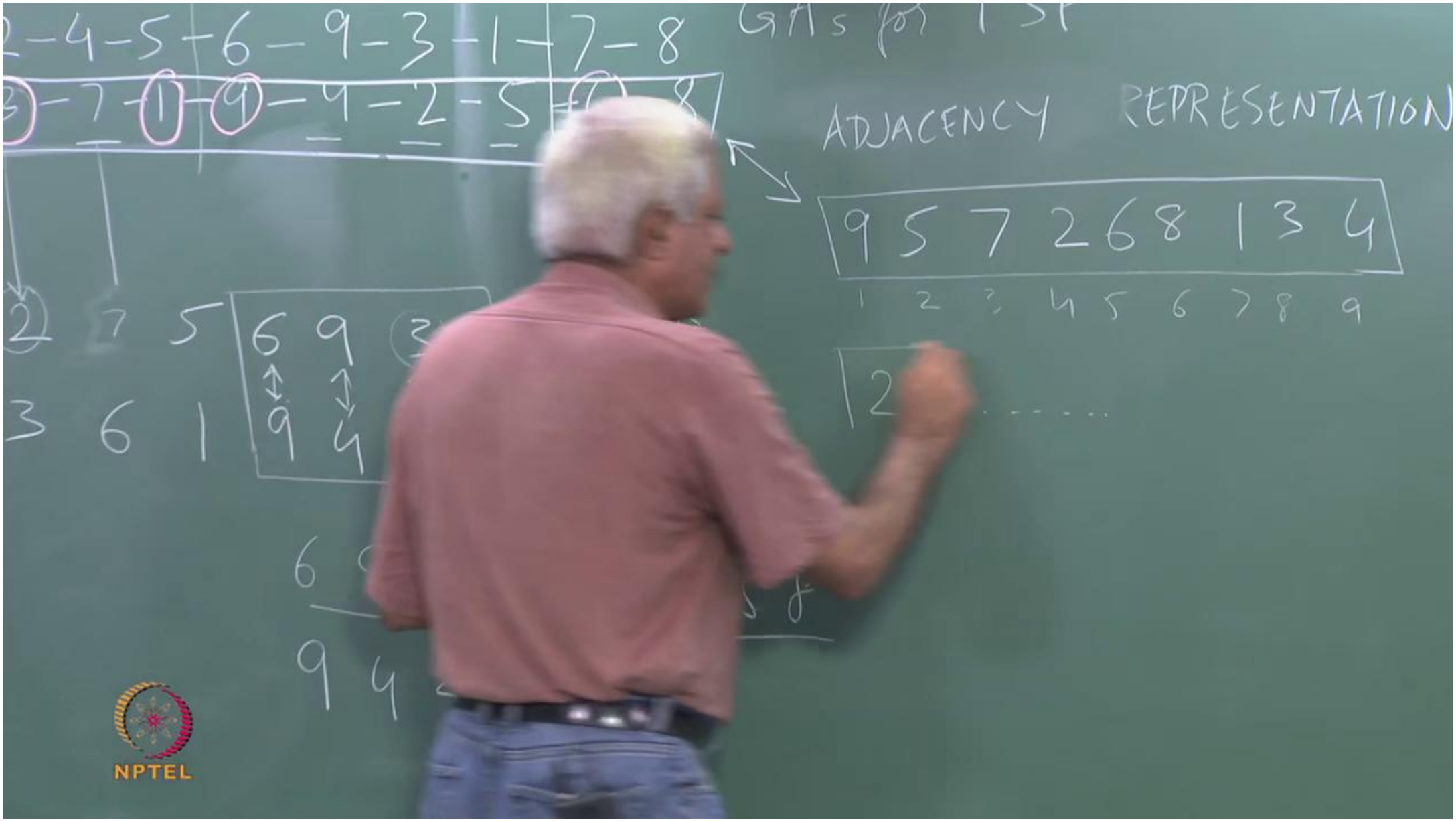
1 2 3 4 5 6 7 8 9

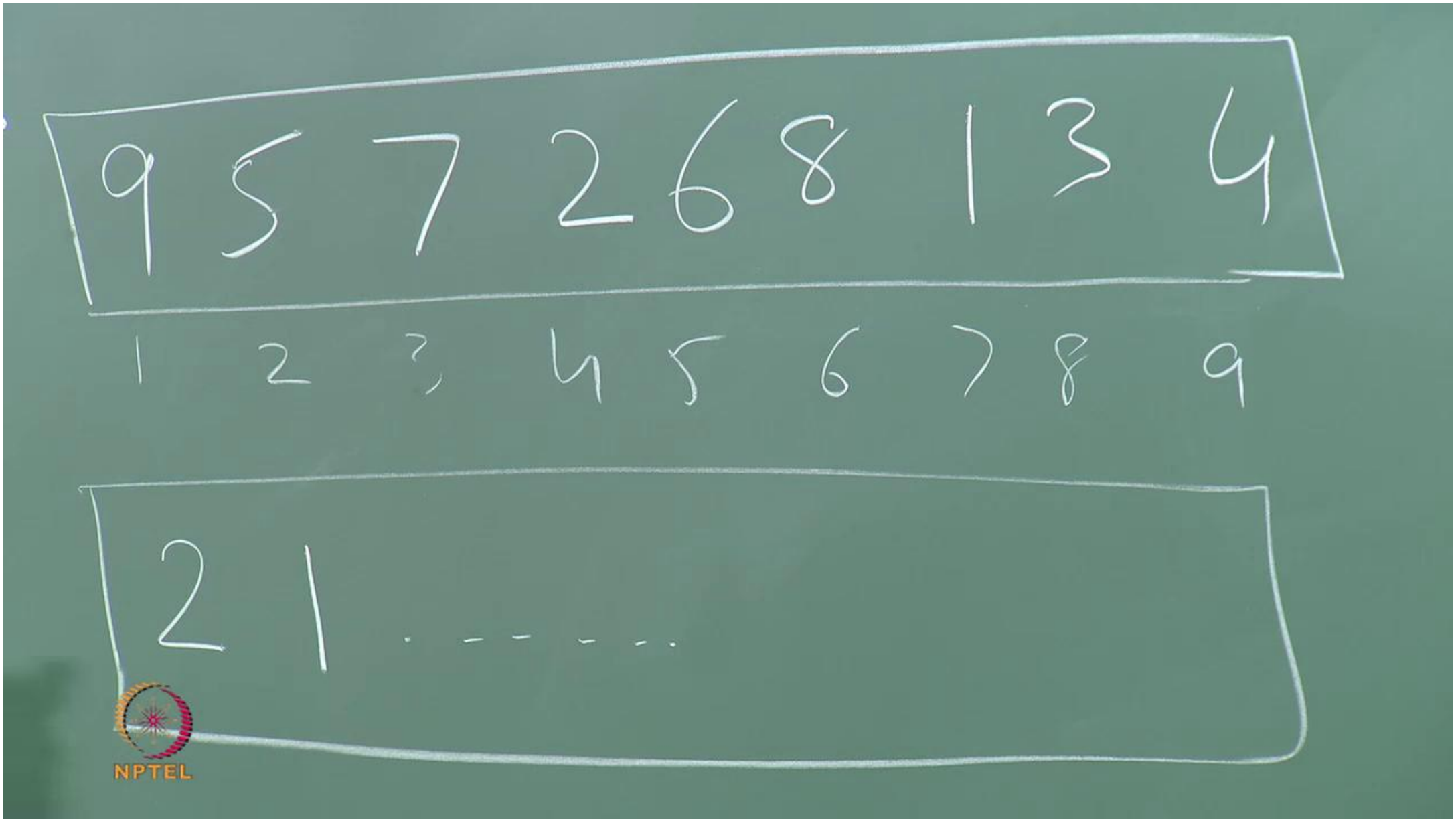

ADJACENCY REPRESENTATION
1 2 3 4 5 6 7 8 9
NPTEL

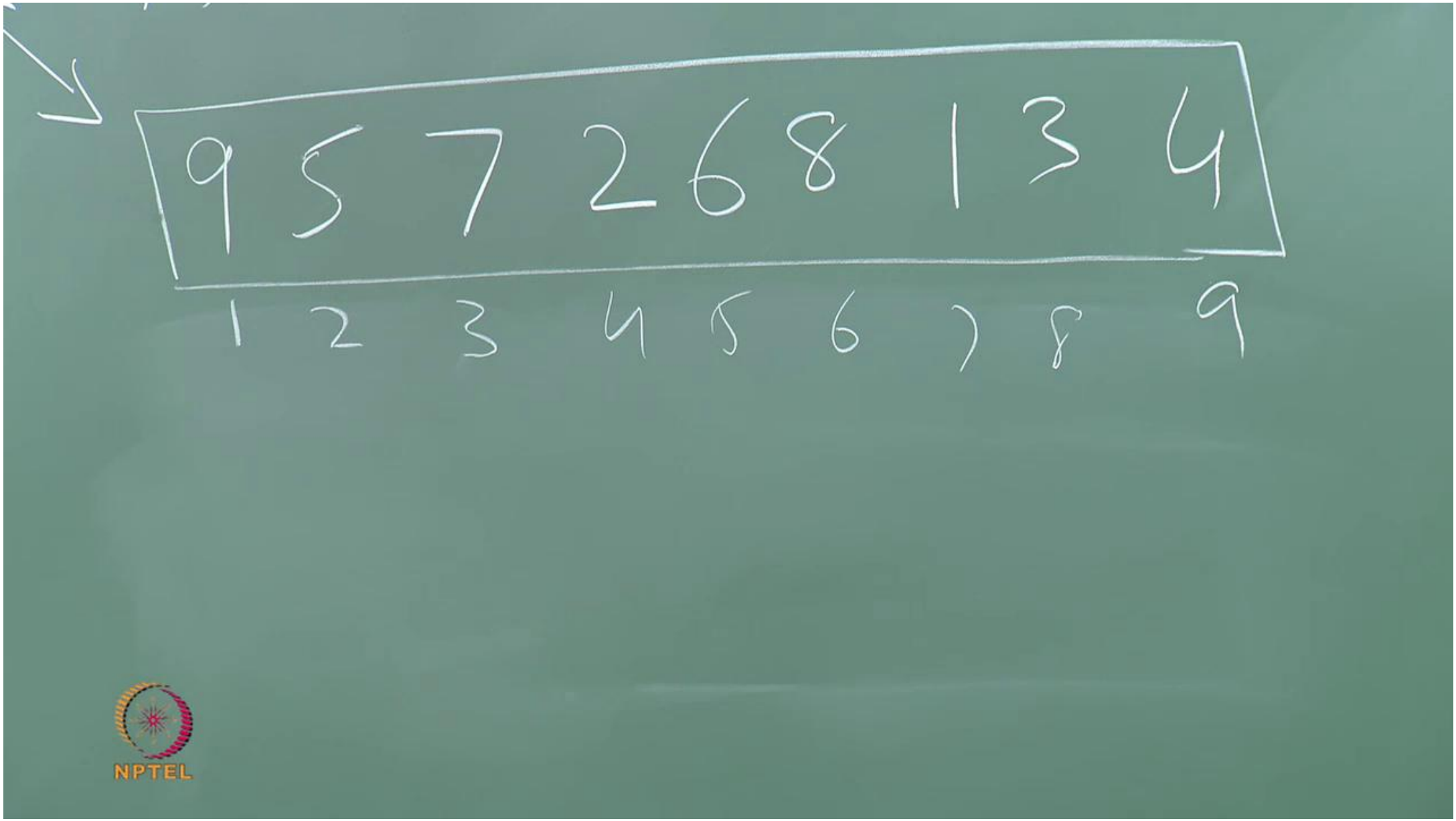
ADJACENCY REPRESENTATION

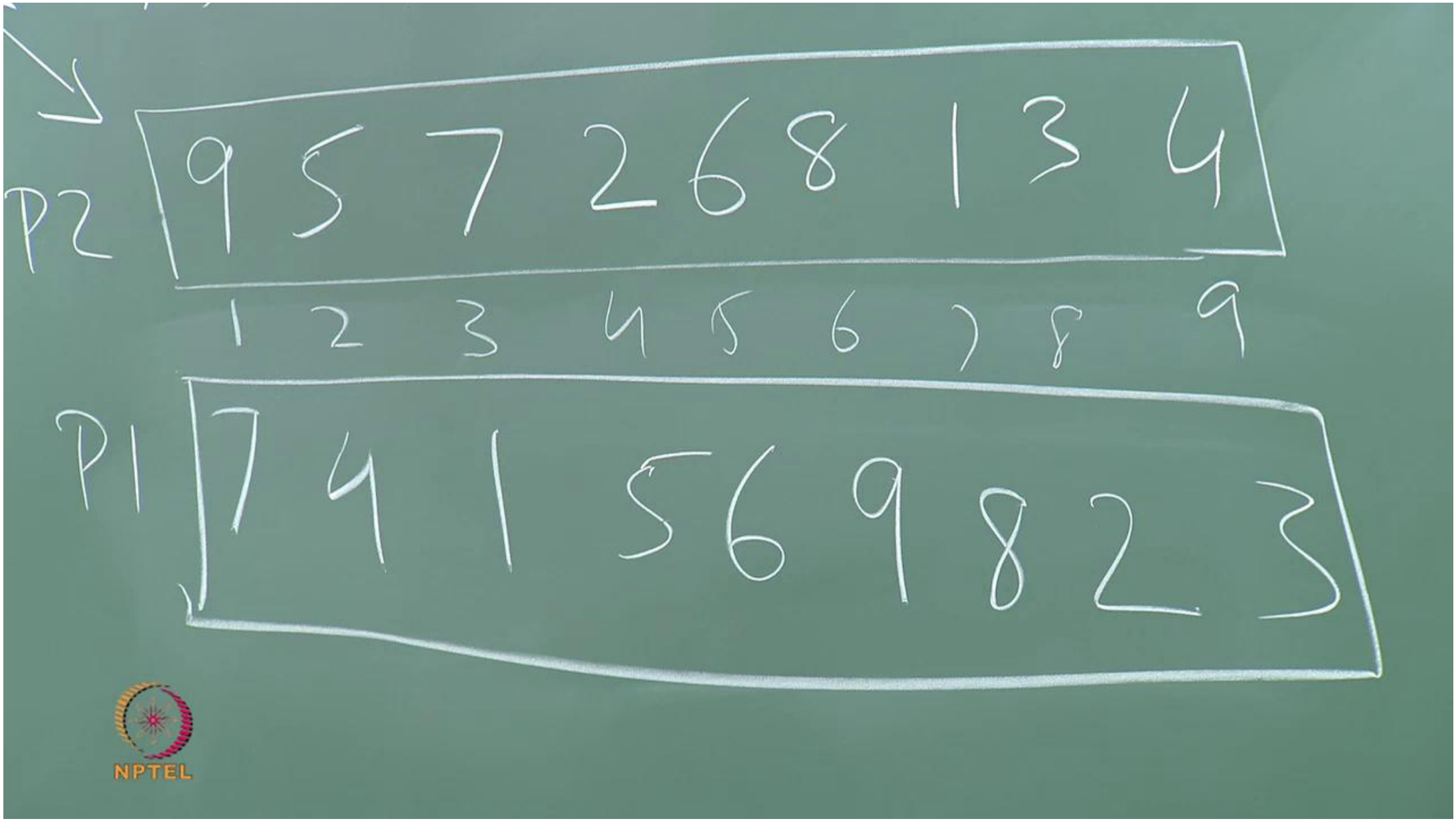
9	5	7	2	6	8	1	3	4
1	2	3	4	5	6	7	8	9

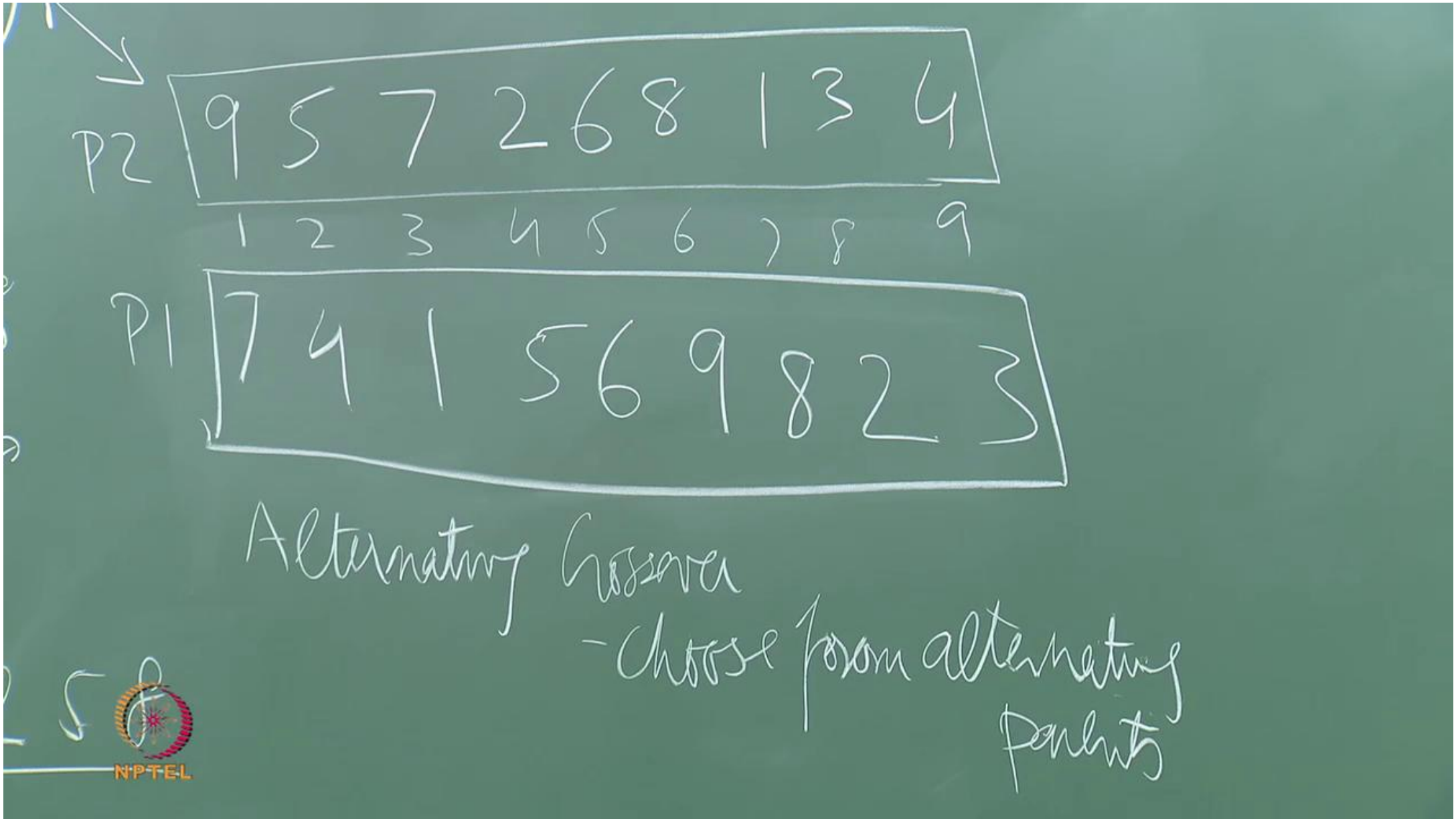

Path representation
2-4-5-6-9-3-1-7-8
Partially mapped crossover
(PMX)
Order
ADJA
6 9 3 1
9 4 2 5
4 8
7 8
6 9 3 1
9 4 2 5
7 4 2 5 8
NPTEL

