Video Lectures On

Artificial Intelligence

Lecture 12

TSP Greedy Methods

Prof. Deepak Khemani

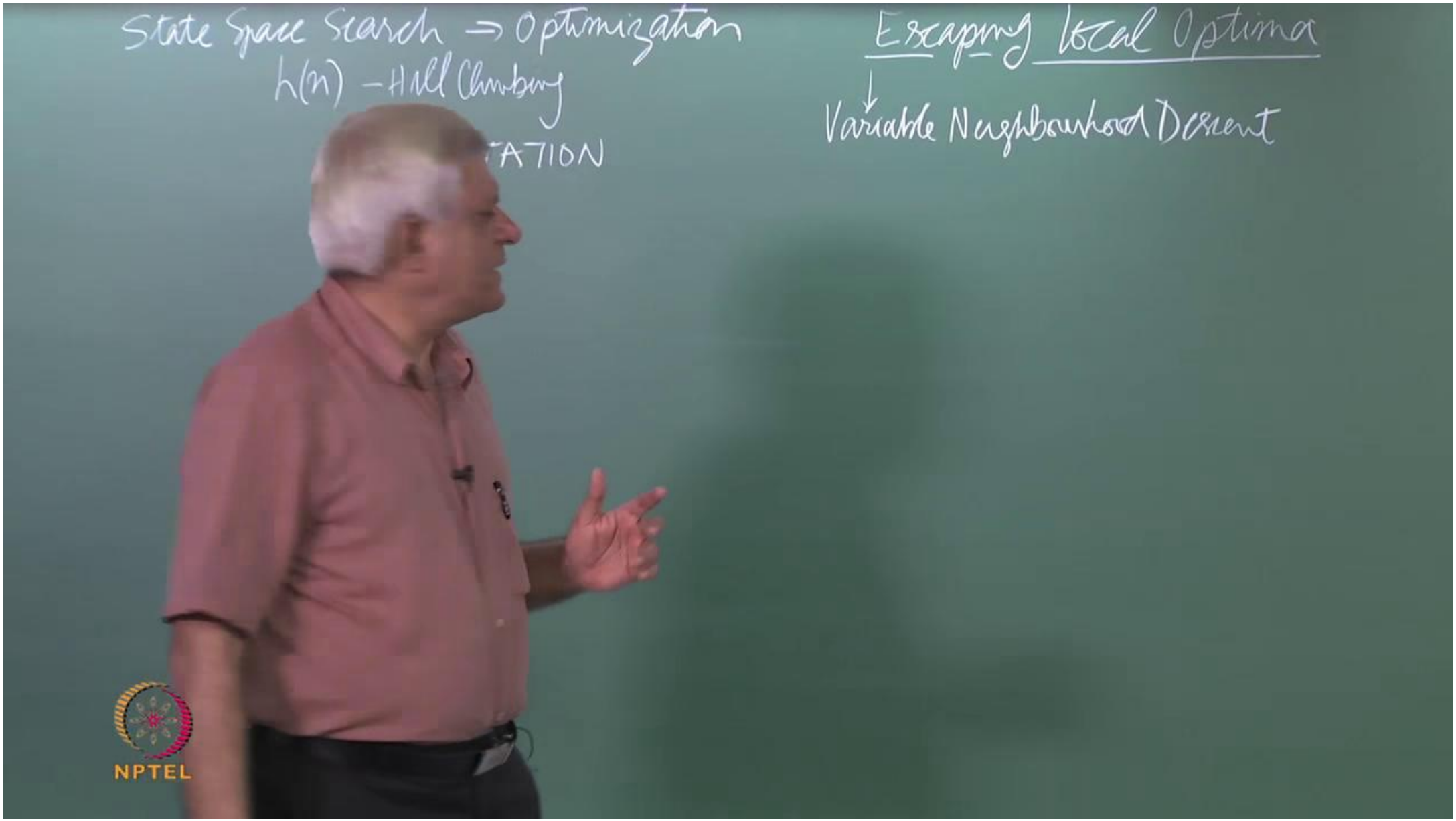
Department of Computer Science and Engineering