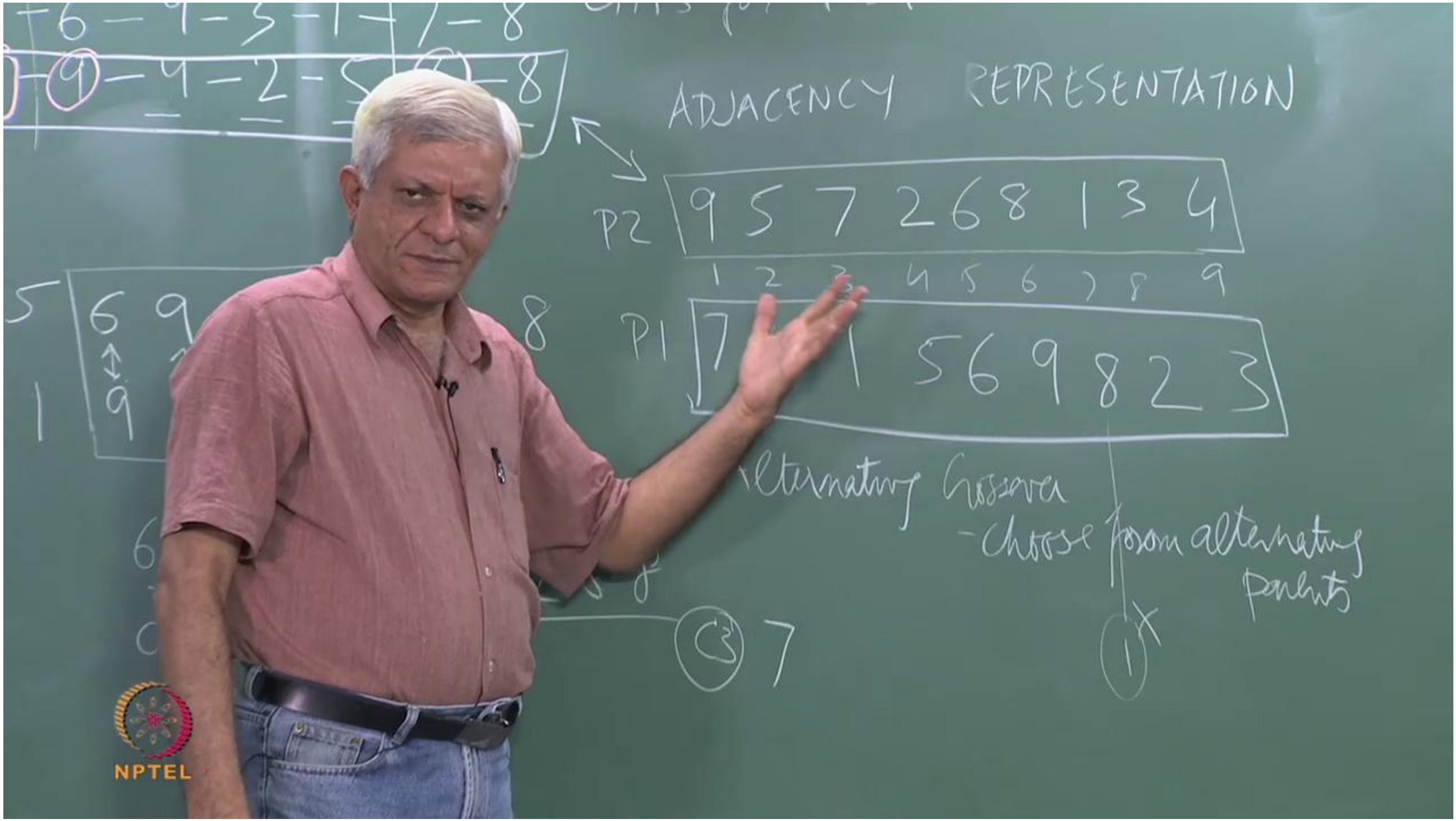

ADJACENCY REPRESENTATION
9 5 7 2 6 8 1 3 4
1 2 3 4 5 6 7 8 9

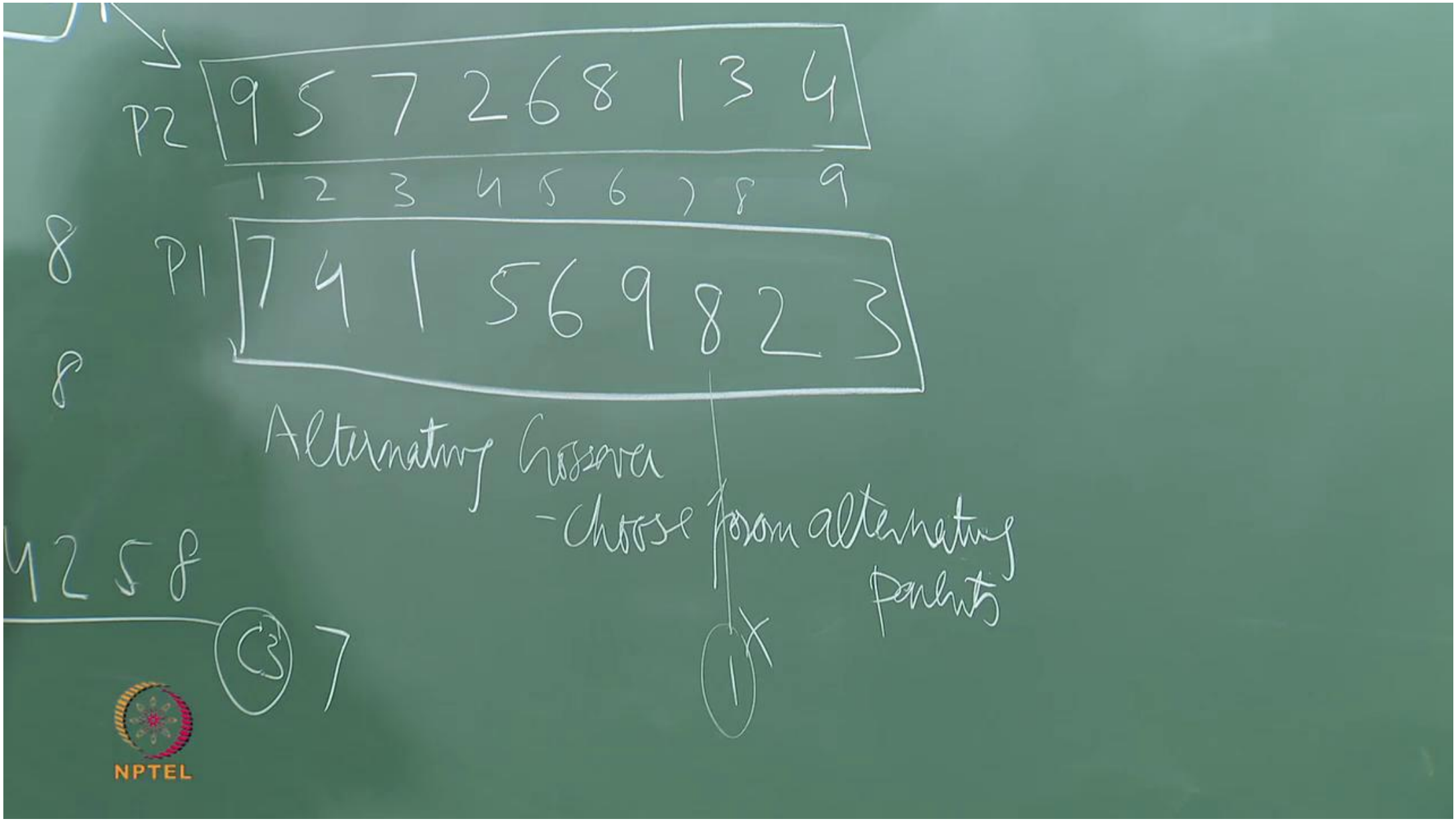

9 5 7 2 6 8 1 3 4
1 2 3 4 5 6 7 8 9
2 1 . . . . . .

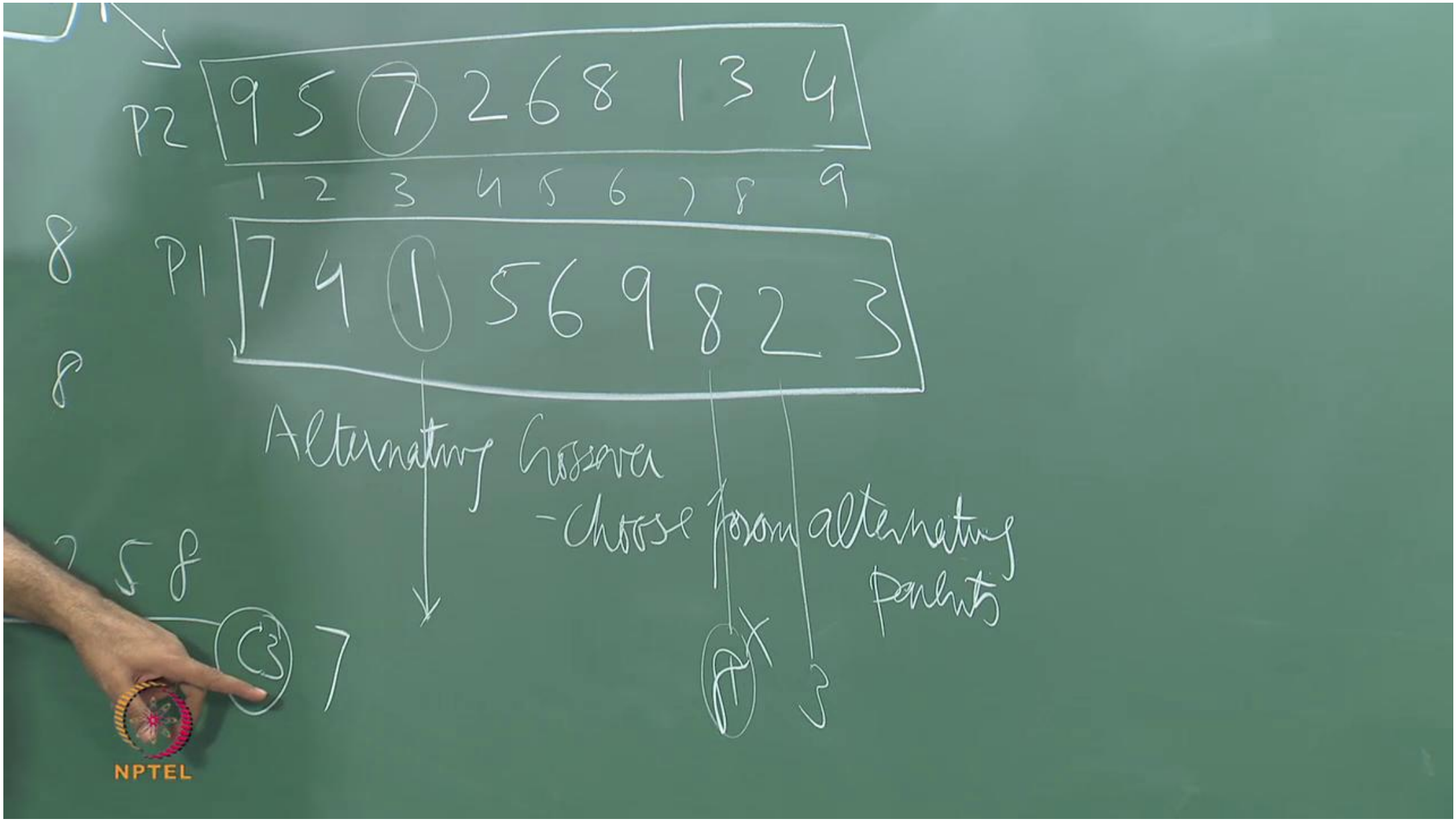

9 5 7 2 6 8 1 3 4
1 2 3 4 5 6 7 8 9

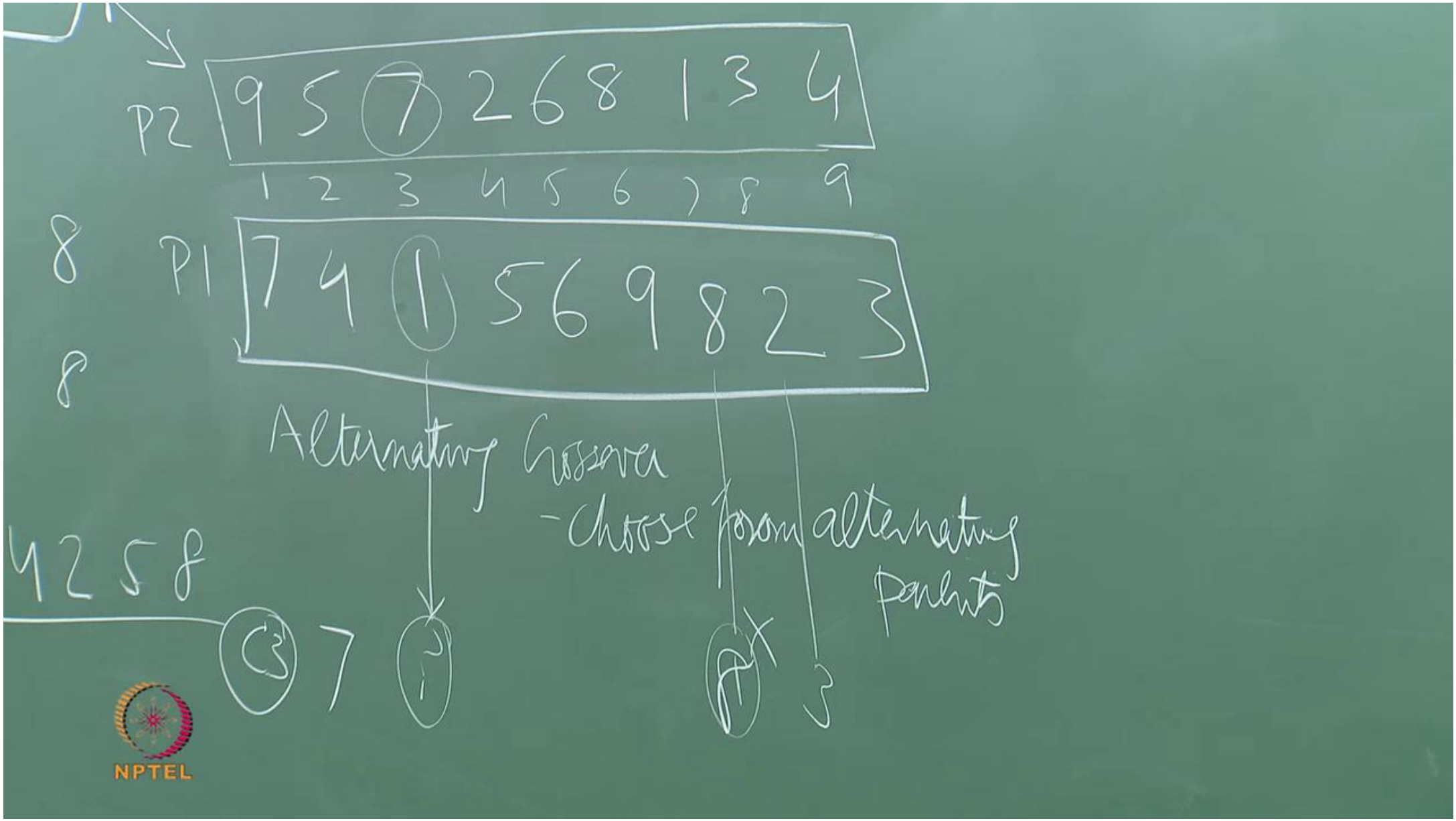

P2
9 5 7 2 6 8 1 3 4
1 2 3 4 5 6 7 8 9
P1
7 4 1 5 6 9 8 2 3
NPTEL

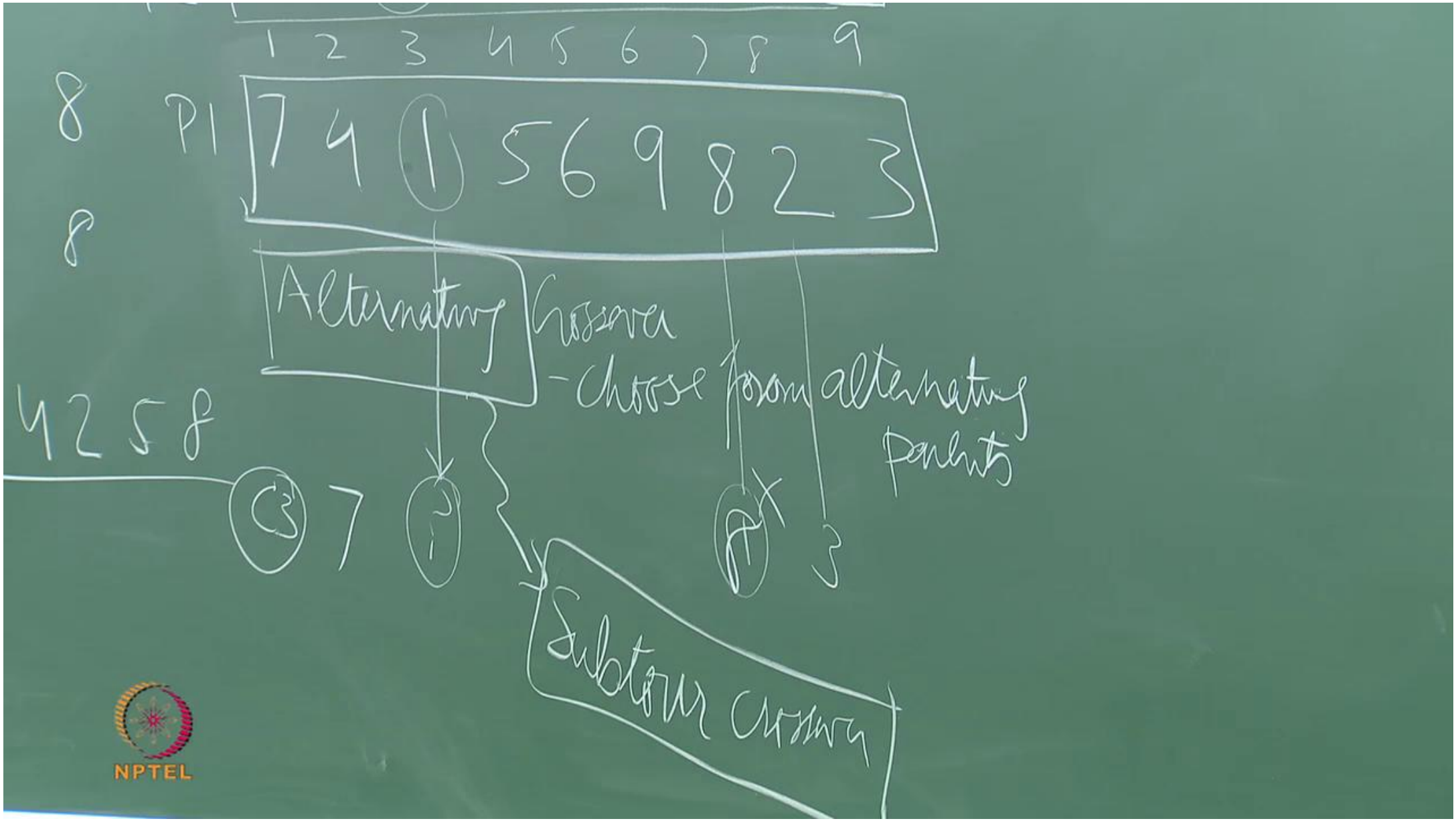

P2
9 5 7 2 6 8 1 3 4
1 2 3 4 5 6 7 8 9
P1
7 4 1 5 6 9 8 2 3
Alternating Crossover
- Choose from alternating parents

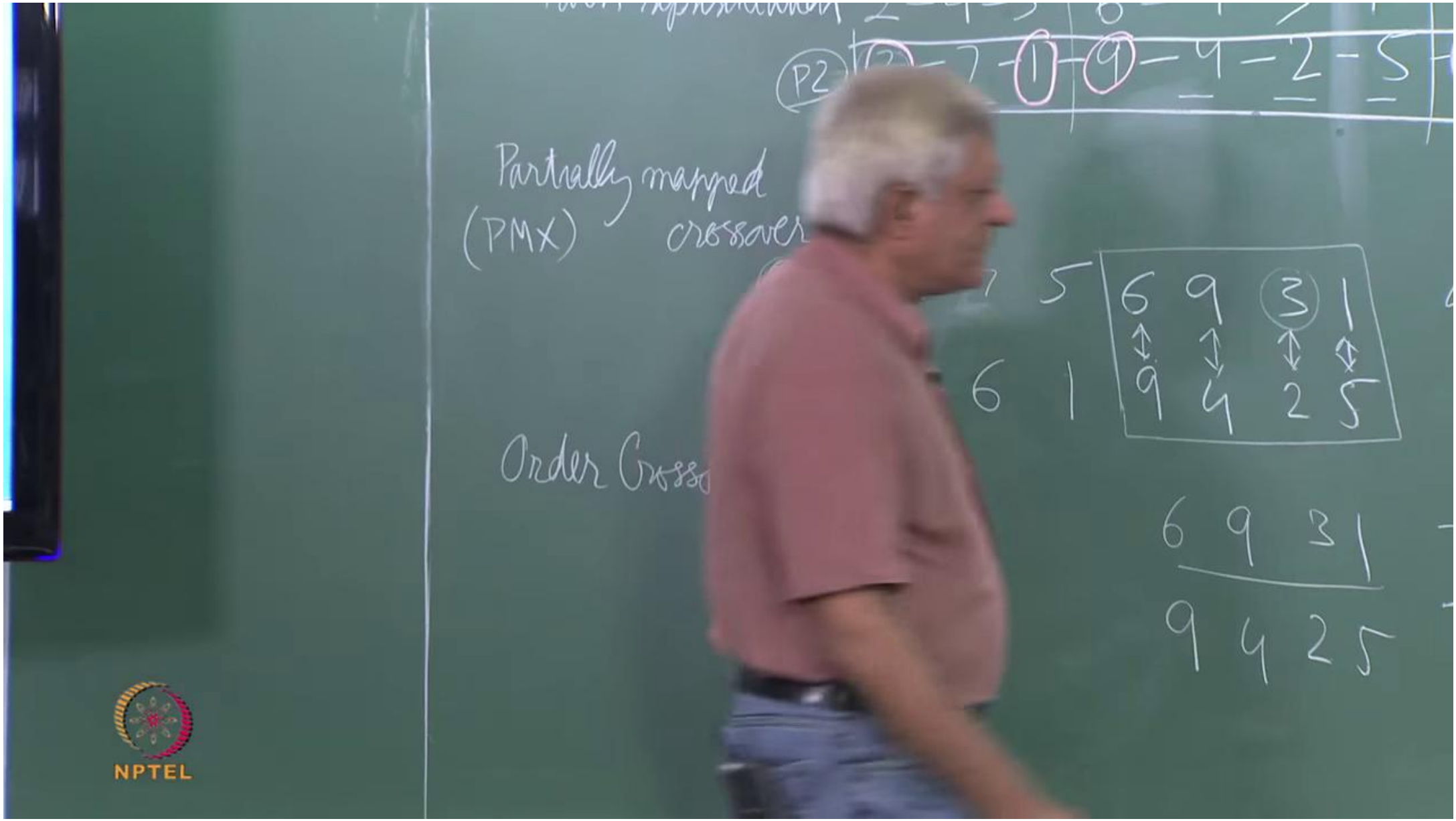

ADJACENCY REPRESENTATION
P2
9 5 7 2 6 8 1 3 4
1 2 3 4 5 6 7 8 9
P1
7 1 5 6 9 8 2 3
Alternating Crossover
- Choose from alternating parents
NPTEL