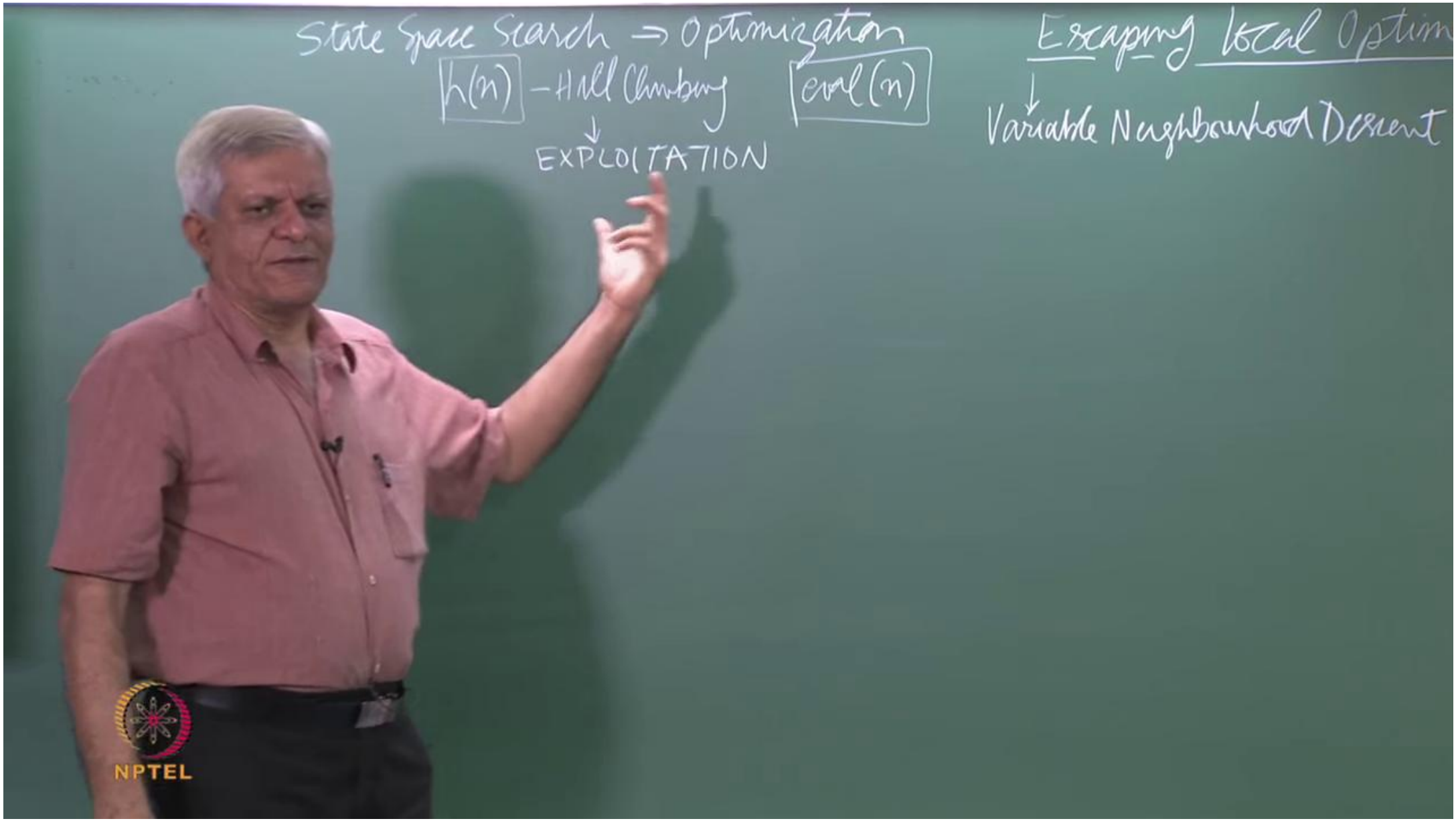
IIT Madras

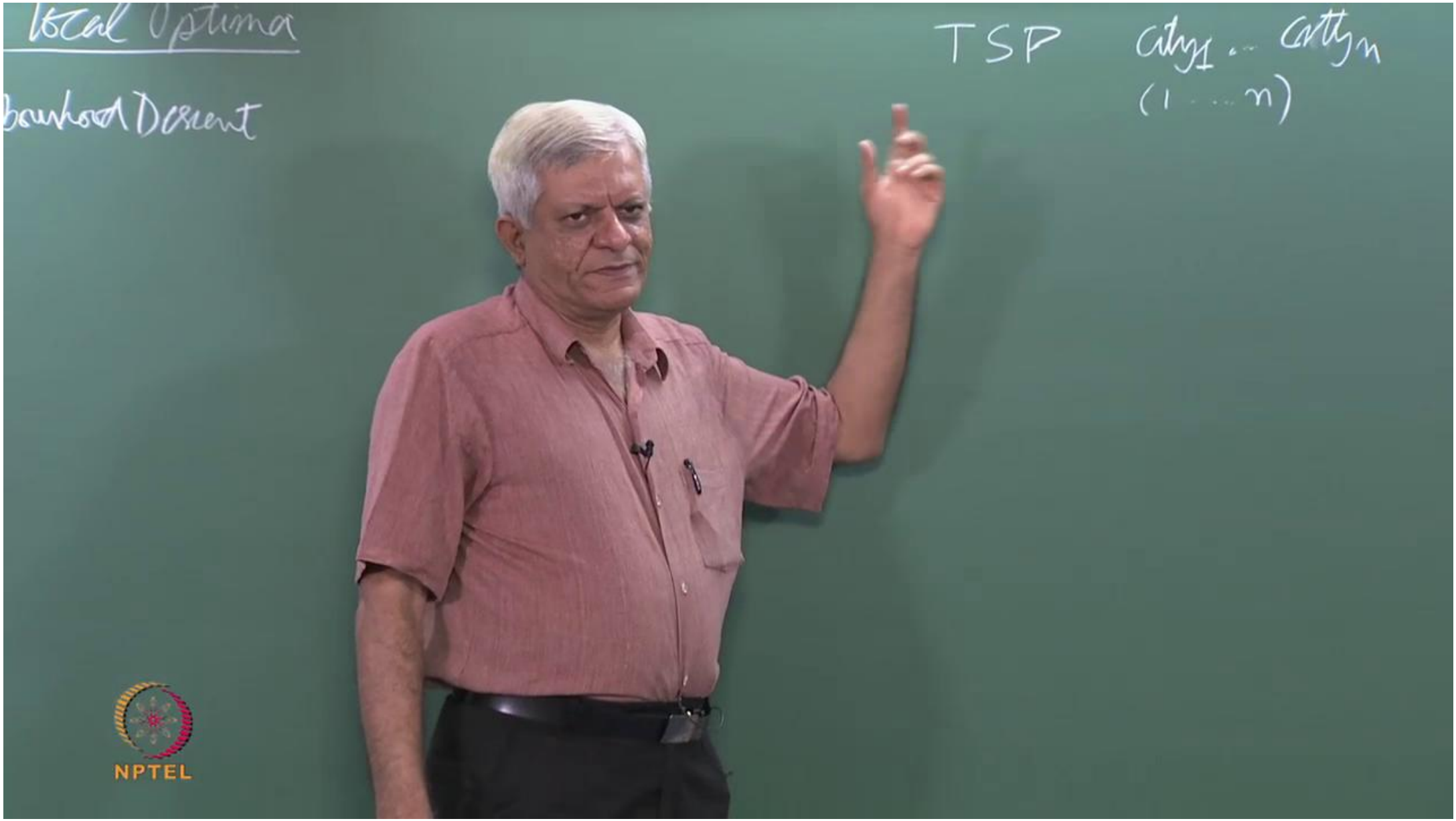
State Space Search ⇒ Optimization

State Space Search ⇒ Optimization

h(n) – Hill Climbing


State Space Search ⇒ Optimization
h(n) – Hill Climbing
Escaping local Optima
Variable Neighbourhood Descent
NPTEL


State Space Search ⇒ Optimization
h(n) - Hill Climbing
eval(n)
EXPLOITATION
Escaping local Optim
Variable Neighbourhood Descent
NPTEL


Local Optima
Neighborhood Descent
TSP
city1 ... cityn
(1 ... n)
NPTEL

TSP city 1 ... city n

(1 ... n)

Complete

TSP city 1 ... city n

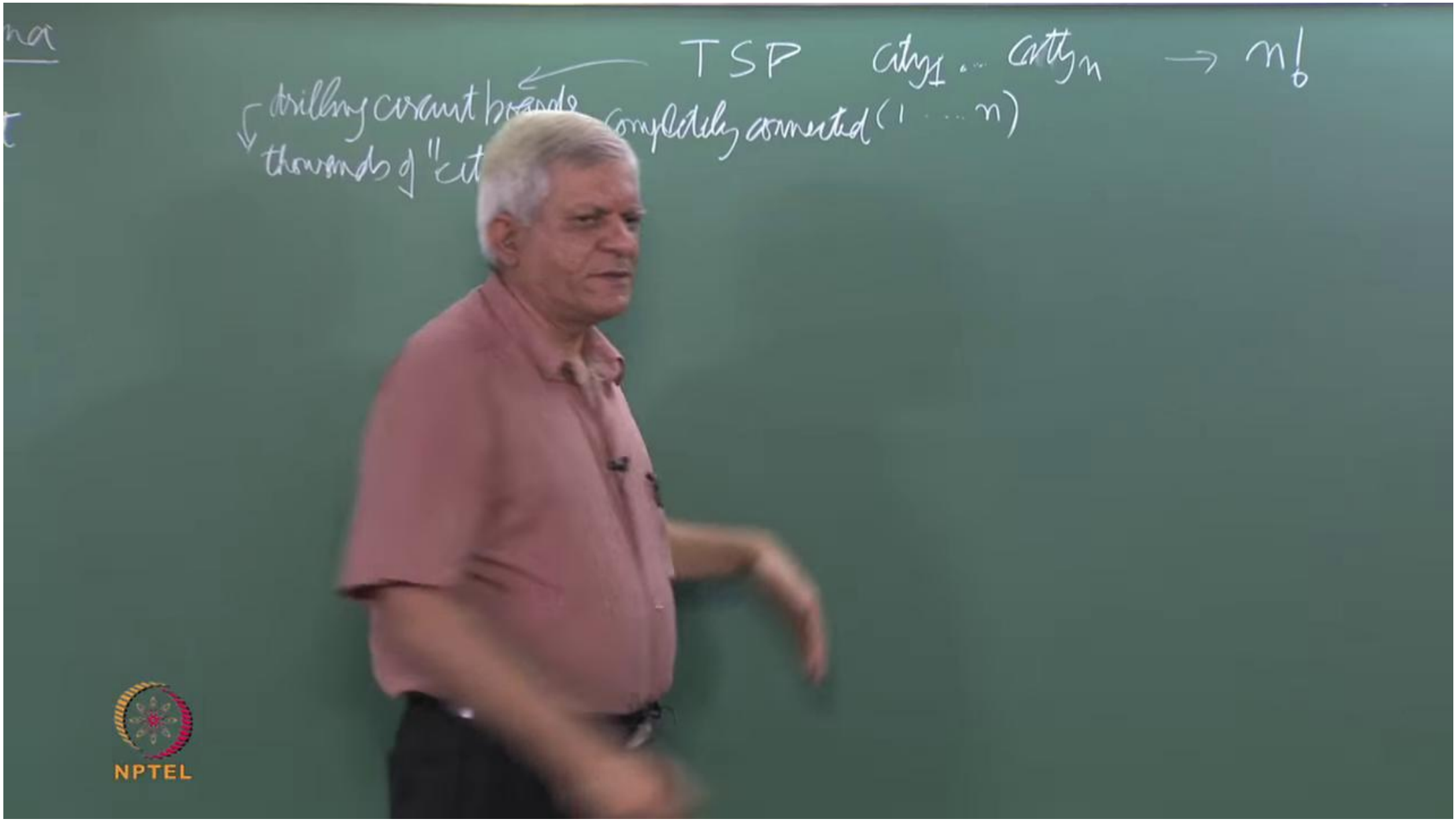
completely connected (1 ... n)