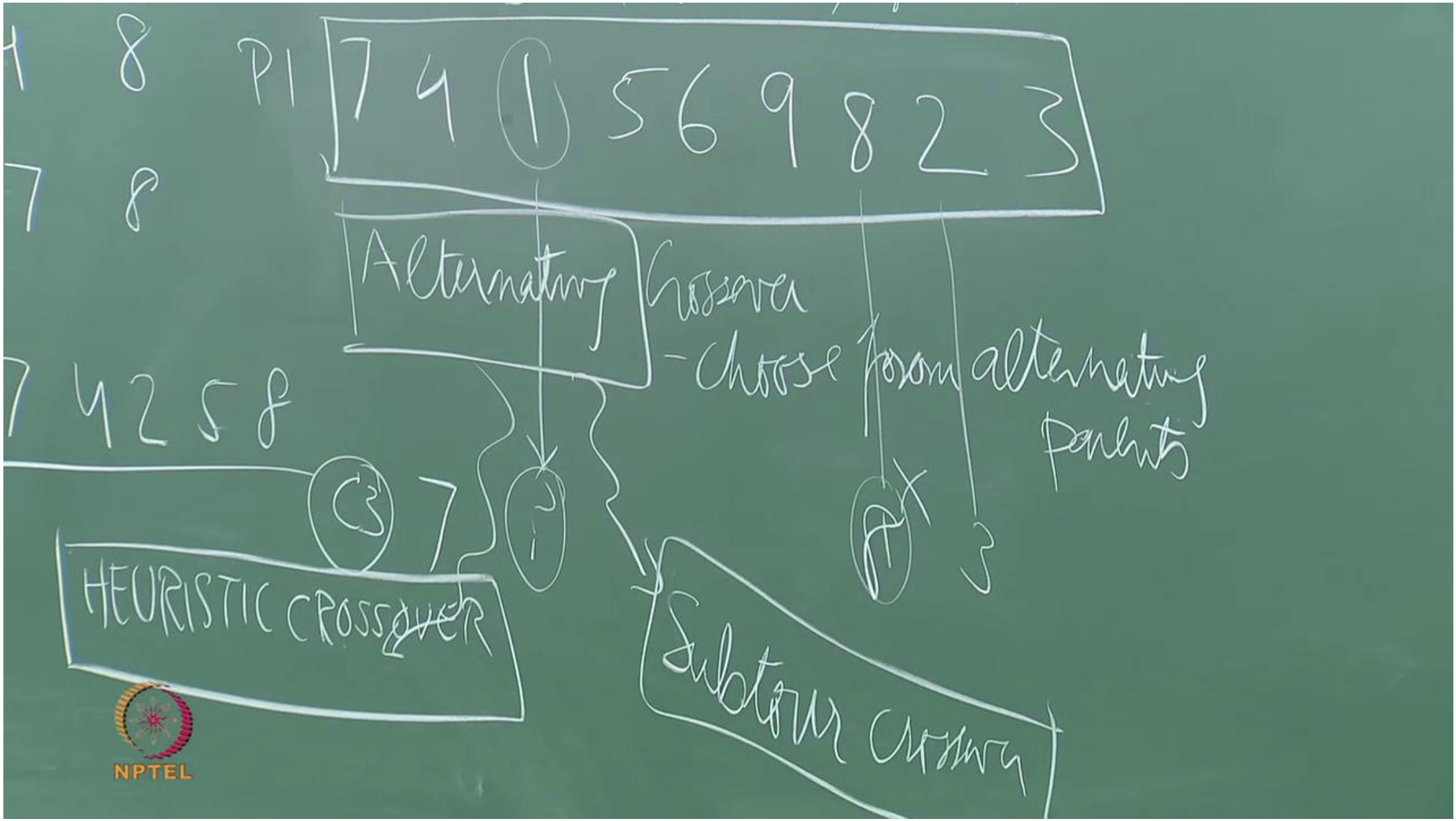

P2 9 5 7 2 6 8 1 3 4
1 2 3 4 5 6 7 8 9
8 P1 7 4 1 5 6 9 8 2 3
8
Alternating Crossover
- Choose from alternating parents
4 2 5 8
3 7
1
NPTEL

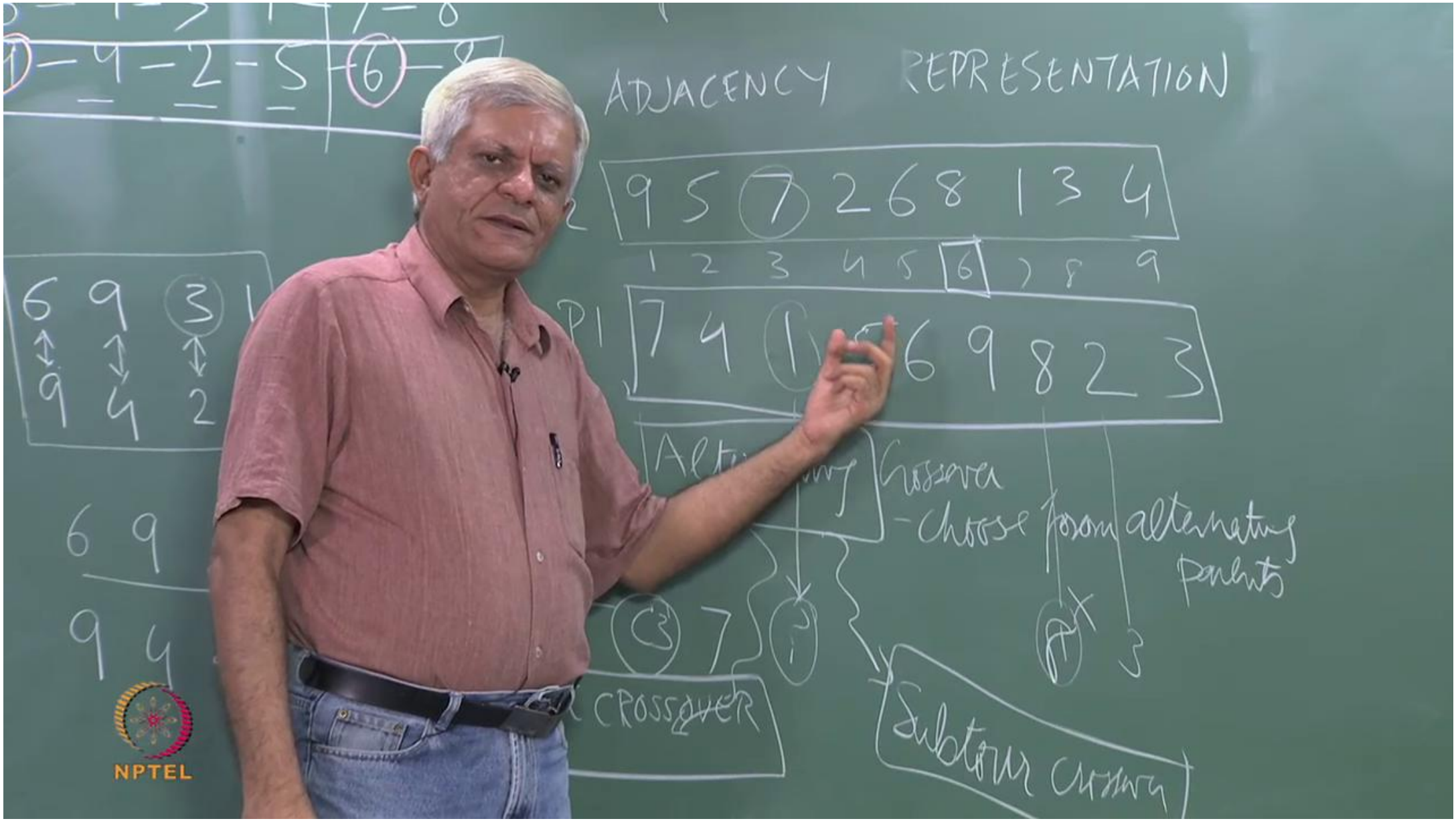

P2 9 5 7 2 6 8 1 3 4
1 2 3 4 5 6 7 8 9
P1 7 4 1 5 6 9 8 2 3
Alternating Crossover
- Choose from alternating parents

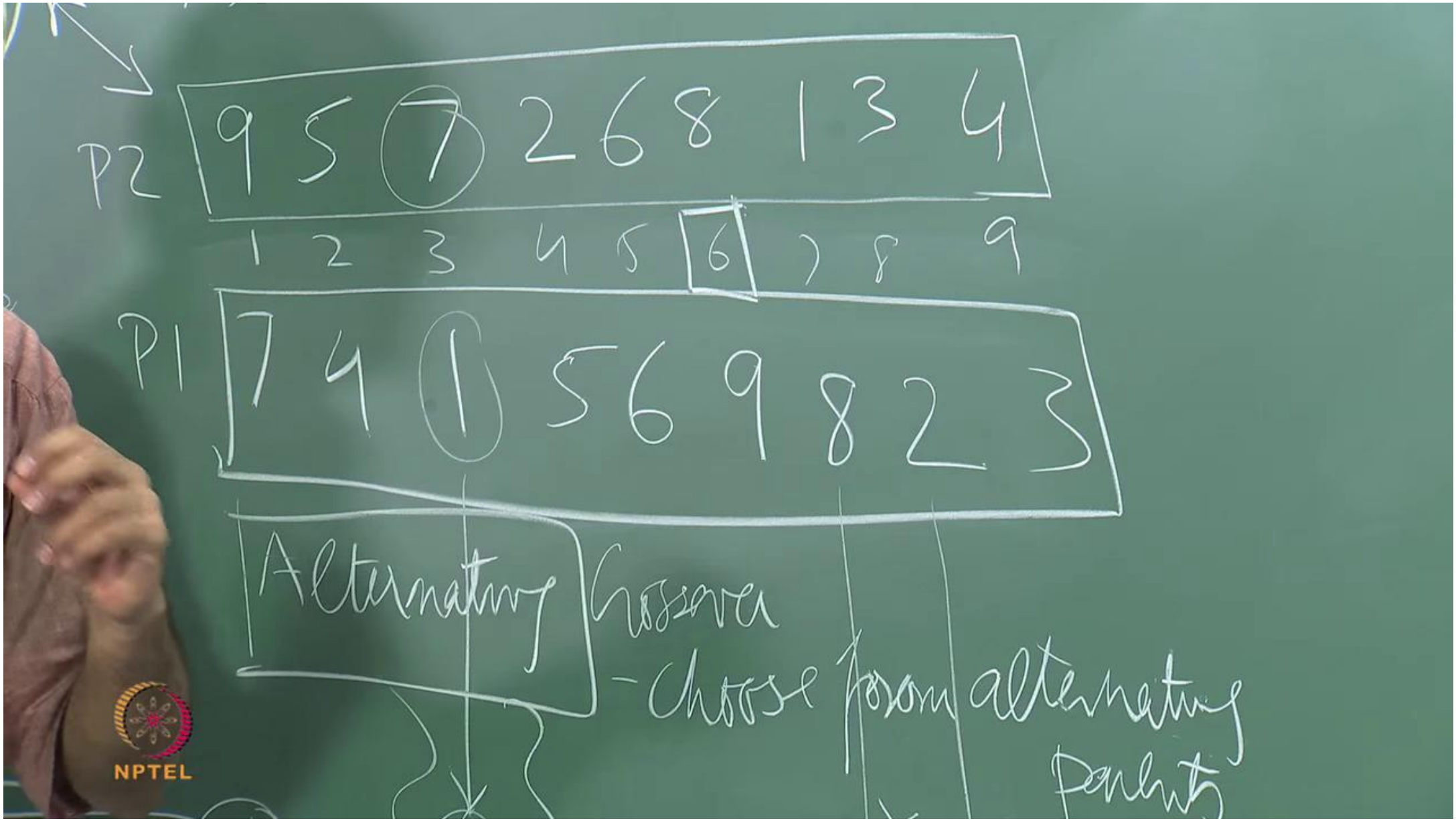

P2 9 5 7 2 6 8 1 3 4
1 2 3 4 5 6 7 8 9
8 P1 7 4 1 5 6 9 8 2 3
8
Alternating Crossover
- Choose from alternating parents
4 2 5 8
C3 7 1 3

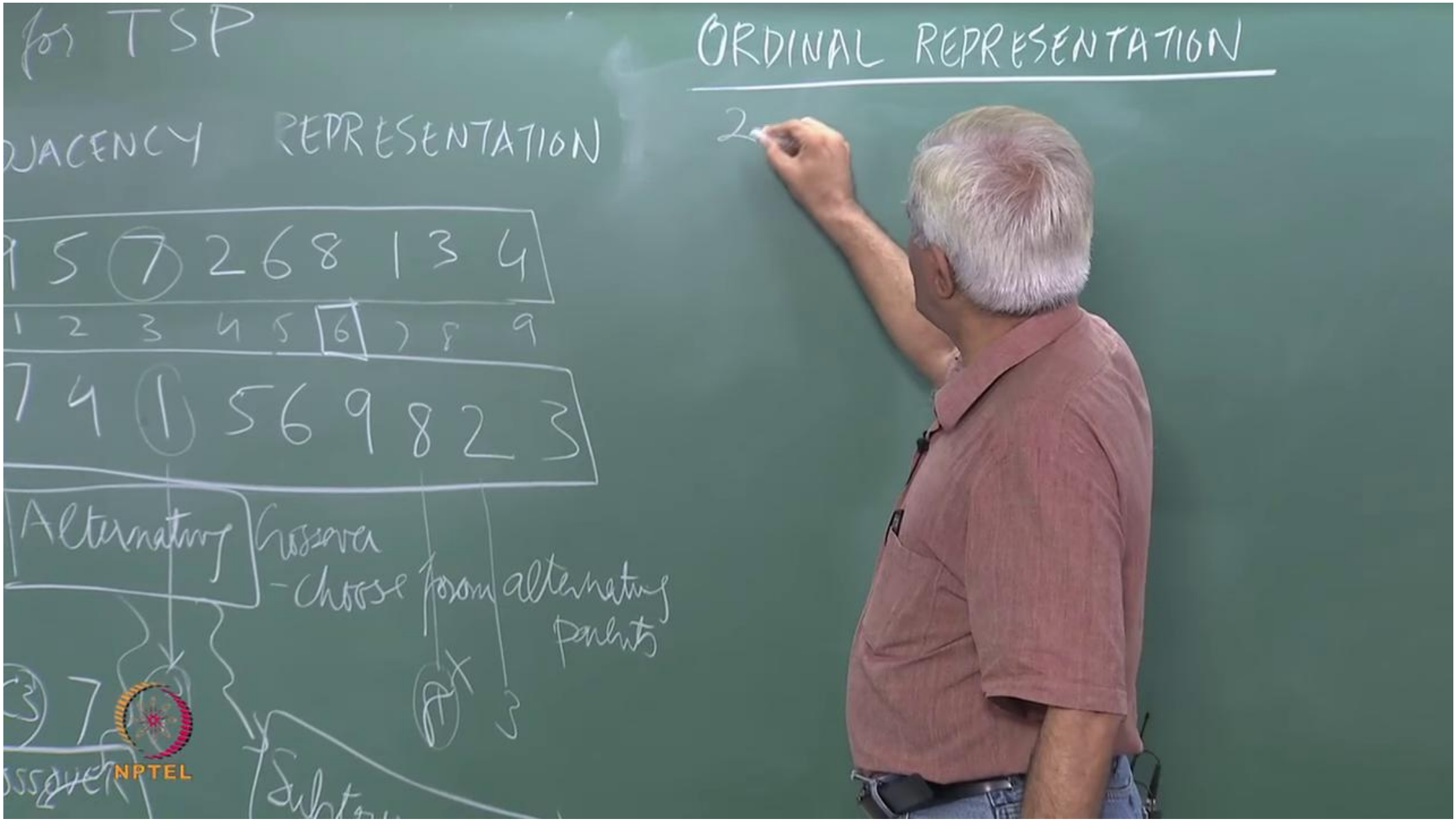

1 2 3 4 5 6 7 8 9
8
P1
7 4 1 5 6 9 8 2 3
8
Alternating
Crossover
- choose from alternating
parents
4 2 5 8
3 7
Subtour crossover
NPTEL


P2
Partially mapped
(PMX)
crossover
Order Cross
6 9 3 1
9 4 2 5
6 9 3 1
9 4 2 5


8
P1 7 4 1 5 6 9 8 2 3
7 8
Alternating
Crossover
- choose from alternating
parents
7 4 2 5 8
C3 7
HEURISTIC CROSSOVER
Subtour
NPTEL

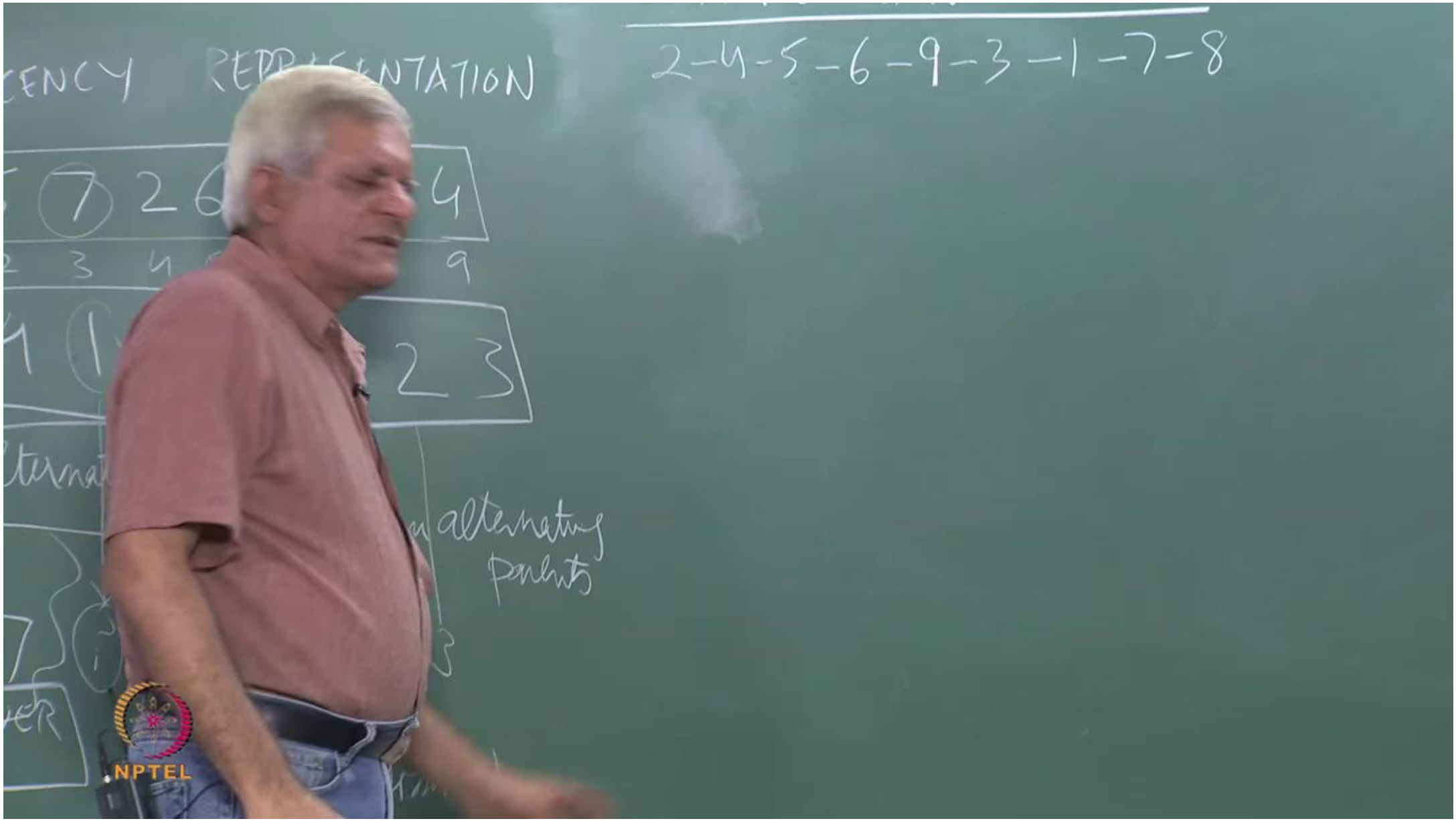

ADJACENCY REPRESENTATION
9 5 7 2 6 8 1 3 4
1 2 3 4 5 6 7 8 9
7 4 1 6 9 8 2 3
Crossover
- choose from alternating parents
CROSSOVER
NPTEL


P2
9 5 7 2 6 8 1 3 4
1 2 3 4 5 6 7 8 9
P1
7 4 1 5 6 9 8 2 3
Alternating
Crossover
- choose from alternating
parents
NPTEL


for TSP
ORDINAL REPRESENTATION
JACENCY REPRESENTATION
Alternating
Crossover
- choose from alternating parents
NPTEL