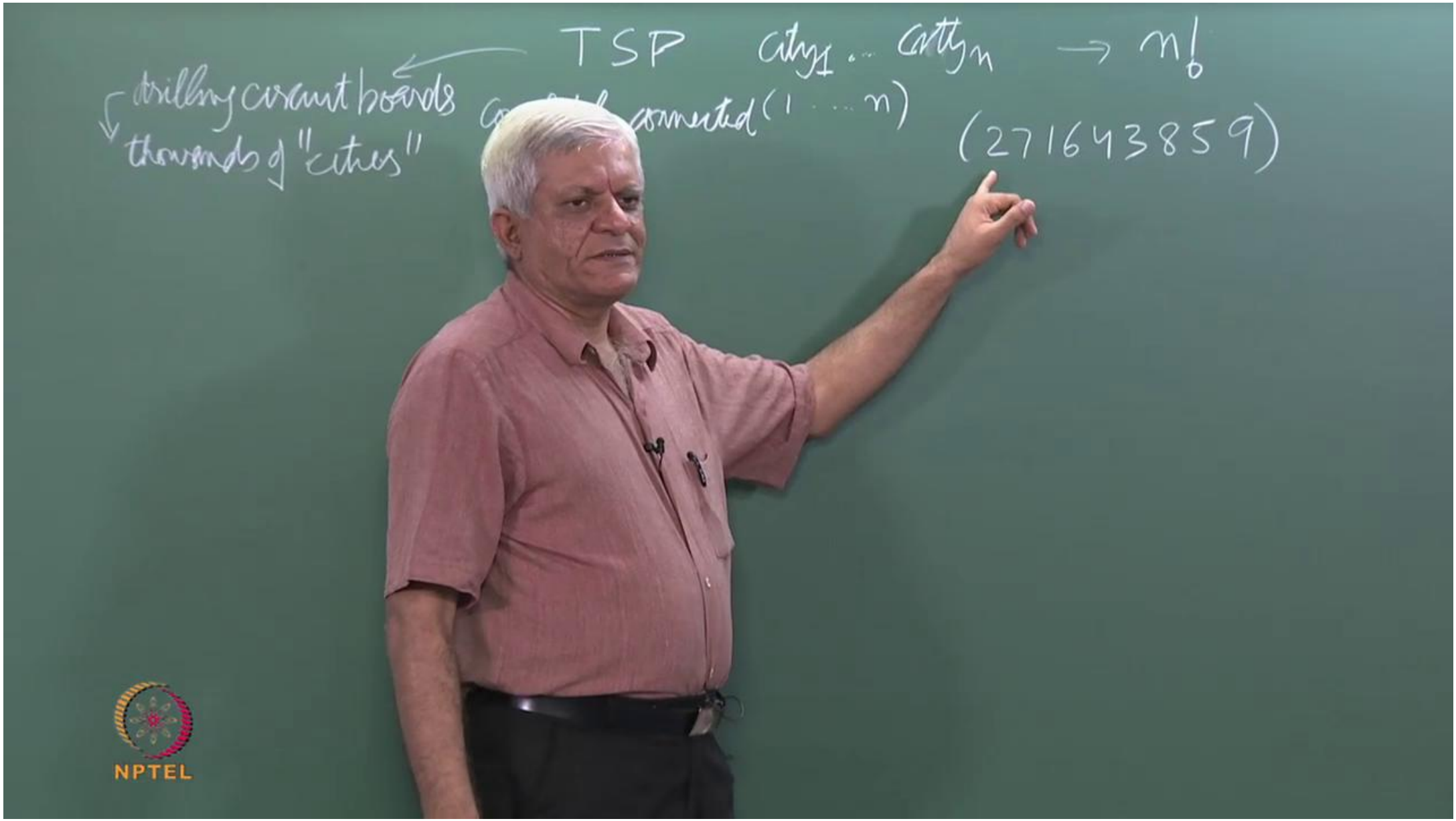
TSP city 1 ... city n