ORDINAL REPRESENTATION

2-4-5-6-9-3-1-7-8


2-4-5-6-9-3-1-7-8
alternating
points

Reference index

1 2 3 4 5 6 7 8 9

ORDINAL REPRESENTATION

2-4-5-6-9-3-1-7-8

Reference index

1 2 3 4 5 6 7 8 9

2

ORDINAL REPRESENTATION

2-4-5-6-9-3-1-7-8

233352111

Reference index

1 2 3 4 5 6 7 8 9

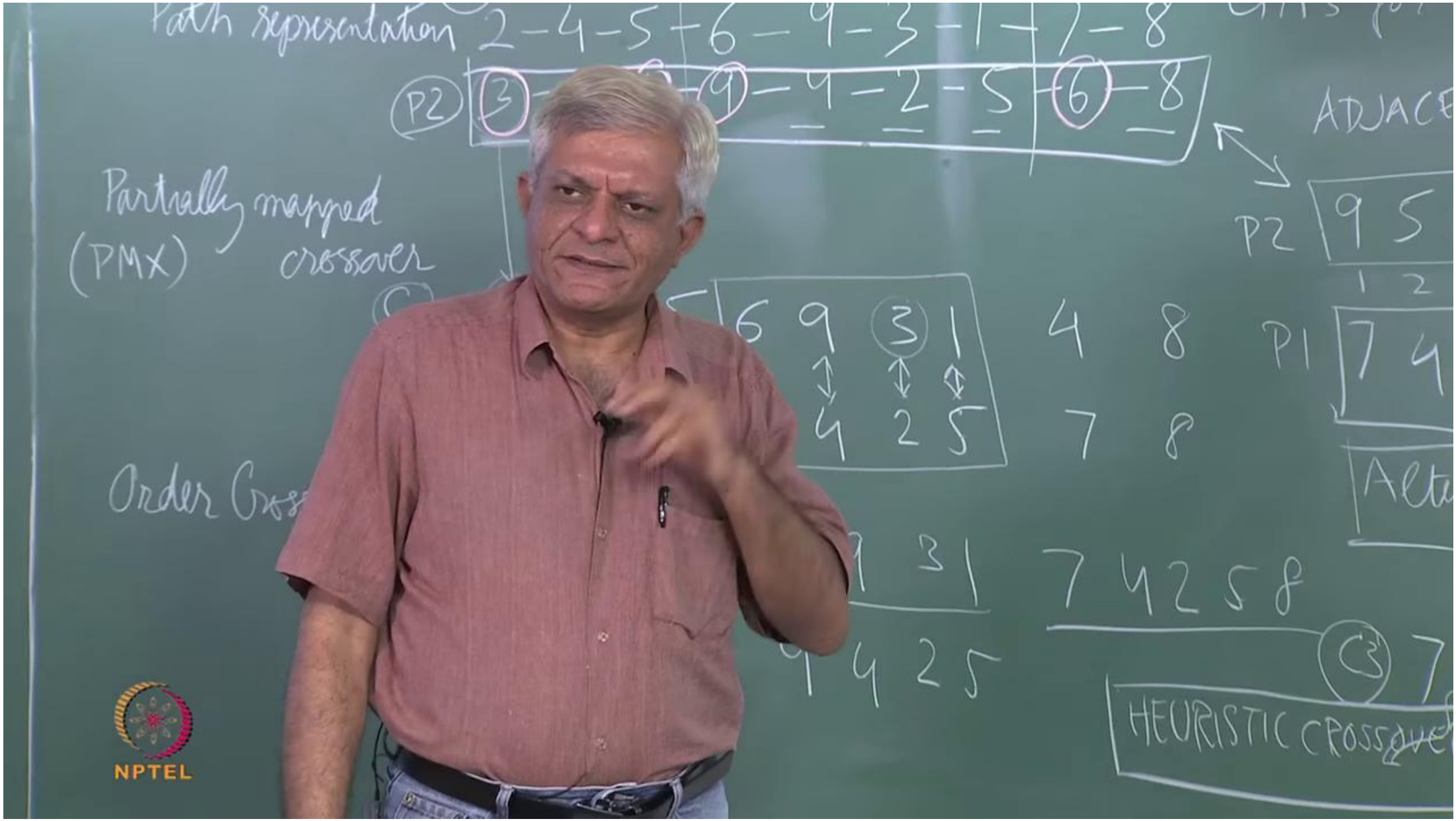
ORDINAL REPRESENTATION

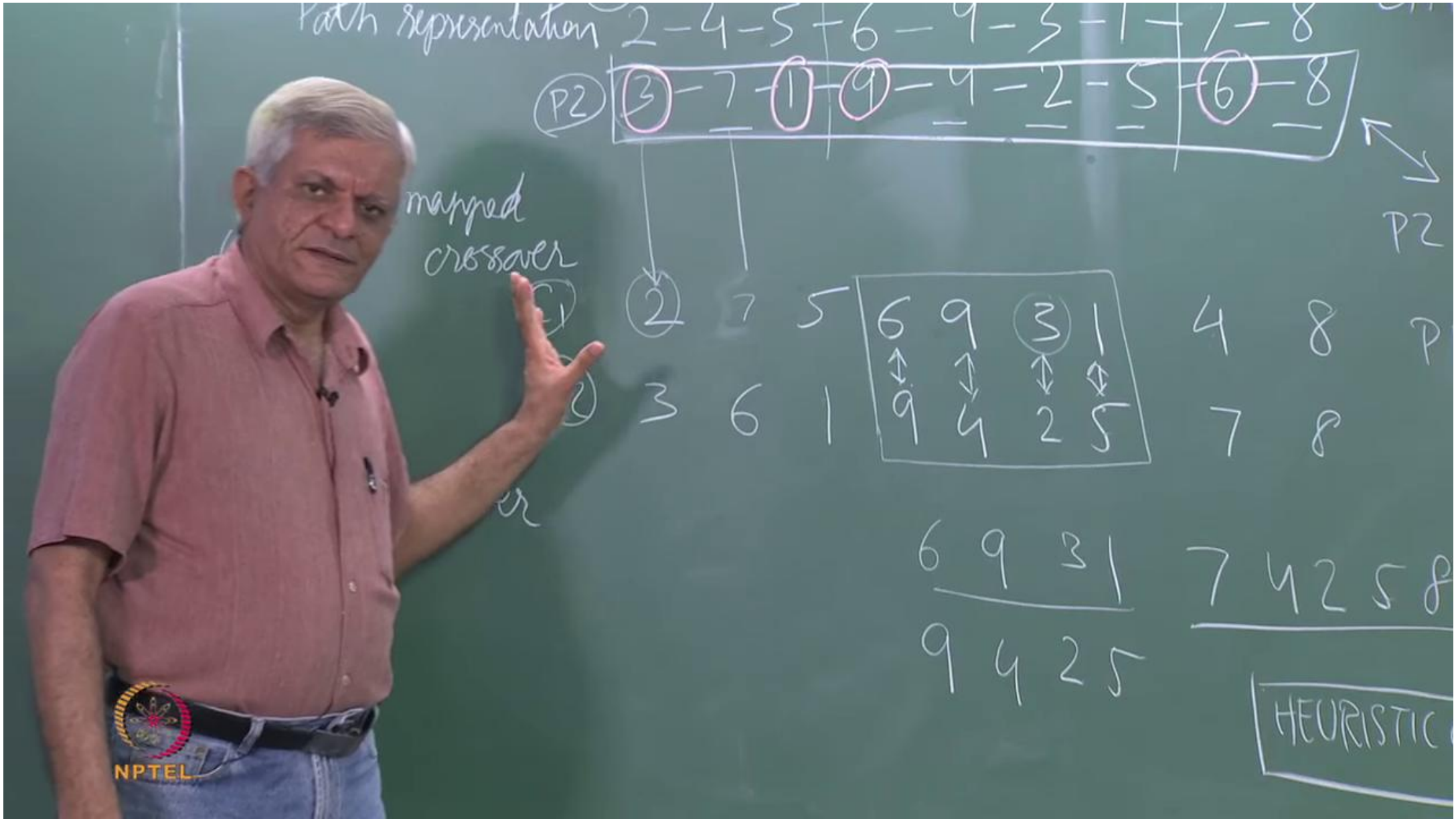
2-4-5-6-9-3-1-7-8

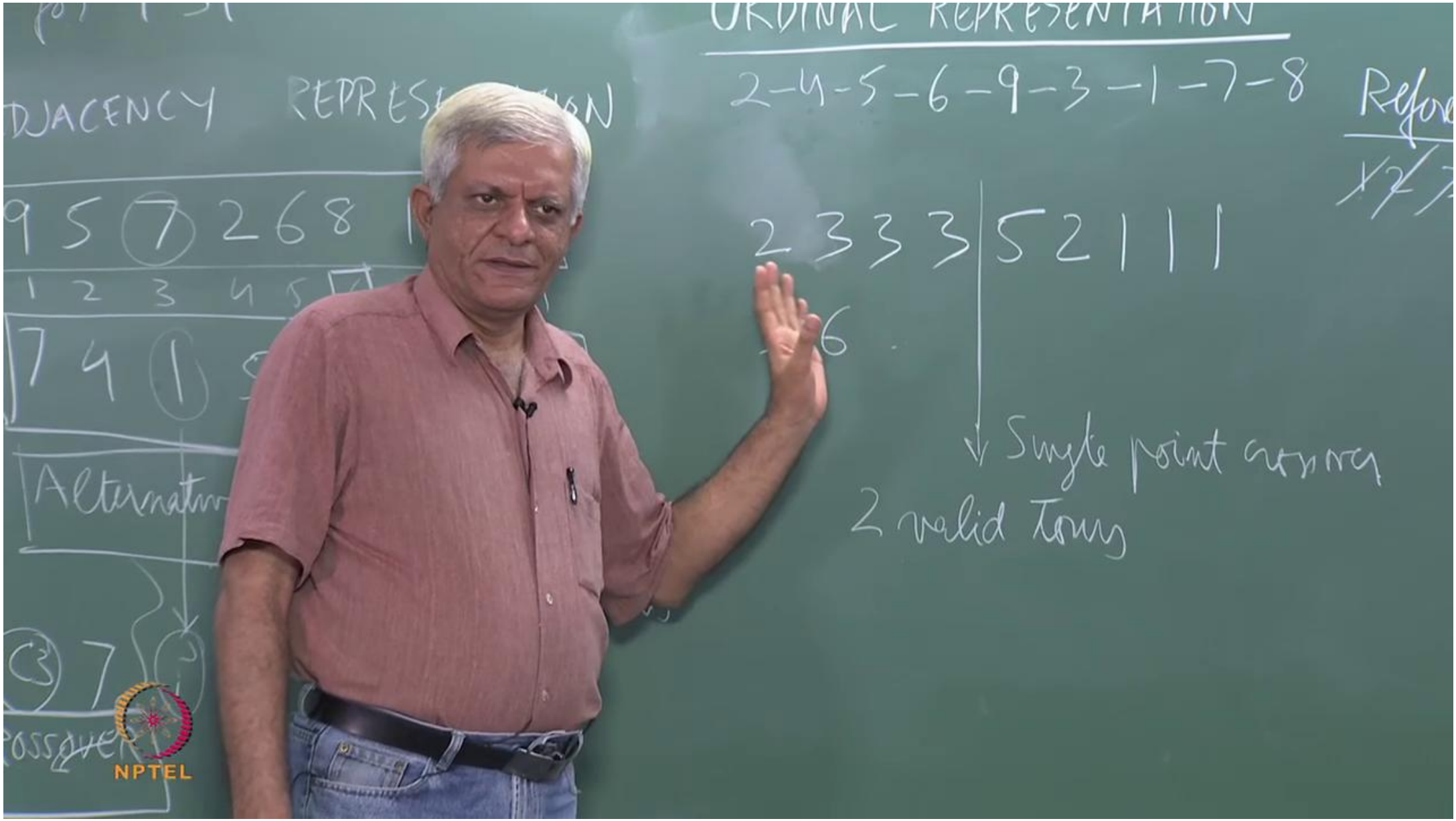
23335211

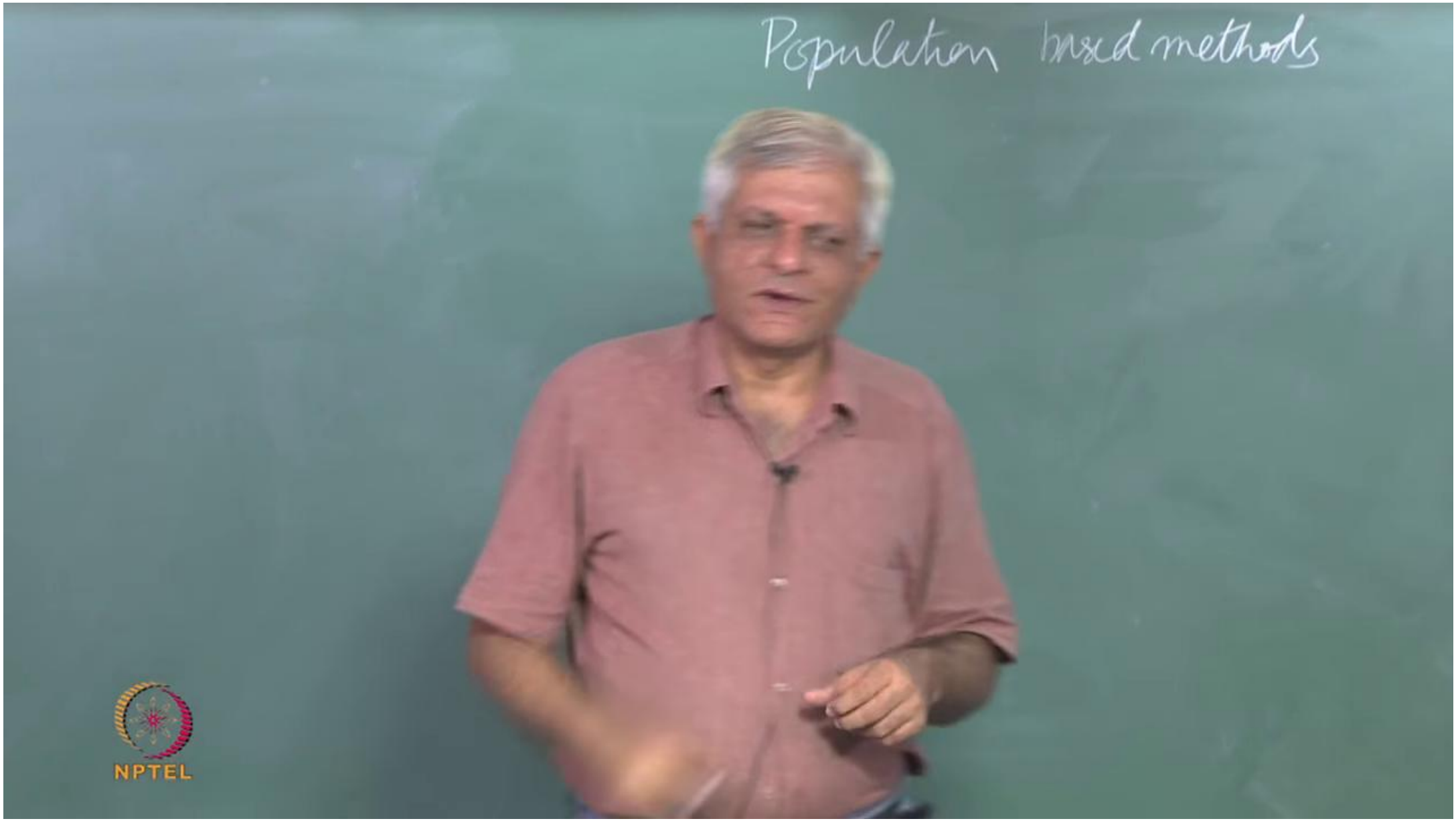
Reference index

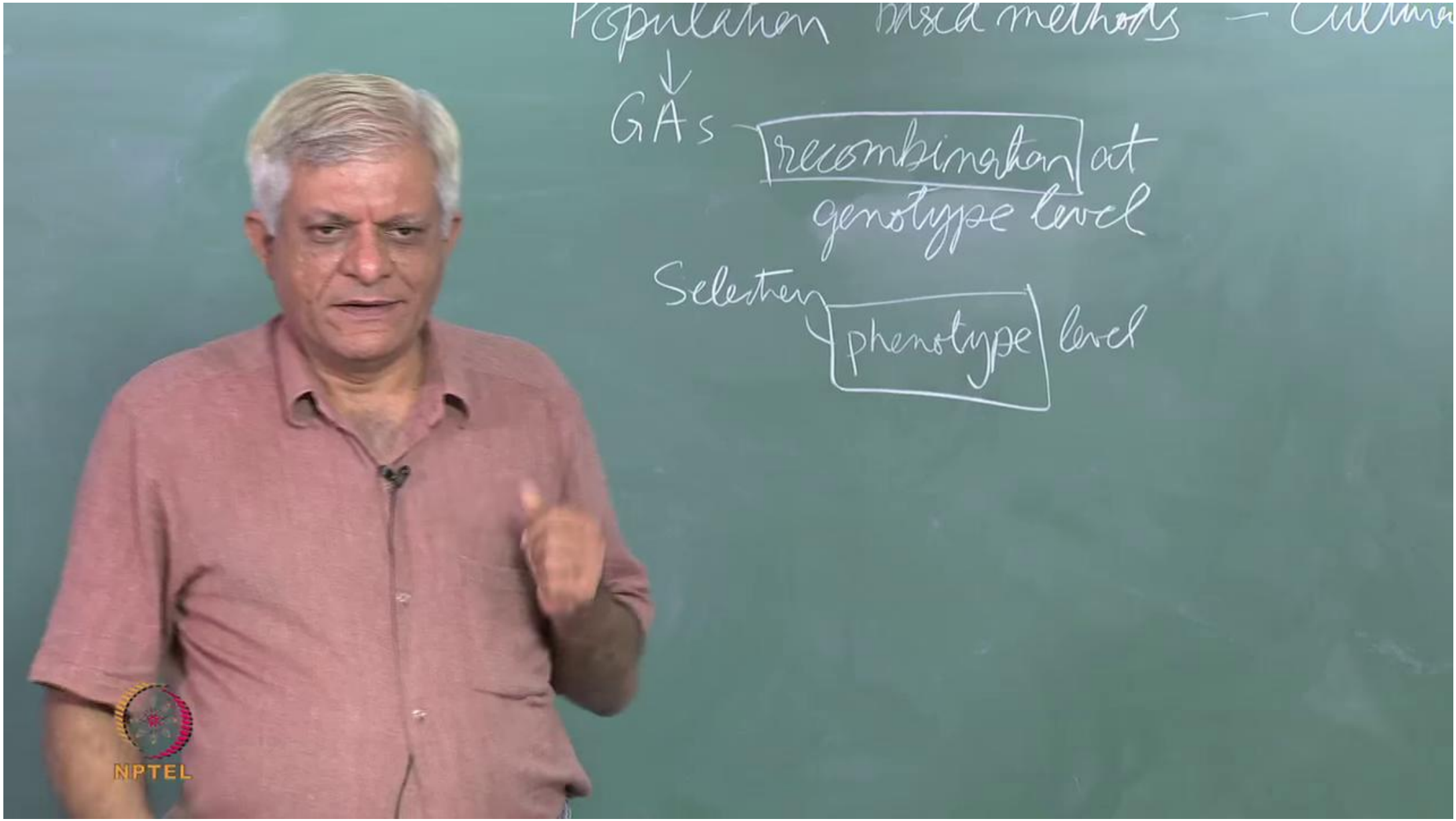
1 2 3 4 5 6 7 8 9

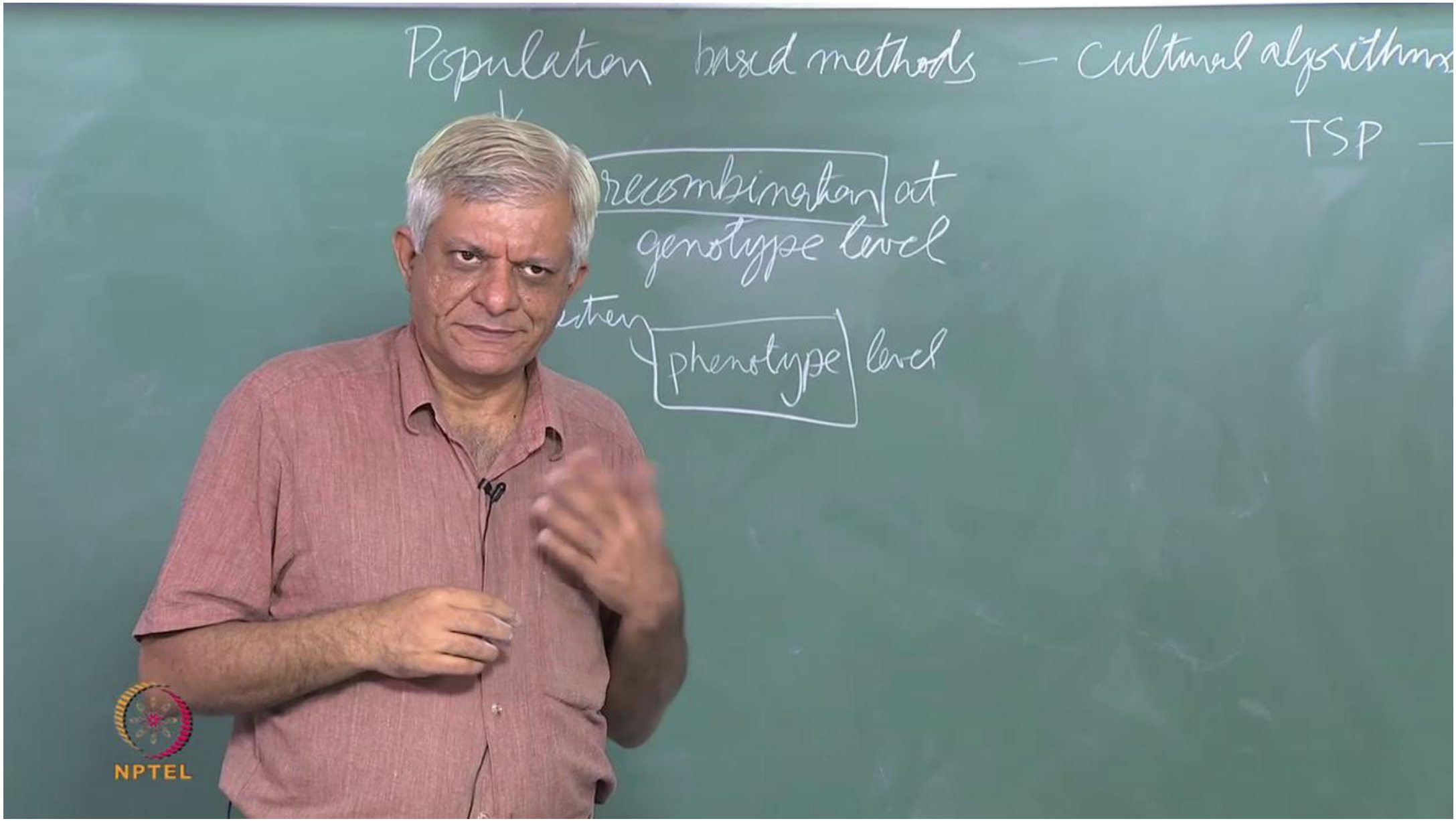

Path representation
2-4-5-6-9-3-1-7-8
P2
Partially mapped
(PMX)
crossover
Order Cross
ADJACE
P2
P1
HEURISTIC CROSSOVE
NPTEL


Path representation
2-4-5-6-9-3-1-7-8
P2
3-7-0-9-4-2-5-6-8
mapped
crossover
P2
2 7 5
3 6 1
6 9 3 1
9 4 2 5
4 8
7 8
6 9 3 1
9 4 2 5
7 4 2 5 8
HEURISTIC
NPTEL


ORDINAL REPRESENTATION
2-4-5-6-9-3-1-7-8
2333|52111
Single point crossover
2 valid Tours
NPTEL


Population based methods
NPTEL


Population based methods
GAs
recombination at genotype level
Selection
phenotype level
NPTEL


Population based methods – Cultural algorithms
TSP
recombination at
genotype level
phenotype level
NPTEL

- Cultural algorithms → Swarm intelligence

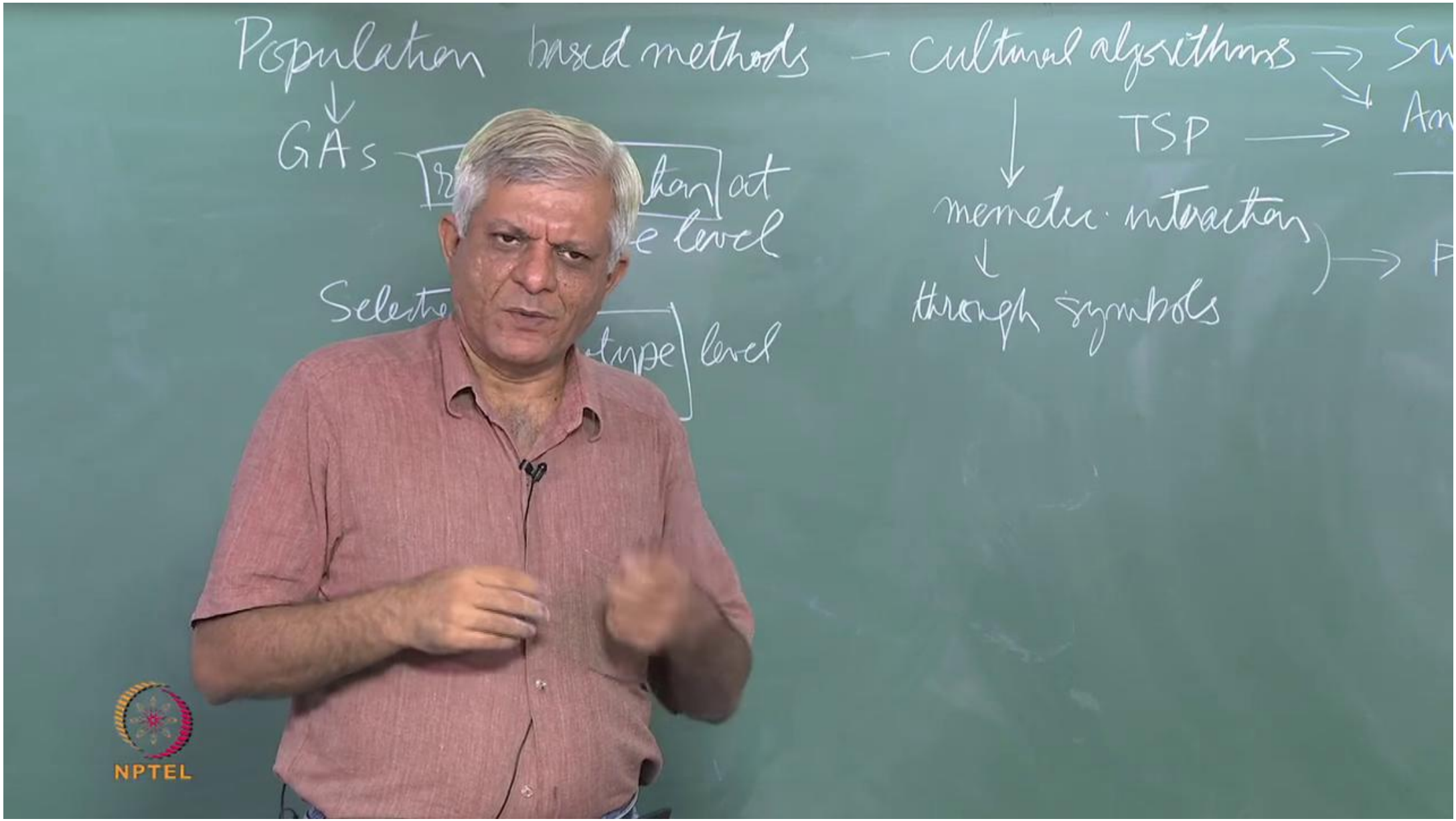
TSP → Ant Colony Optimization

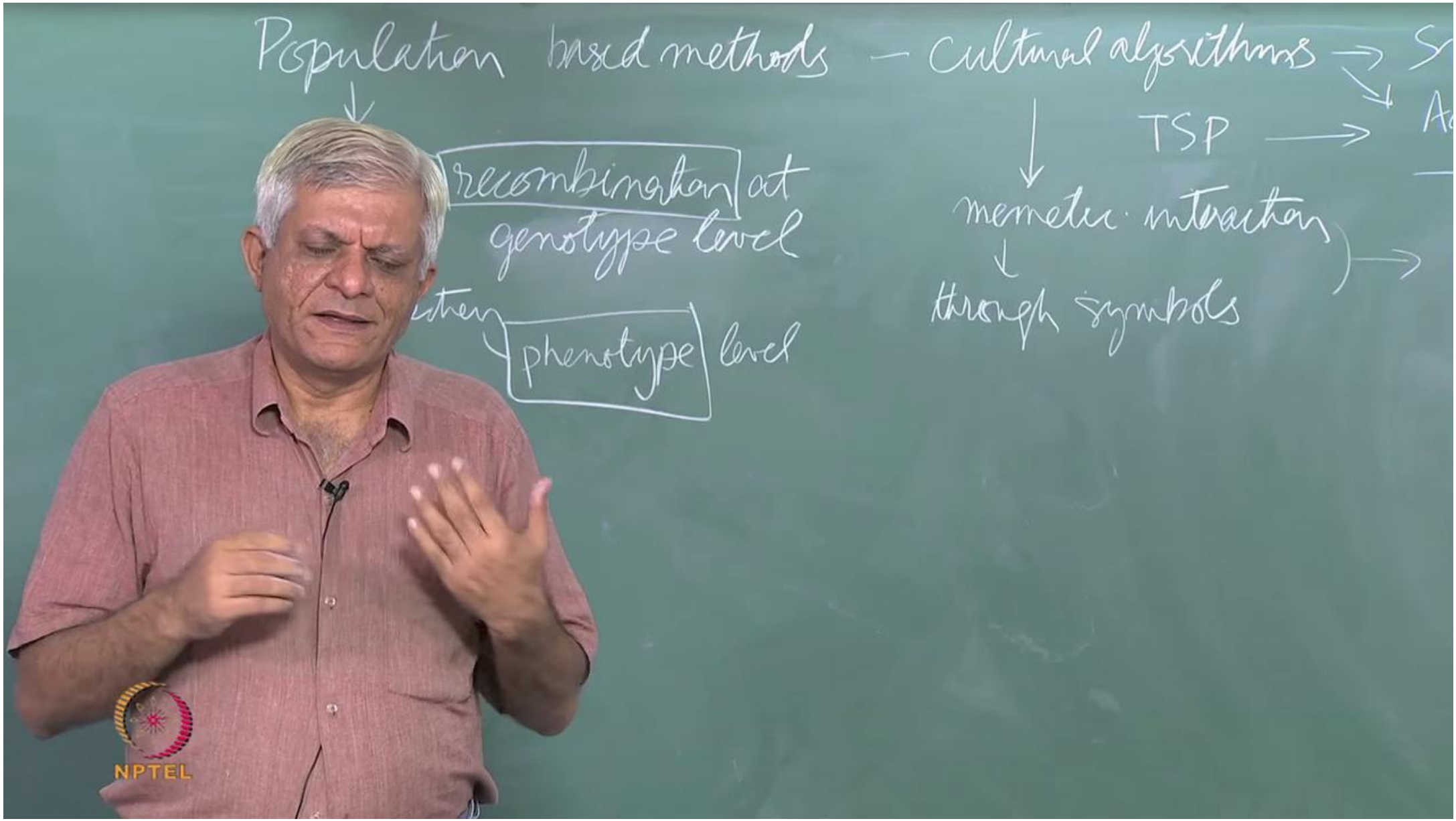
↓

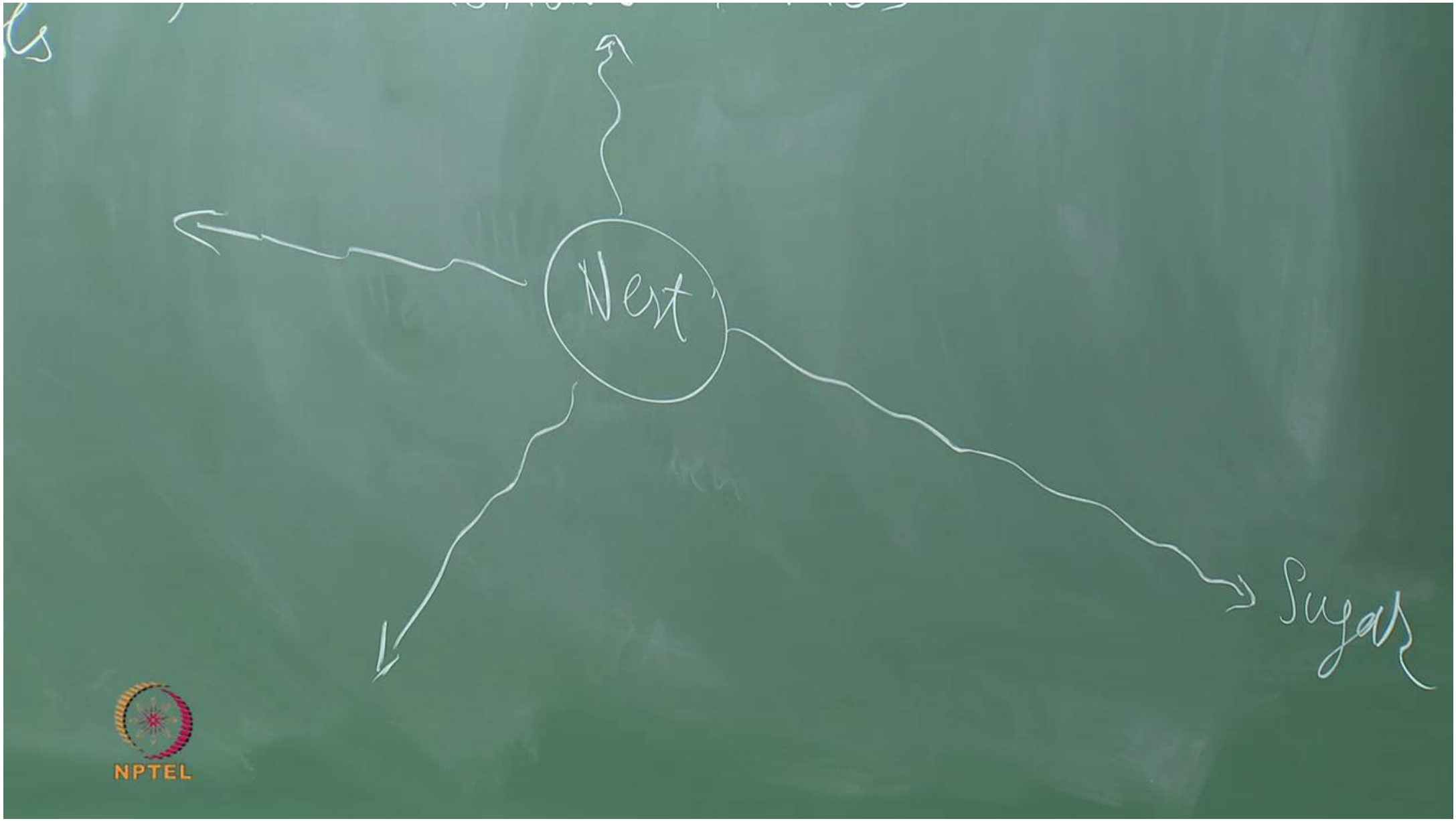
memetic interaction

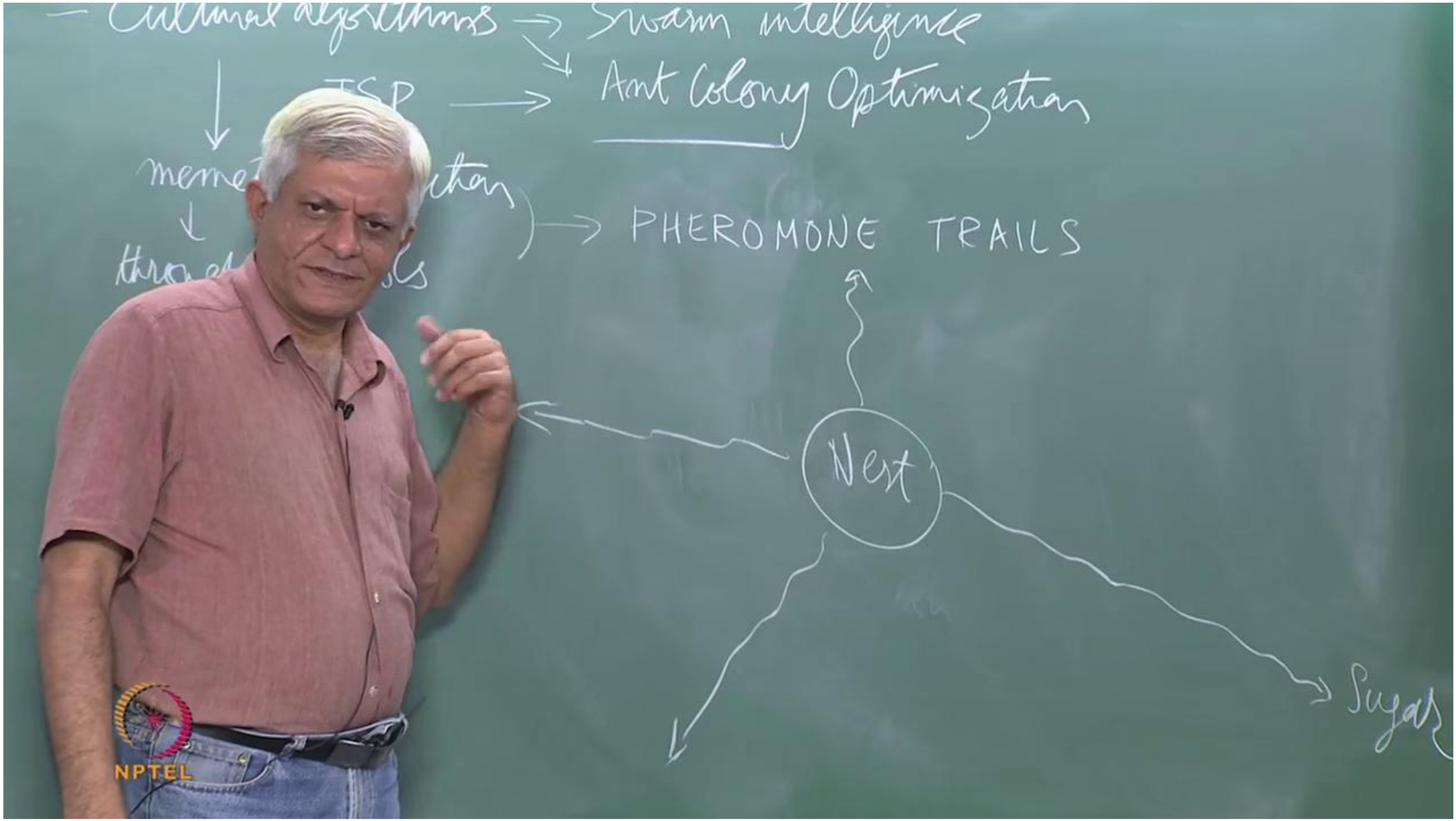
↓

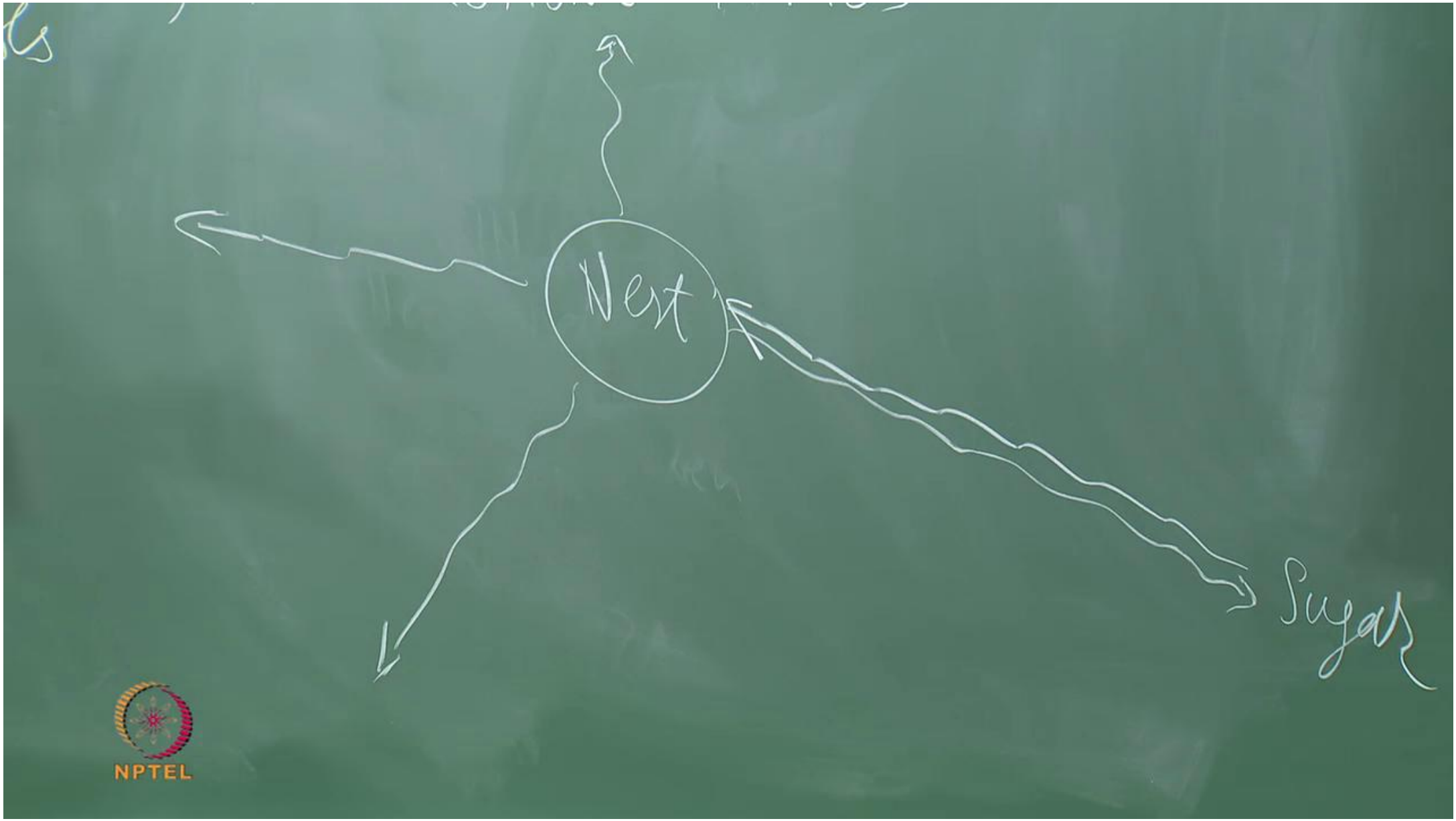
through symbols

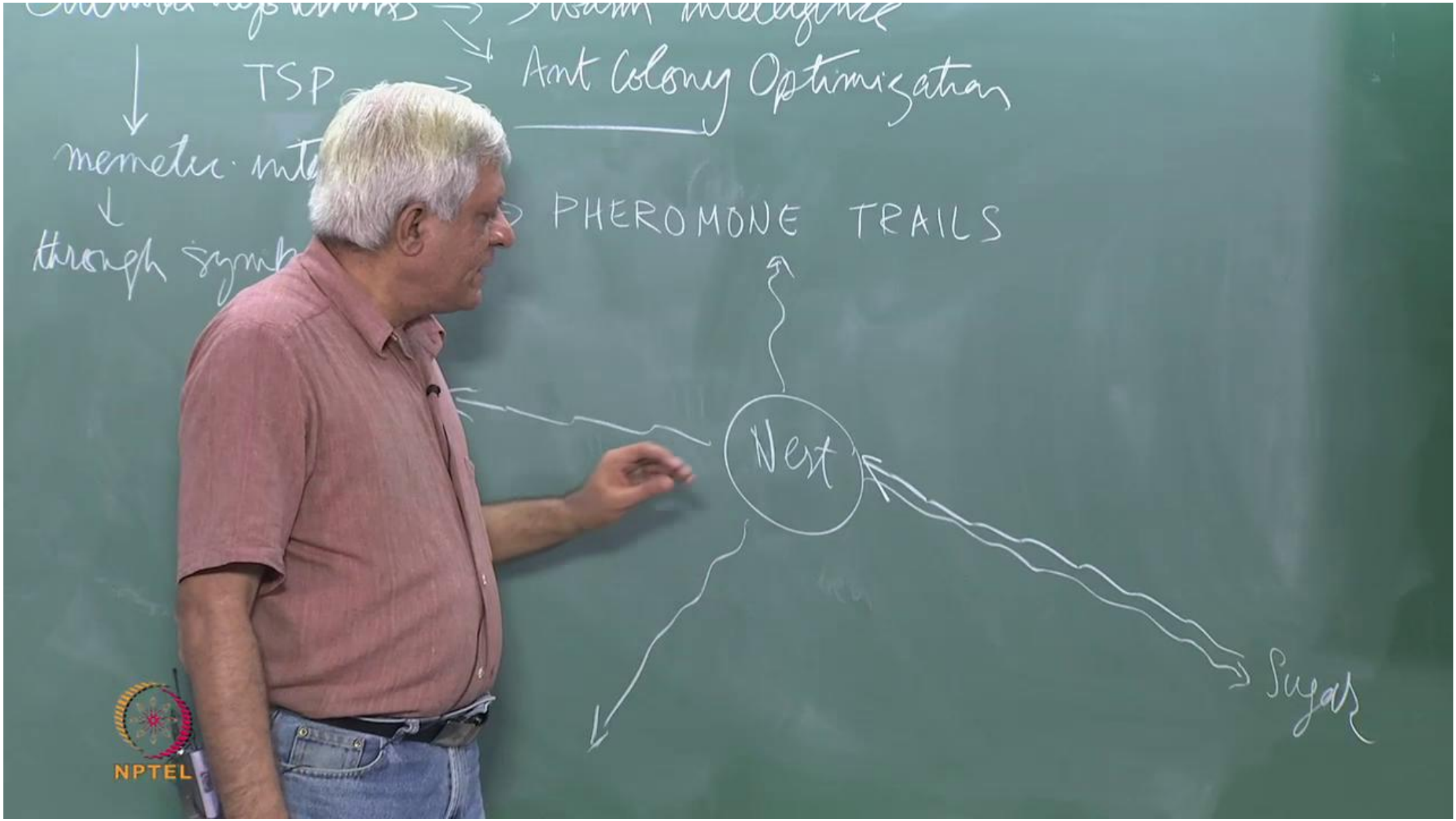

Population based methods
GAs
Selecto
level
Cultural algorithms
TSP
memetic interaction
through symbols
NPTEL

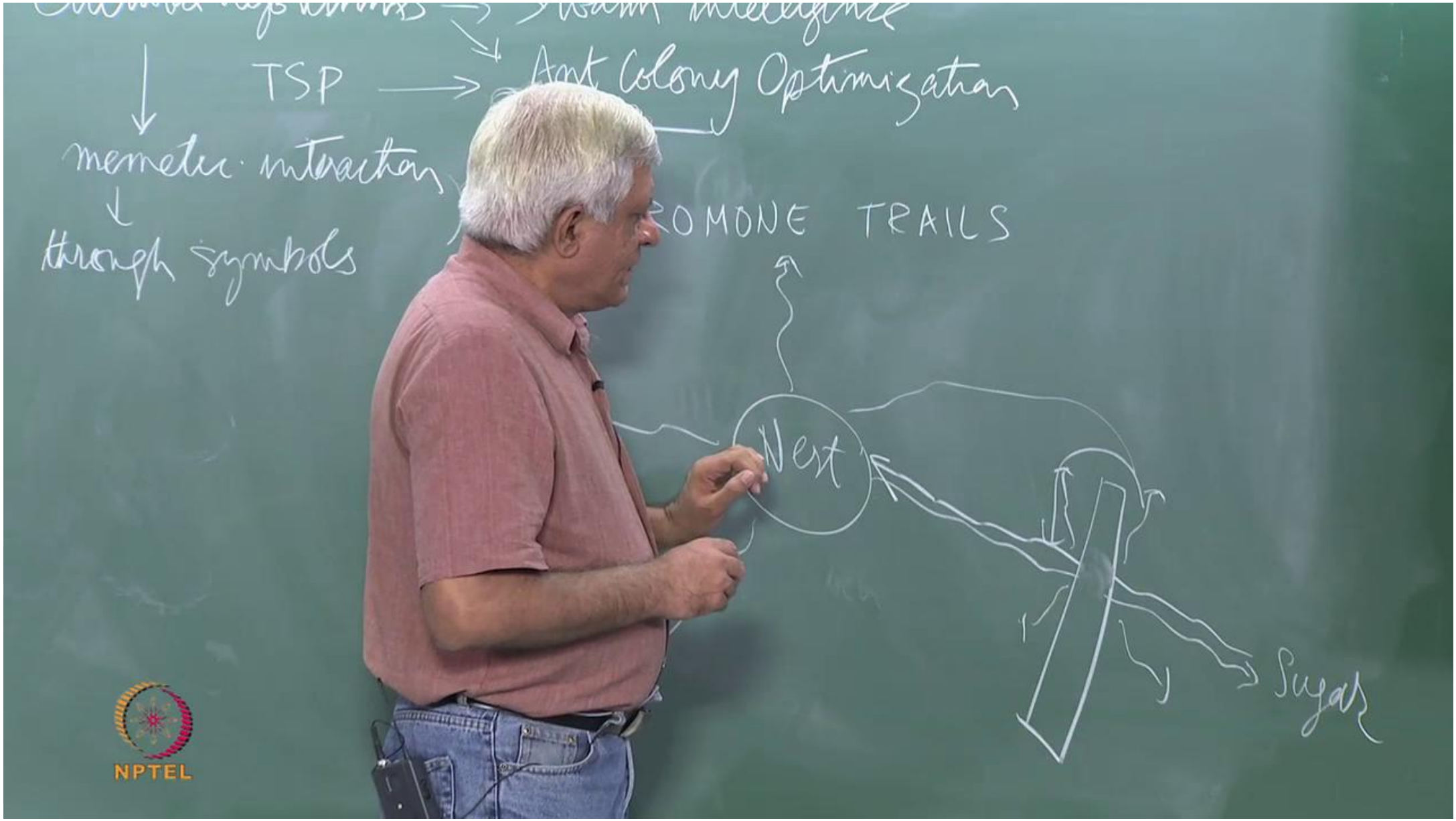

Population based methods
recombination at
genotype level
phenotype level
Cultural algorithms
TSP
memetic interaction
through symbols
NPTEL

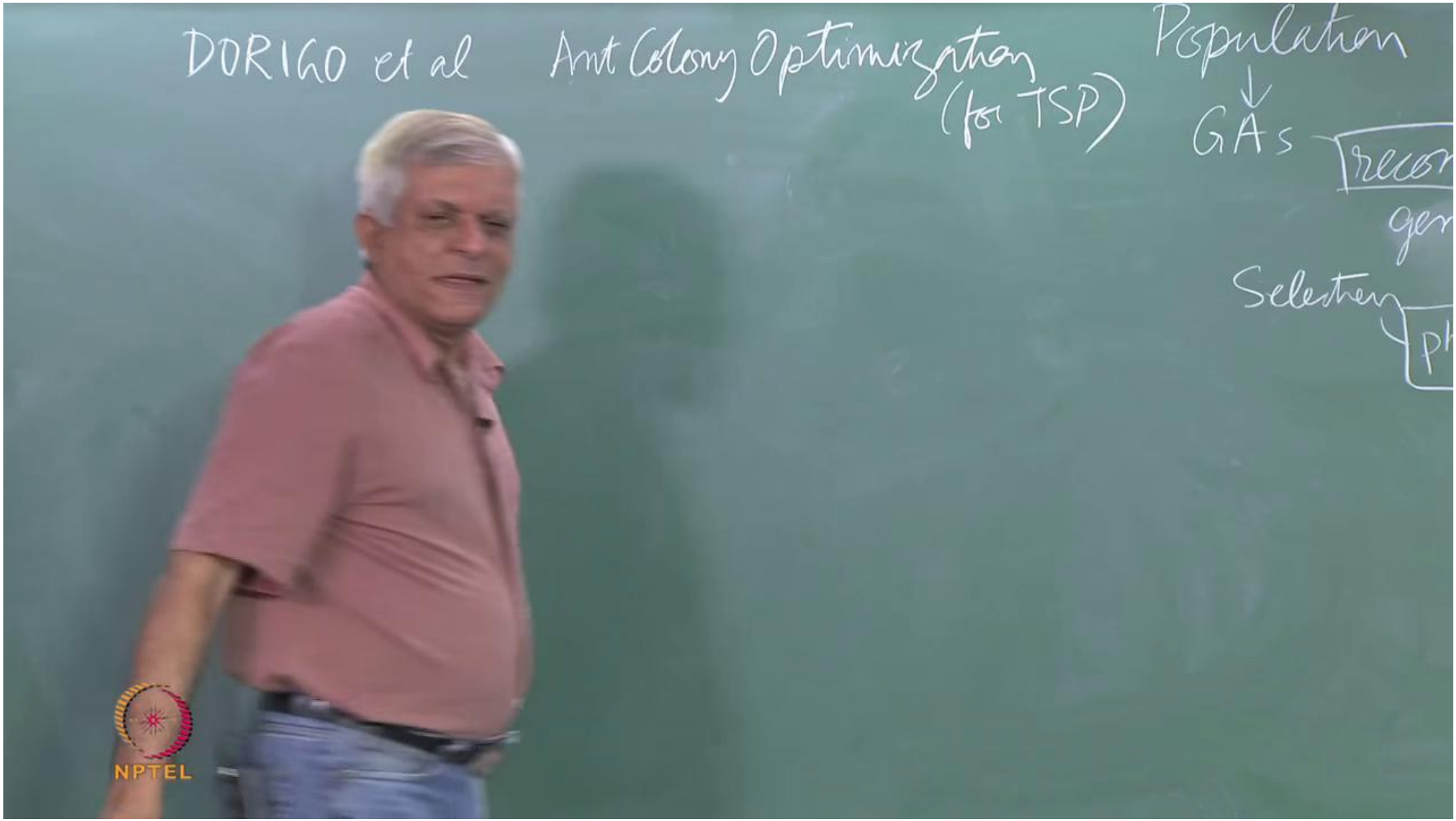

Nex
Sugars

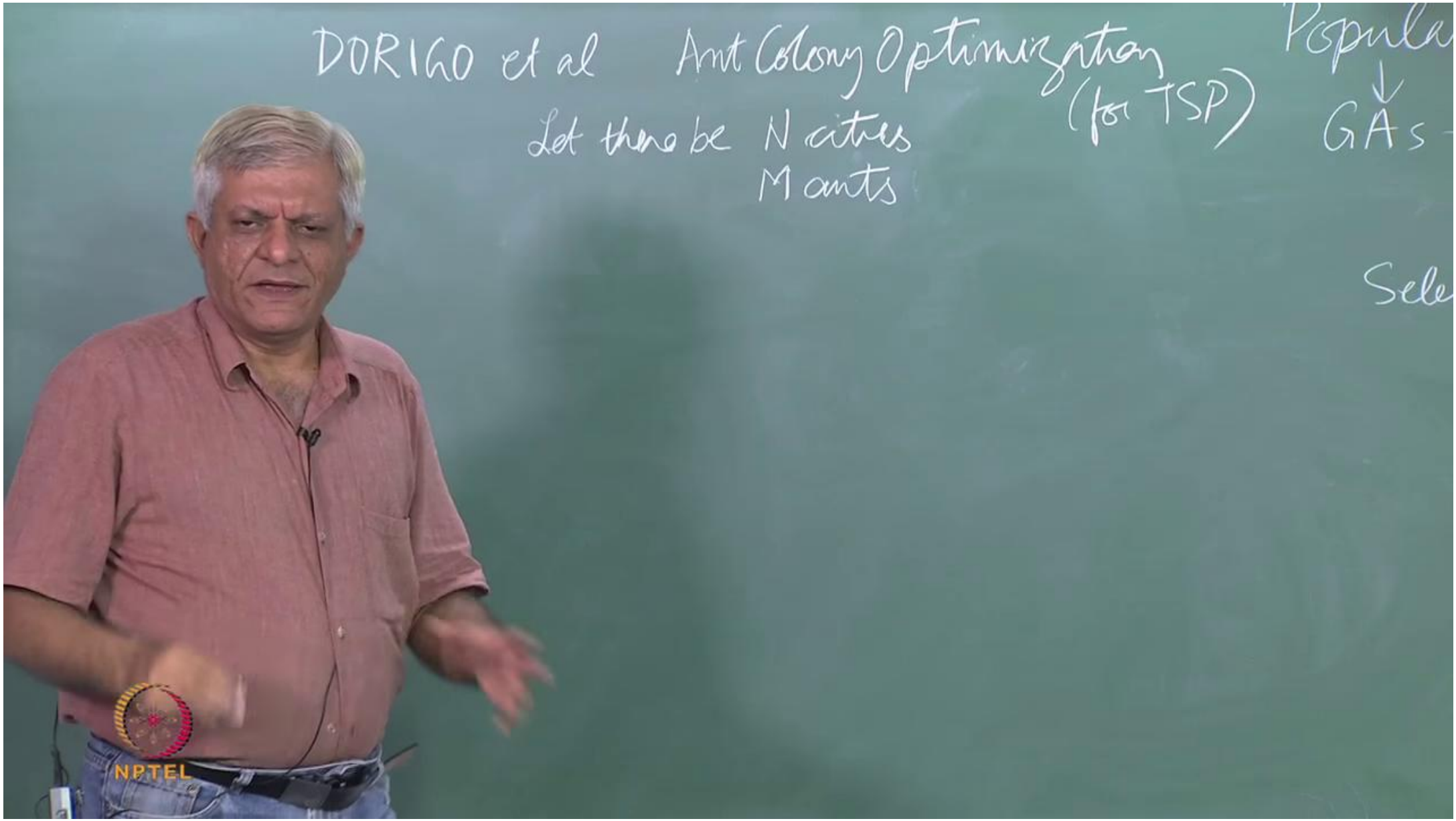

Swarm intelligence
Ant Colony Optimisation
PHEROMONE TRAILS
Nest
Sugar

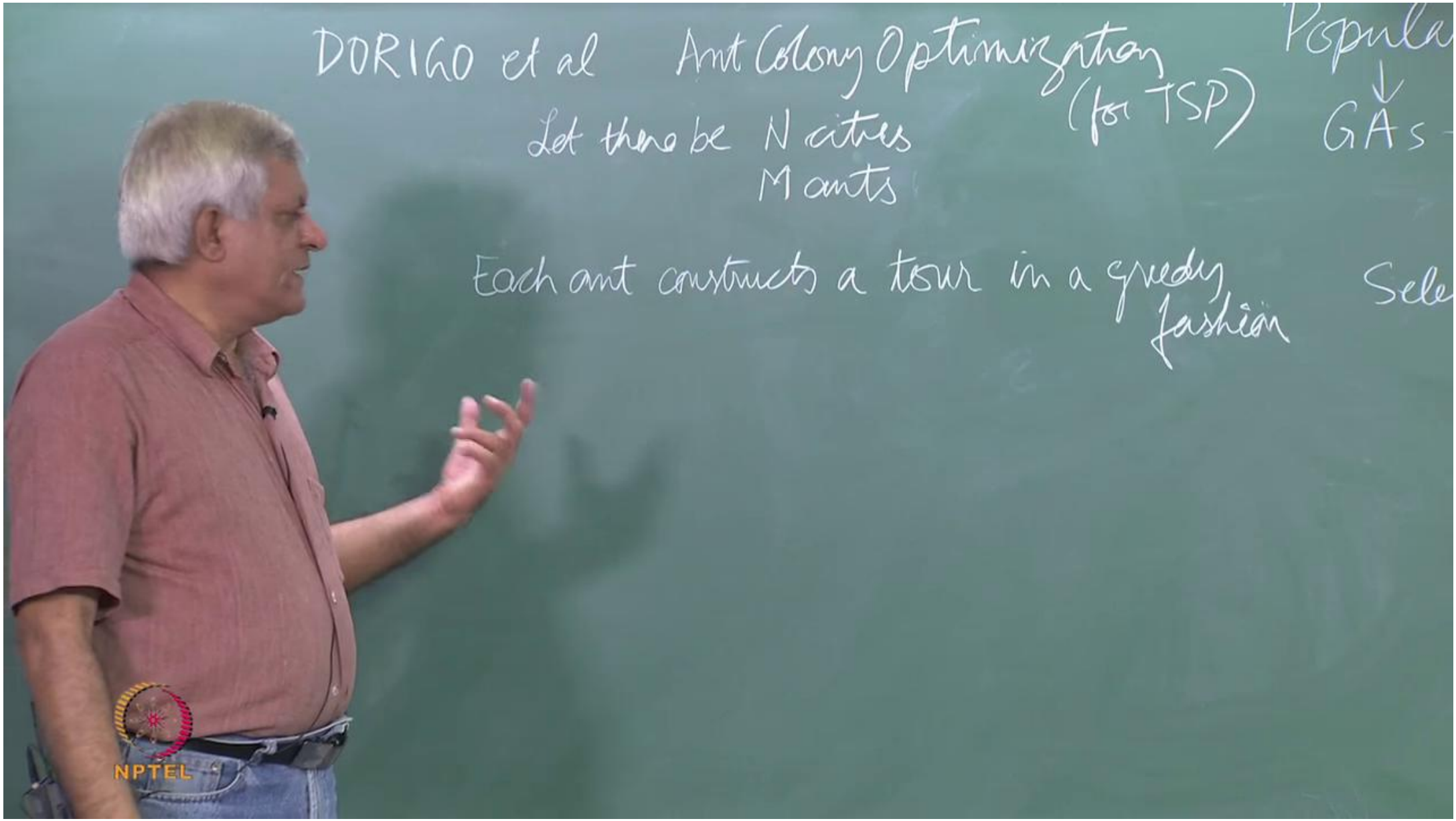

Nest
Sugars


TSP
Ant Colony Optimisation
PHEROMONE TRAILS
Nest
Sugar
NPTEL


TSP
Ant Colony Optimization
memetic interaction
through symbols
ROMONE TRAILS
Nest
Sugar
NPTEL


DORIGO et al
Ant Colony Optimization
(for TSP)
Population
GAs
Selection


DORIGO et al
Ant Colony Optimization
(for TSP)
Let there be N cities
M ants
Popula
GAs
Sele
NPTEL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Each ant constructs a tour in a greedy fashion
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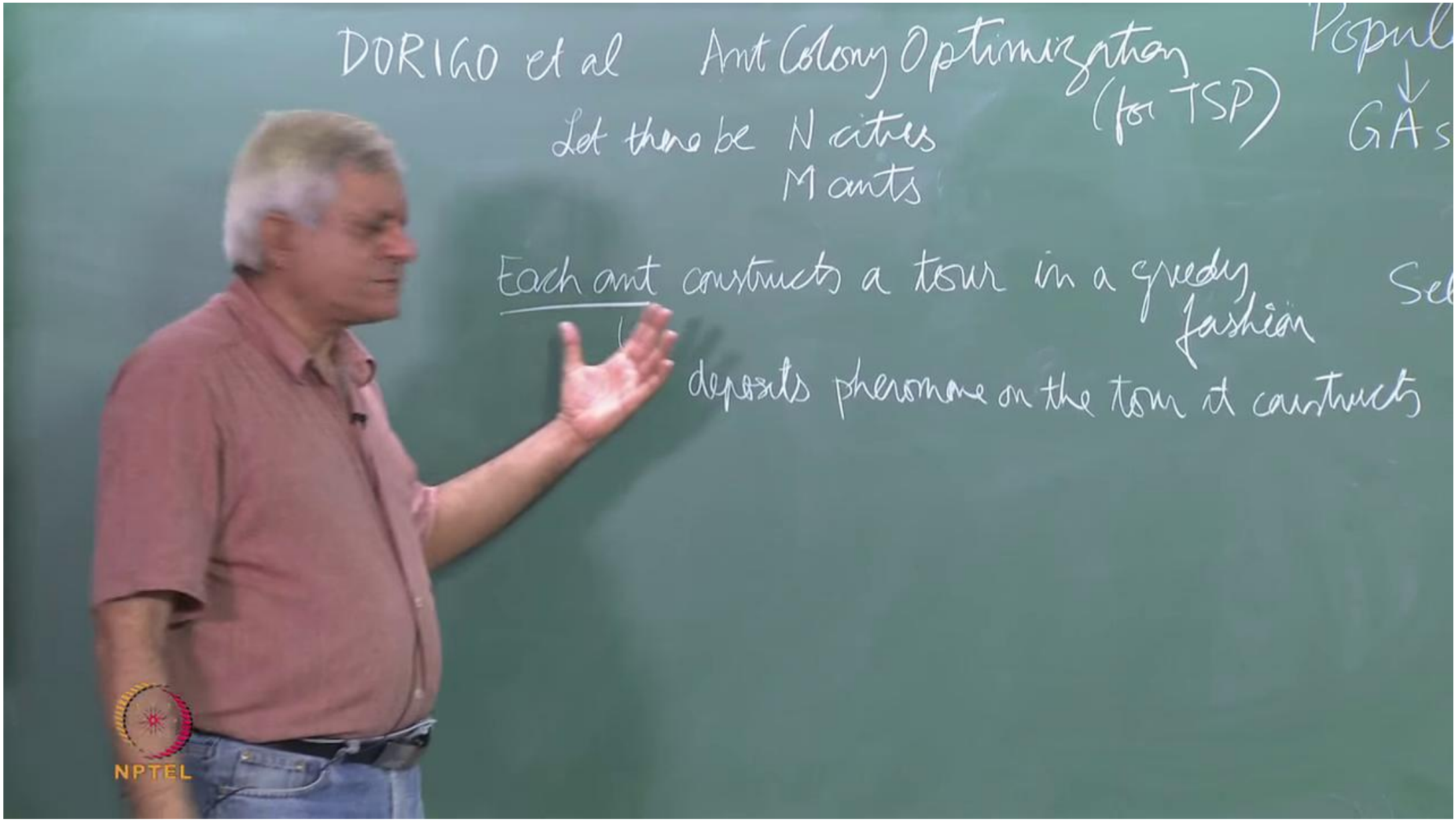
DORIGO et al Ant Colony Optimization (for TSP)
Popul
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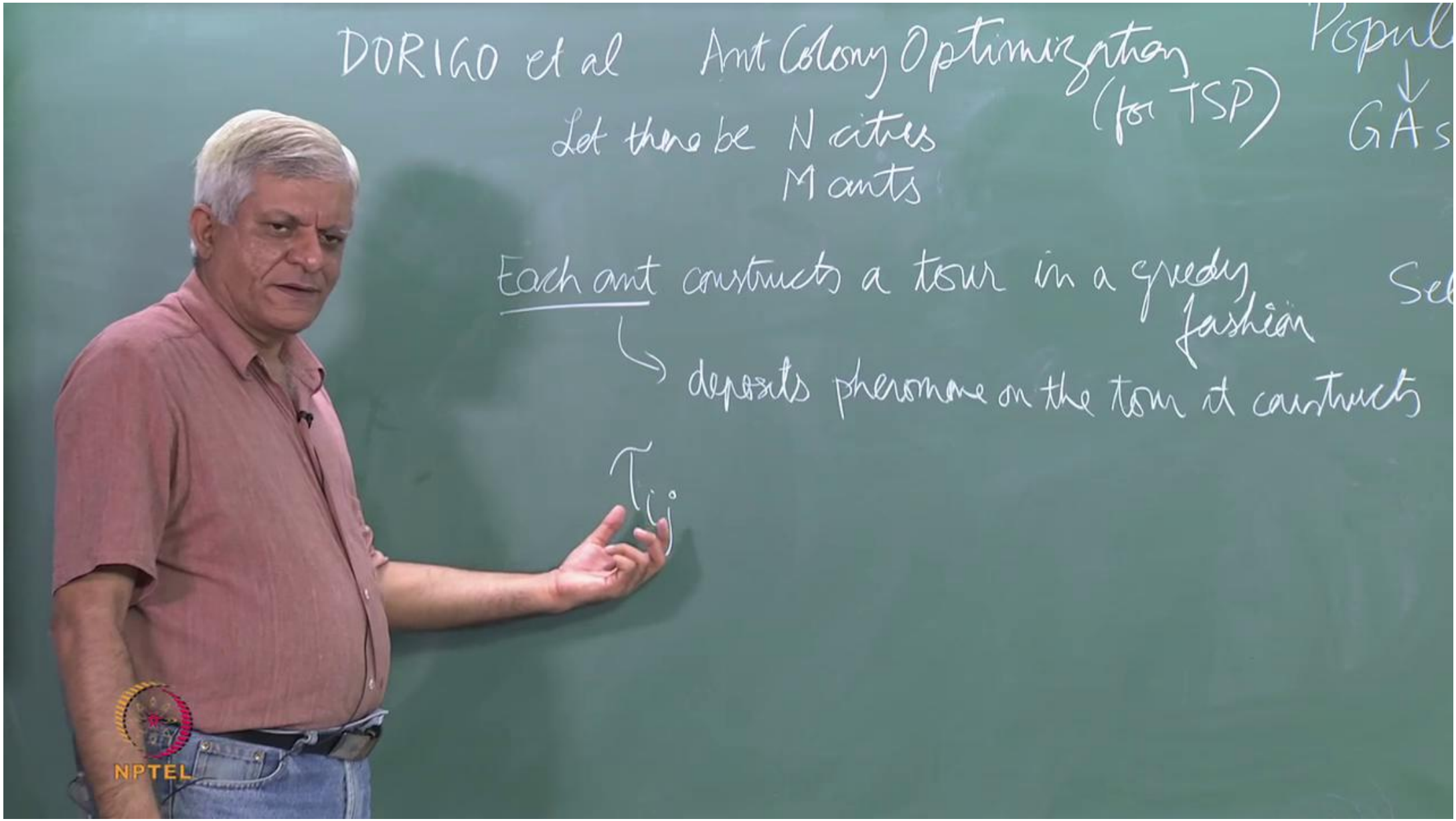
Each ant constructs a tour in a greedy fashion
Sel
deposits pheromone on the tour it constructs
NPTEL


DORIGO et al
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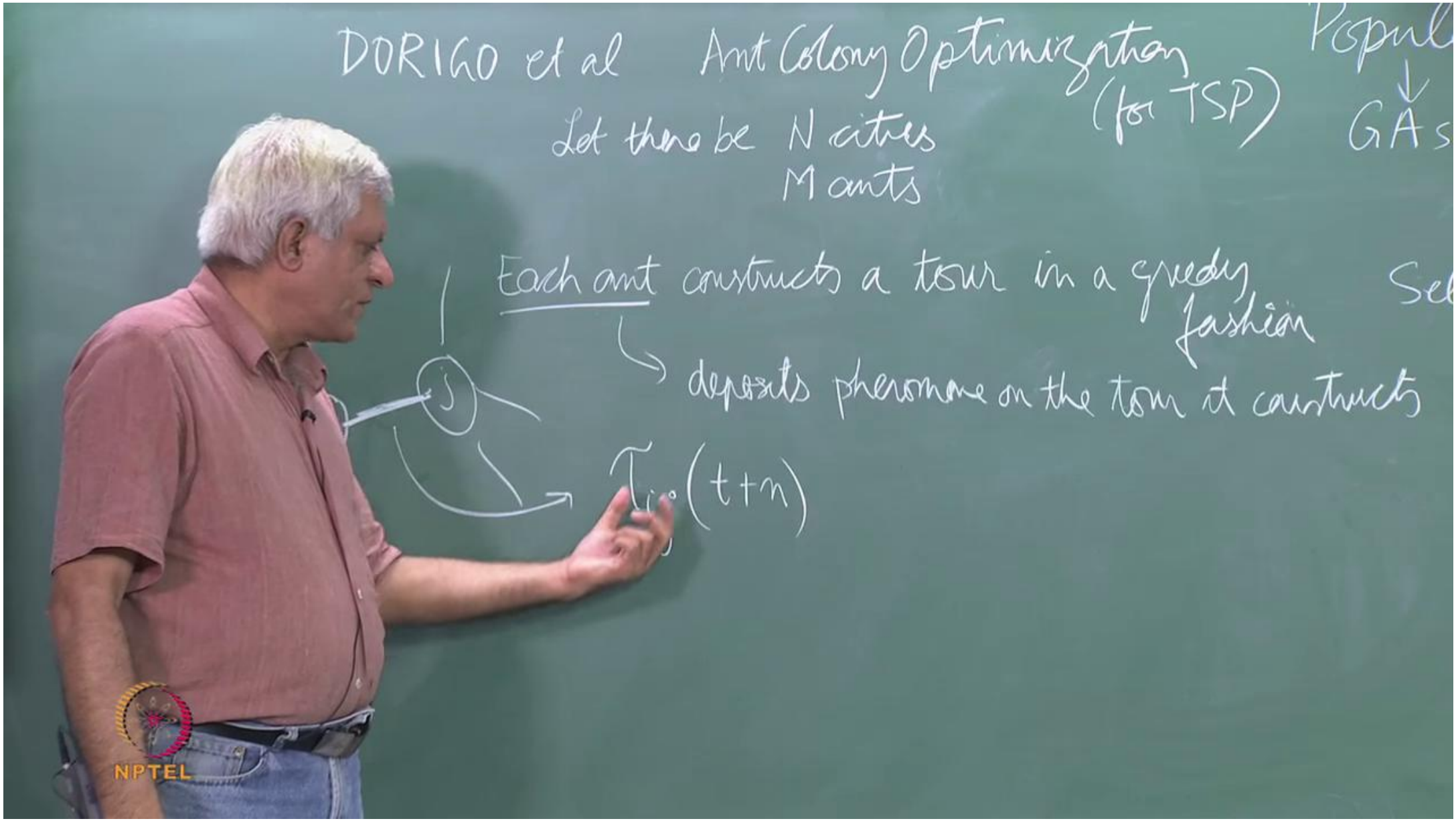
deposits pheromone on the tour it constructs
τ_{ij}
NPTEL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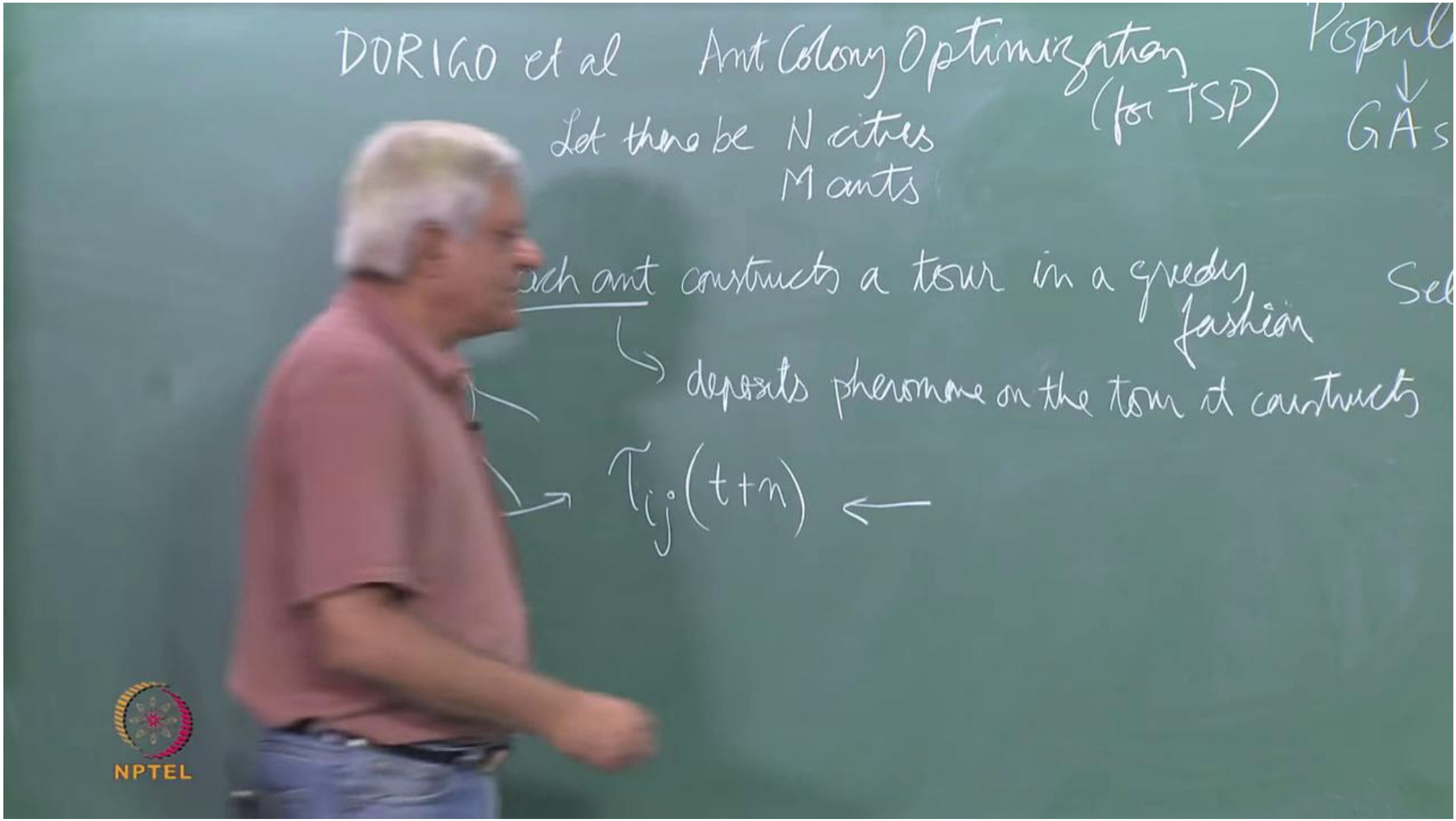
deposits pheromone on the tour it constructs
$\tau_{ij}(t+n)$
NPTEL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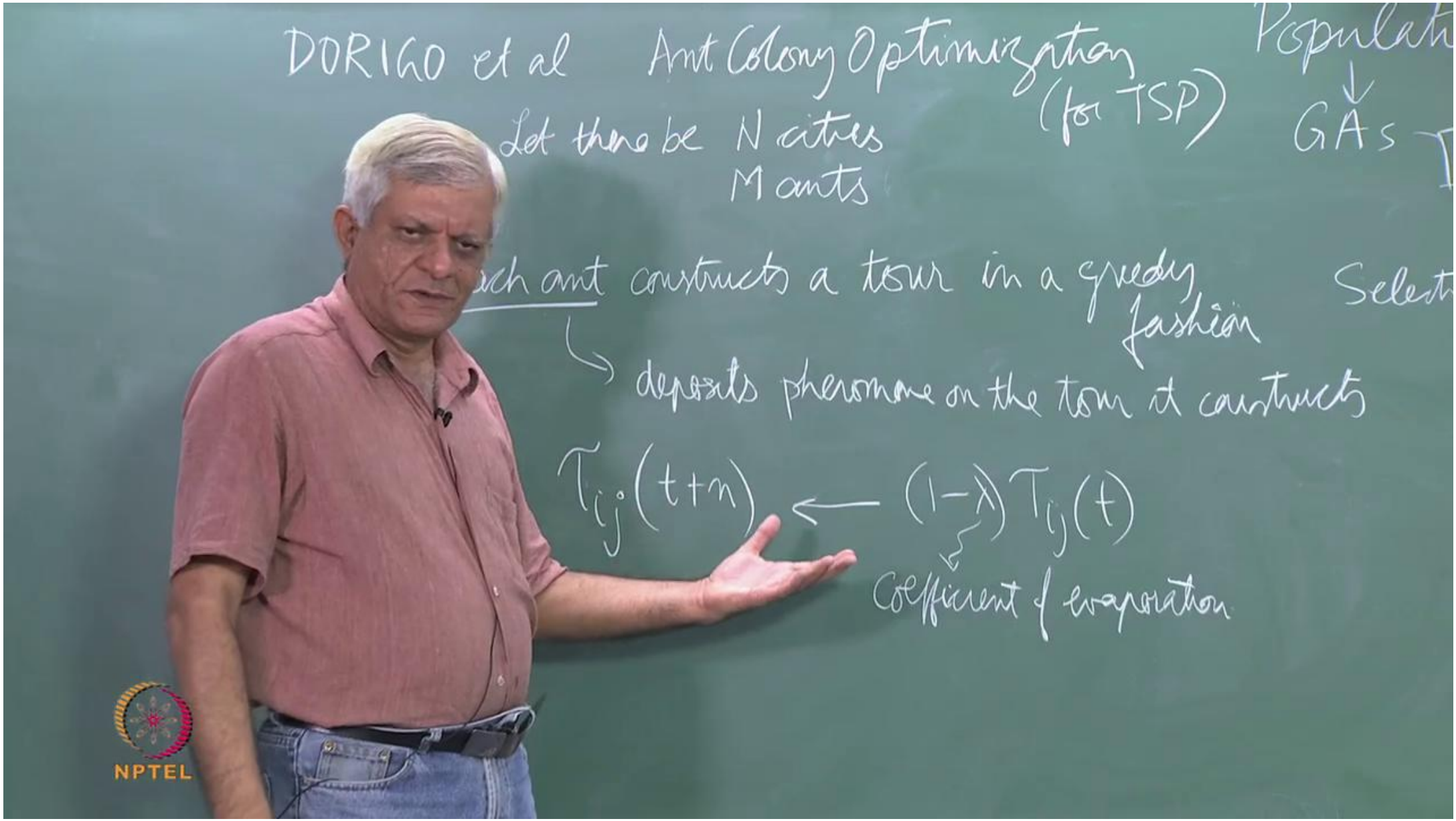
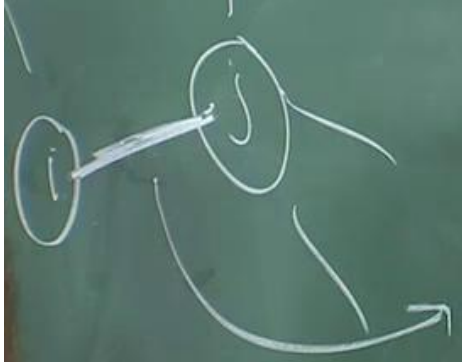

DORIGO et al
Ant Colony Optimization
(for TSP)
Let there be N cities
M ants
each ant constructs a tour in a greedy fashion
deposits pheromone on the tour it constructs
$\tau_{ij}(t+n) \leftarrow (1-\lambda)\,\tau_{ij}(t)$
Coefficient of evaporation
Populati
GAs
Selecti

Each ant constructs a tour in a greedy fashion

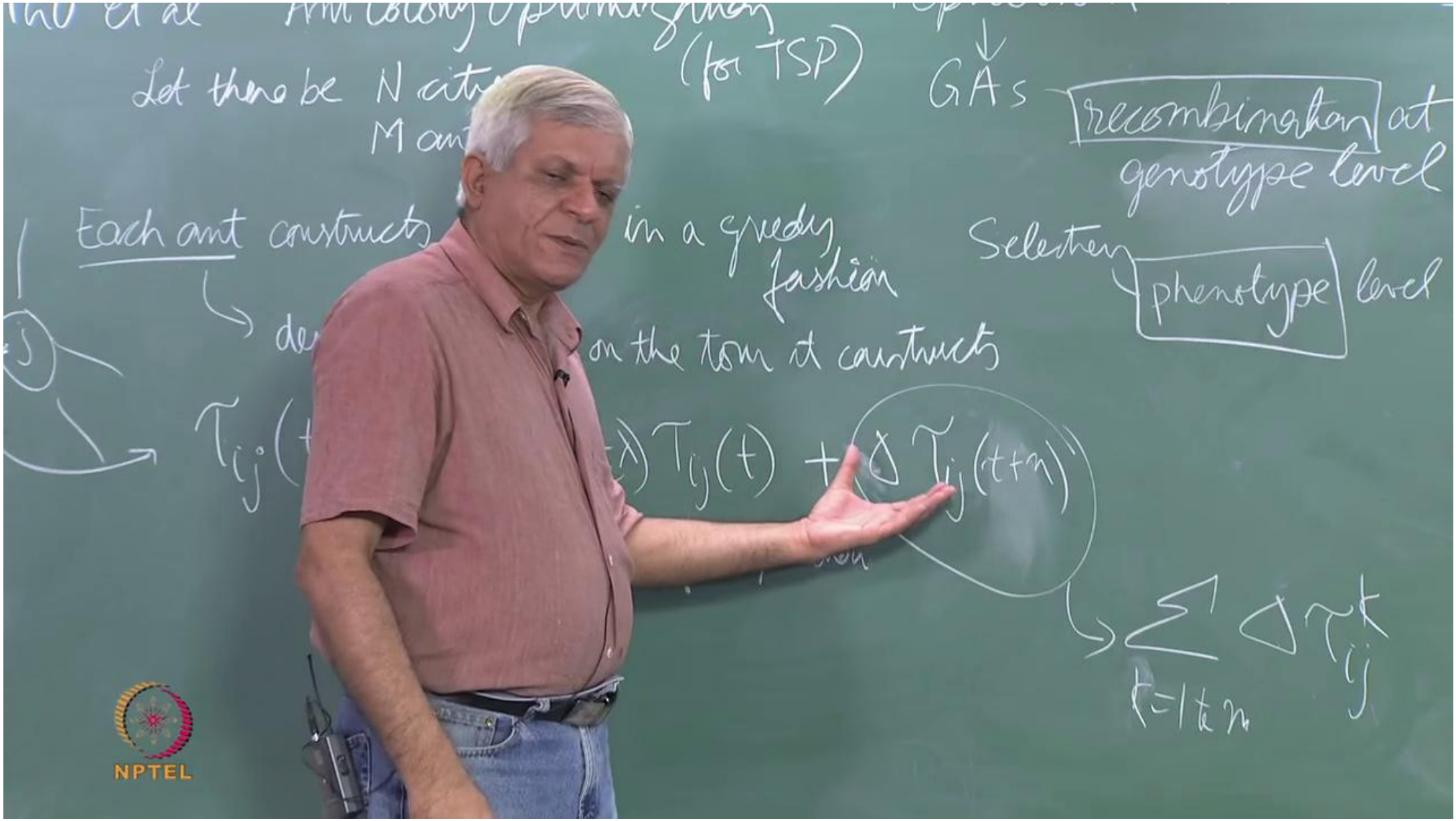
Selecti

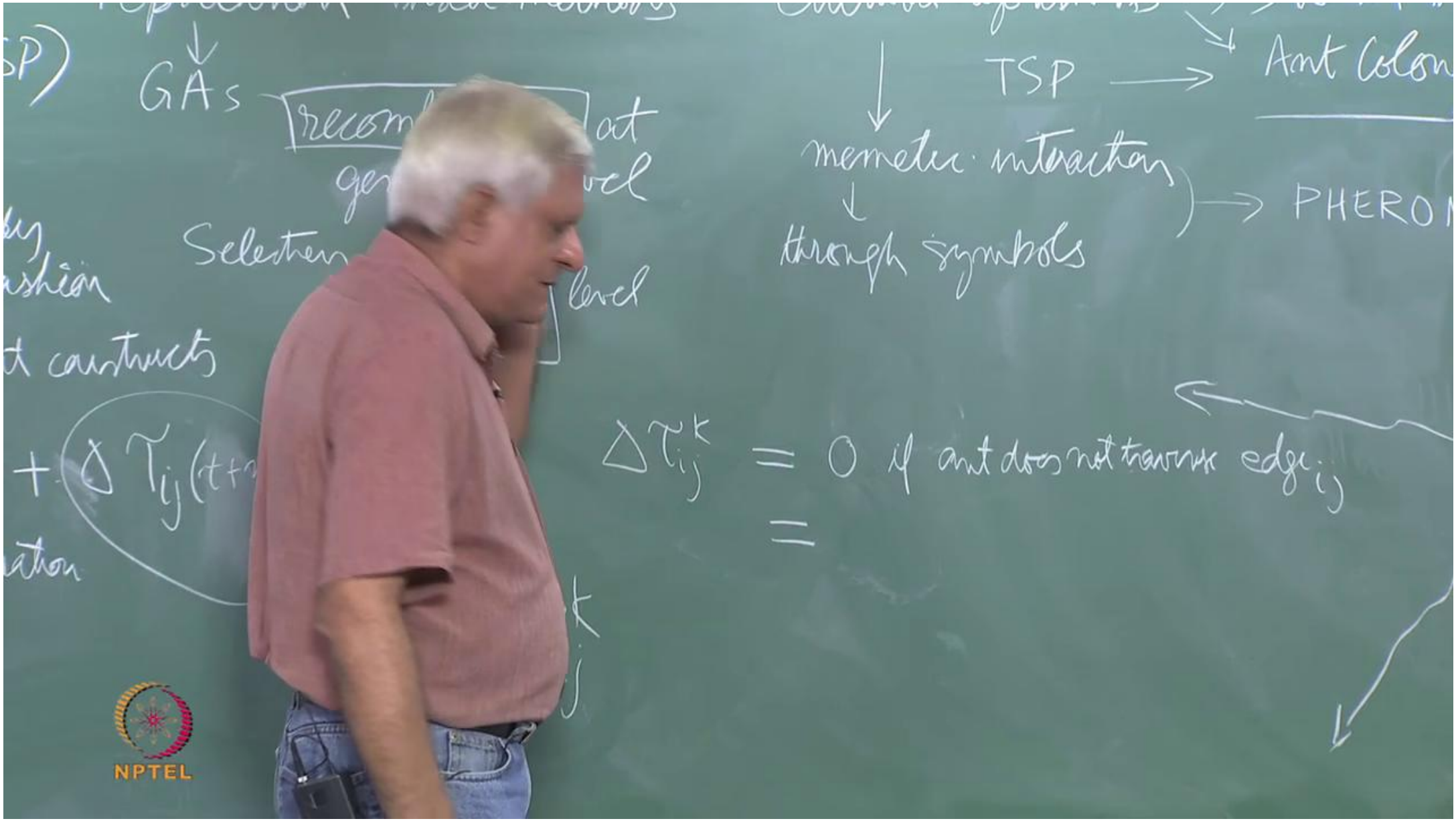


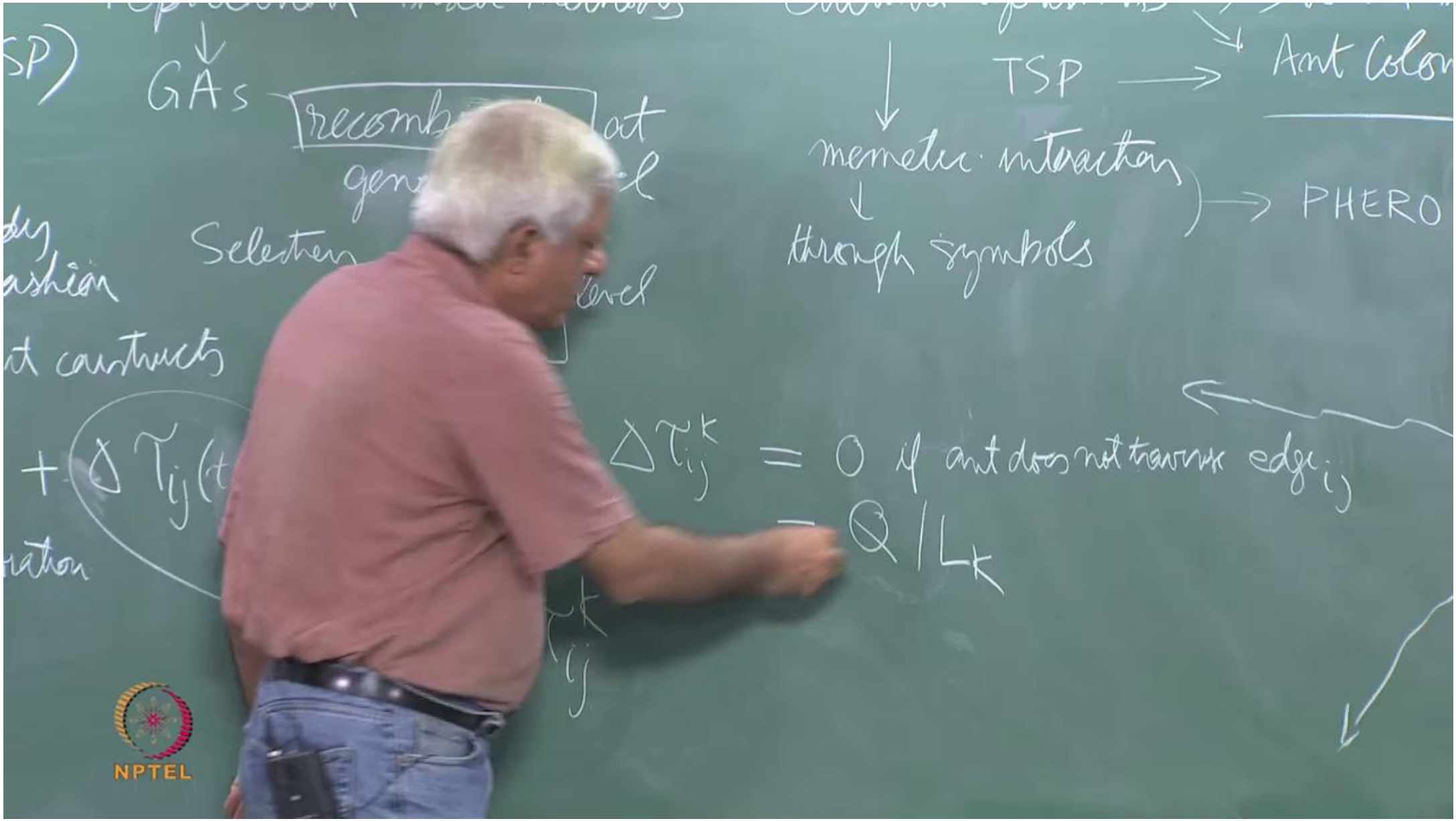
deposits pheromone on the tour it constructs

$$\tau_{ij}(t+n) \leftarrow (1-\lambda)\,\tau_{ij}(t) + \tau_{ij}(n)$$

λ: coefficient of evaporation

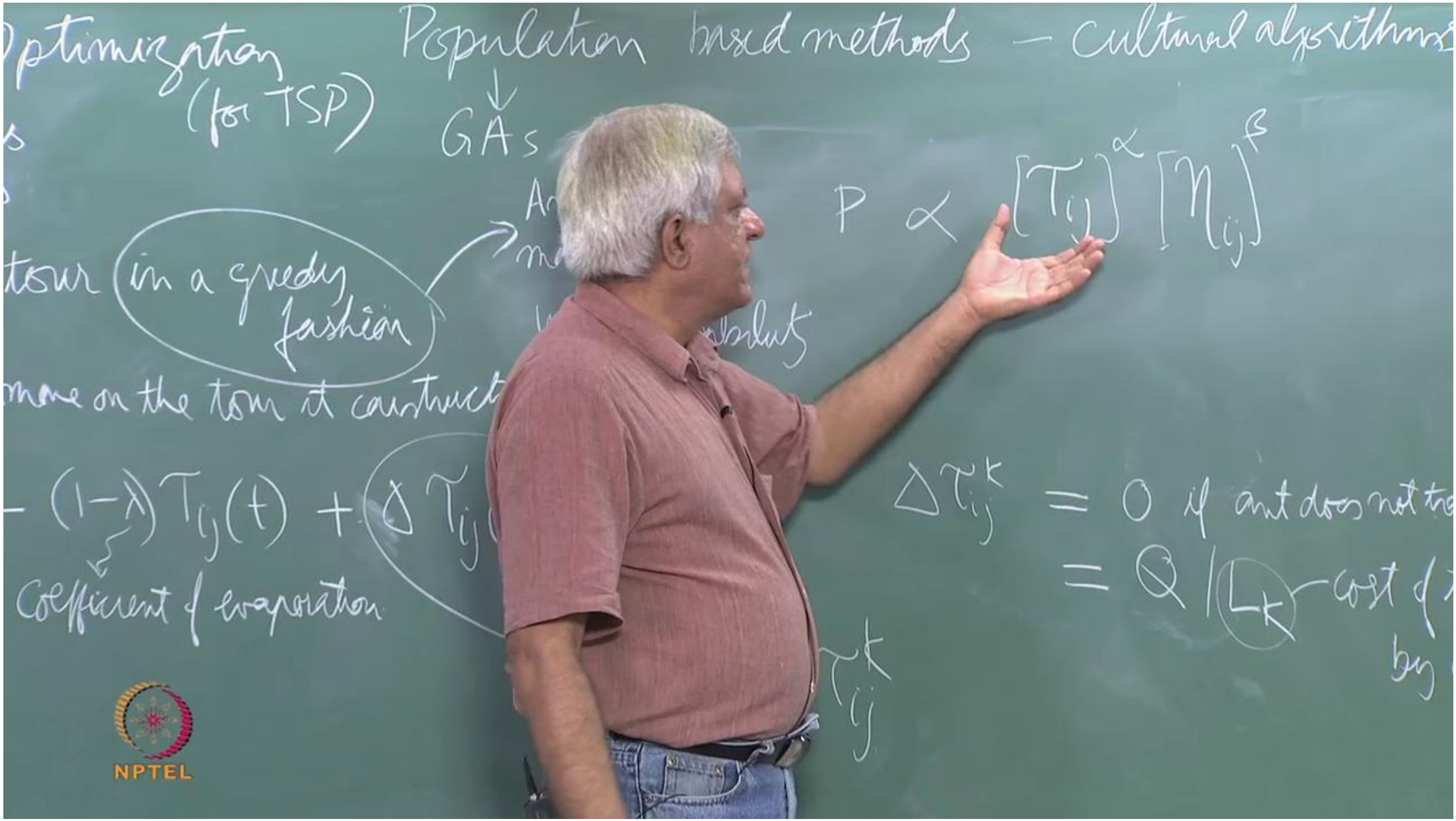

Let there be N
(for TSP)
GAs
recombination at genotype level
Each ant constructs
in a greedy fashion
Selection
phenotype level
on the tour it constructs
NPTEL

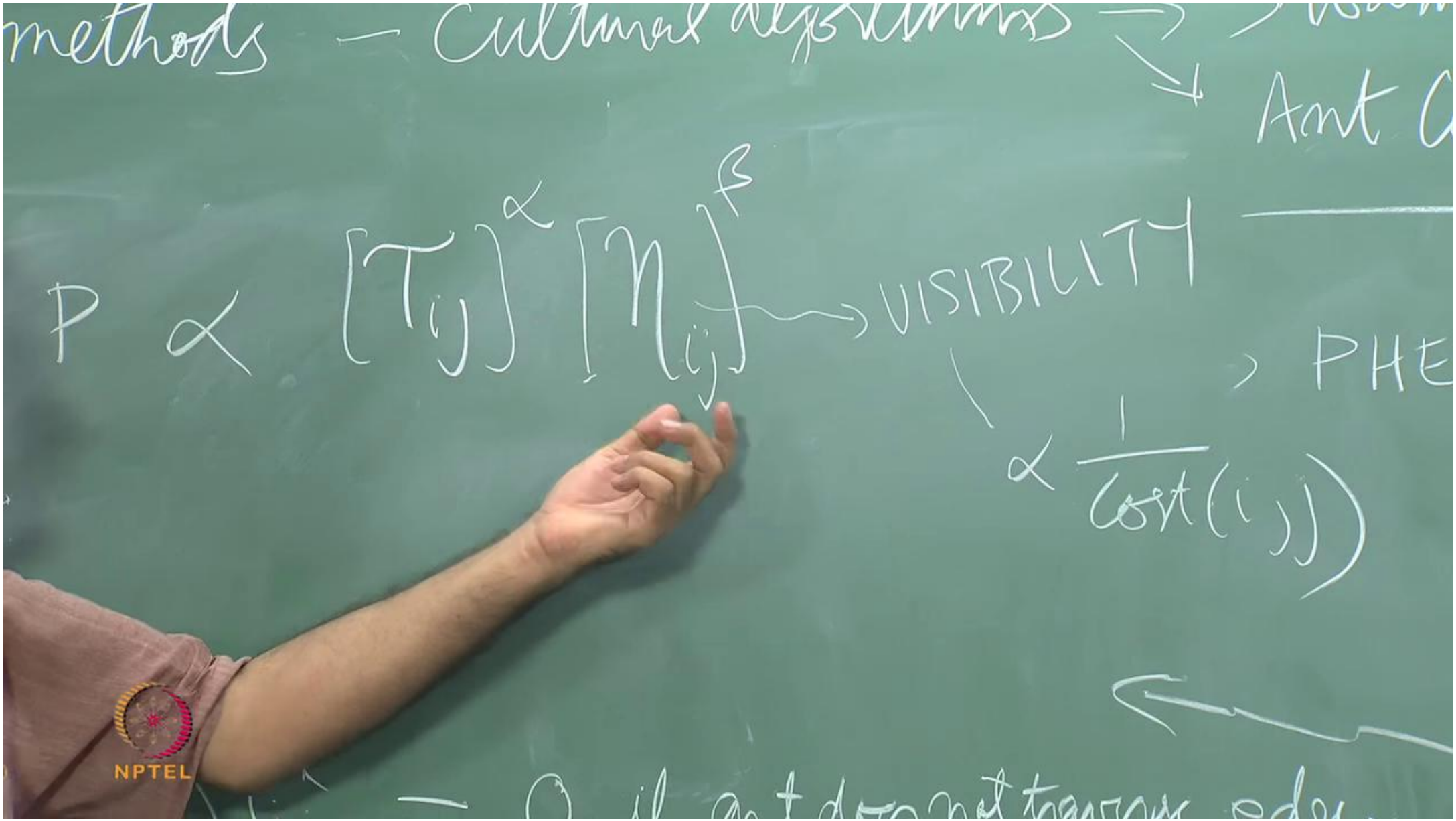

GAs
TSP
Ant Colon
memetic interaction
through symbols
PHERO
Selection
level
$\Delta\tau_{ij}^{k} = 0$ if ant does not traverse edge ij
=
NPTEL

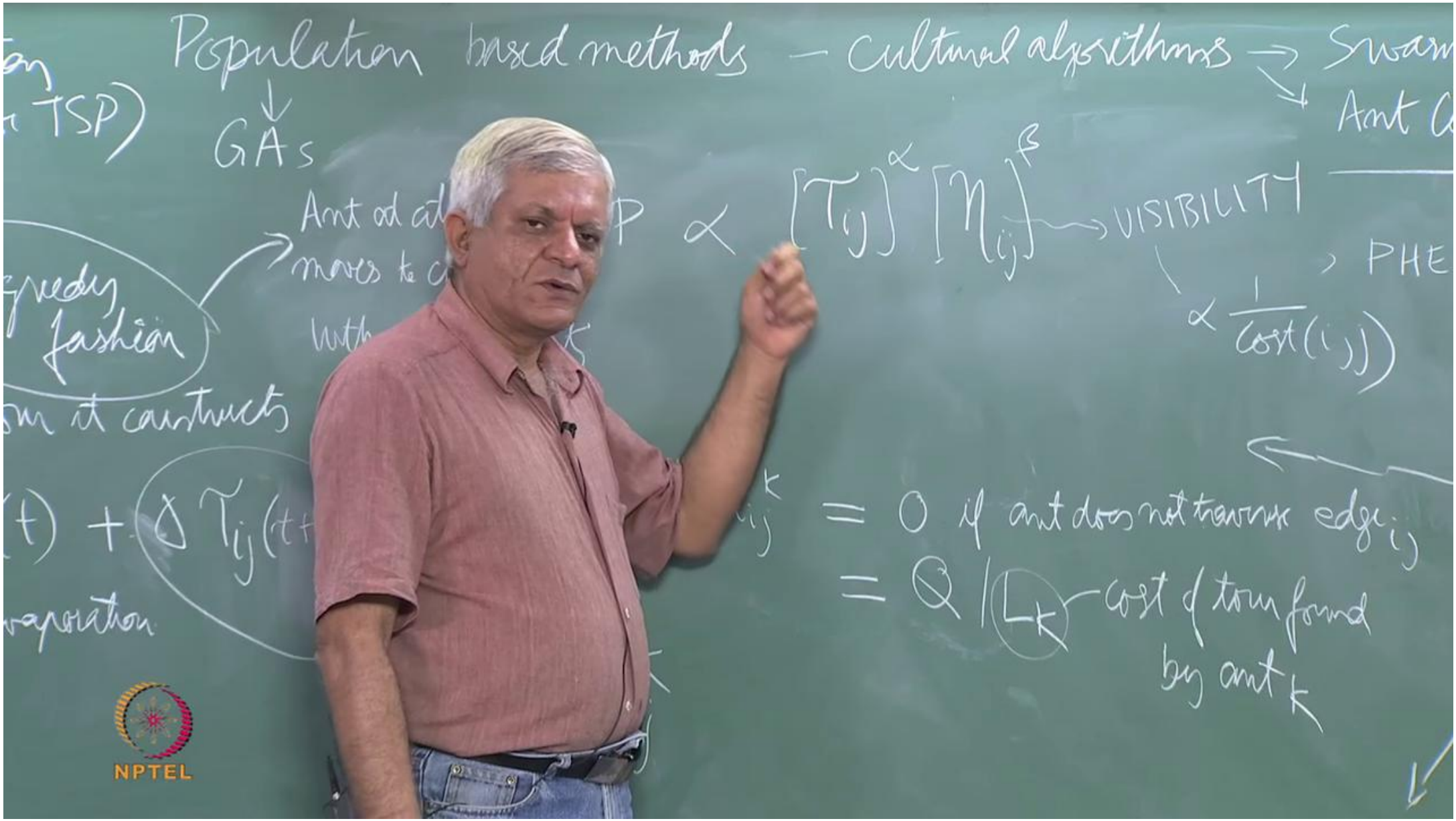

GAs
recomb
Selection
TSP
Ant Colon
memetic interaction
through symbols
PHERO
$\Delta\tau_{ij}^k = 0$ if ant does not traverse edge ij
$= Q/L_k$
NPTEL

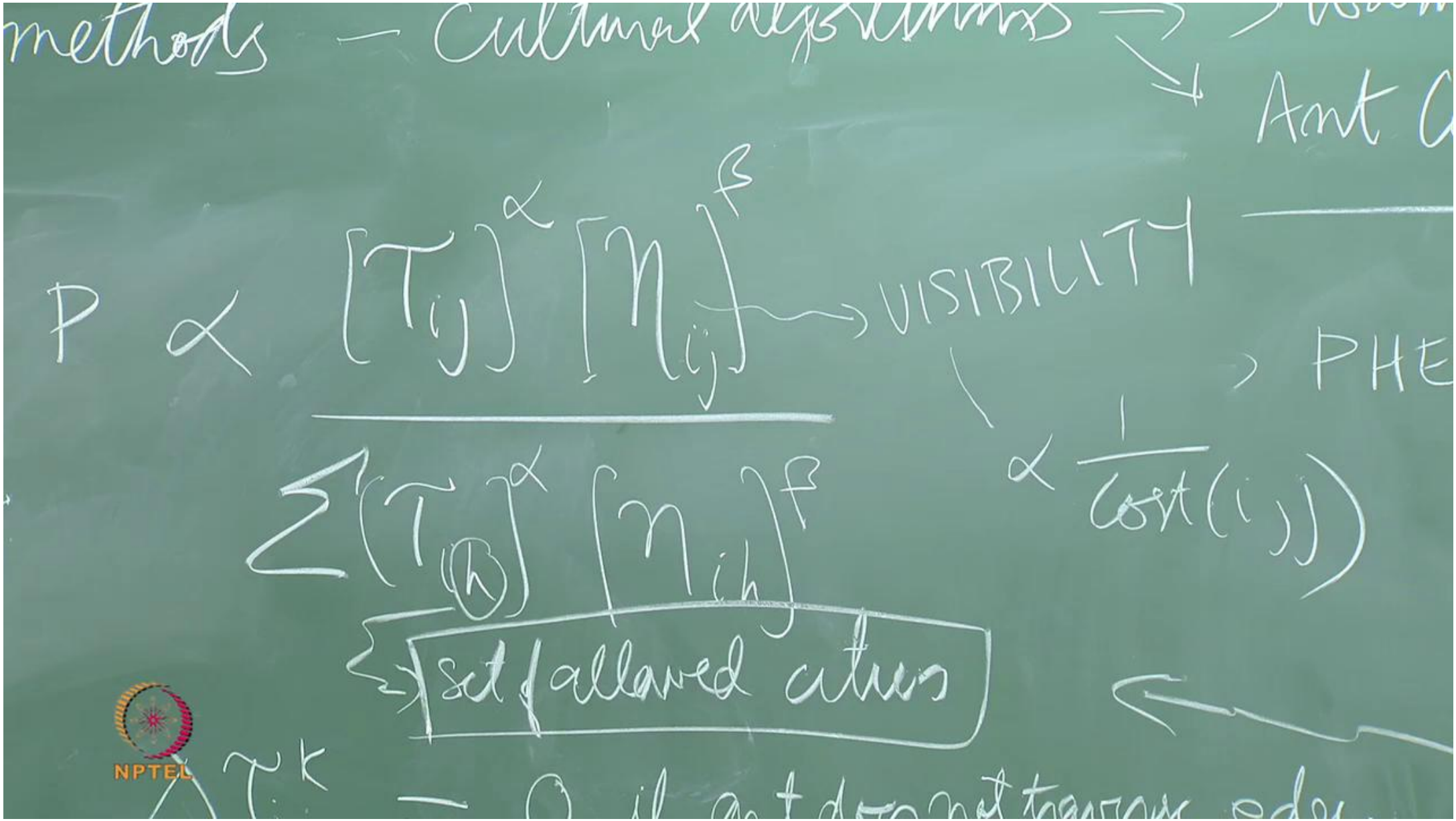
$\Delta \tau_{ij}^{k} = 0$ if ant does not traverse edge (i,j)

$= Q / L_k$ — cost of tour found by ant k


Optimization (for TSP)
Population based methods – cultural algorithms
GAs
tour in a greedy fashion
$P \propto [\tau_{ij}]^{\alpha} [\eta_{ij}]^{\beta}$
$(1-\rho)\tau_{ij}(t)$
coefficient of evaporation
$\Delta\tau_{ij}^{k} = 0$ if ant does not
$= Q/L_k$ – cost of
NPTEL


methods — Cultural algorithms
Ant C
$P \propto [\tau_{ij}]^{\alpha} [\eta_{ij}]^{\beta}$
VISIBILITY
PHE
$\propto \frac{1}{cost(i,j)}$
NPTEL


Population based methods – cultural algorithms
GAs
Ant
greedy fashion
$[\tau_{ij}]^{\alpha}[\eta_{ij}]^{\beta}$
VISIBILITY
$\propto \frac{1}{cost(i,j)}$
PHE
$= 0$ if ant does not traverse edge ij
$= Q/L_k$ – cost of tour found by ant k
NPTEL


methods — Cultural algorithms
Ant C
$P \propto \frac{[\tau_{ij}]^{\alpha}[\eta_{ij}]^{\beta}}{\sum([\tau_{ik}]^{\alpha}[\eta_{ik}]^{\beta})}$
VISIBILITY
$\propto \frac{1}{cost(i,j)}$
PHE
set of allowed cities
τ^k — Q if ant does not traverse edg

DORIGO et al Ant Colony Optimization (for TSP)

Let there be N cities
M ants

Each ant constructs a tour in a greedy fashion

deposits pheromone on the tour it cou

$$\tau_{ij}(t+n) \leftarrow (1-\lambda)\,\tau_{ij}(t) + \ldots$$

λ: Coefficient of evaporation