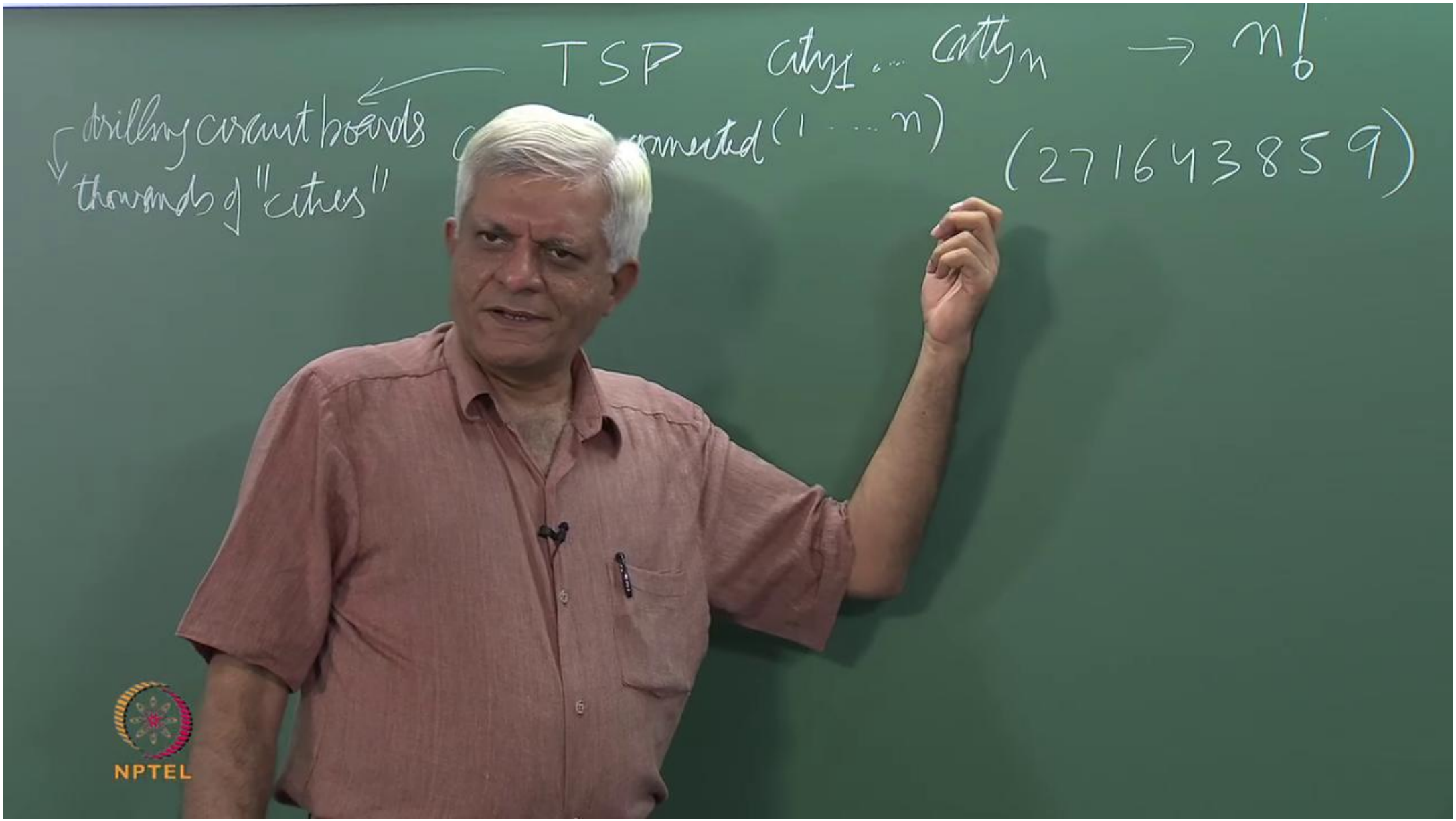
completely connected (1 ... n)

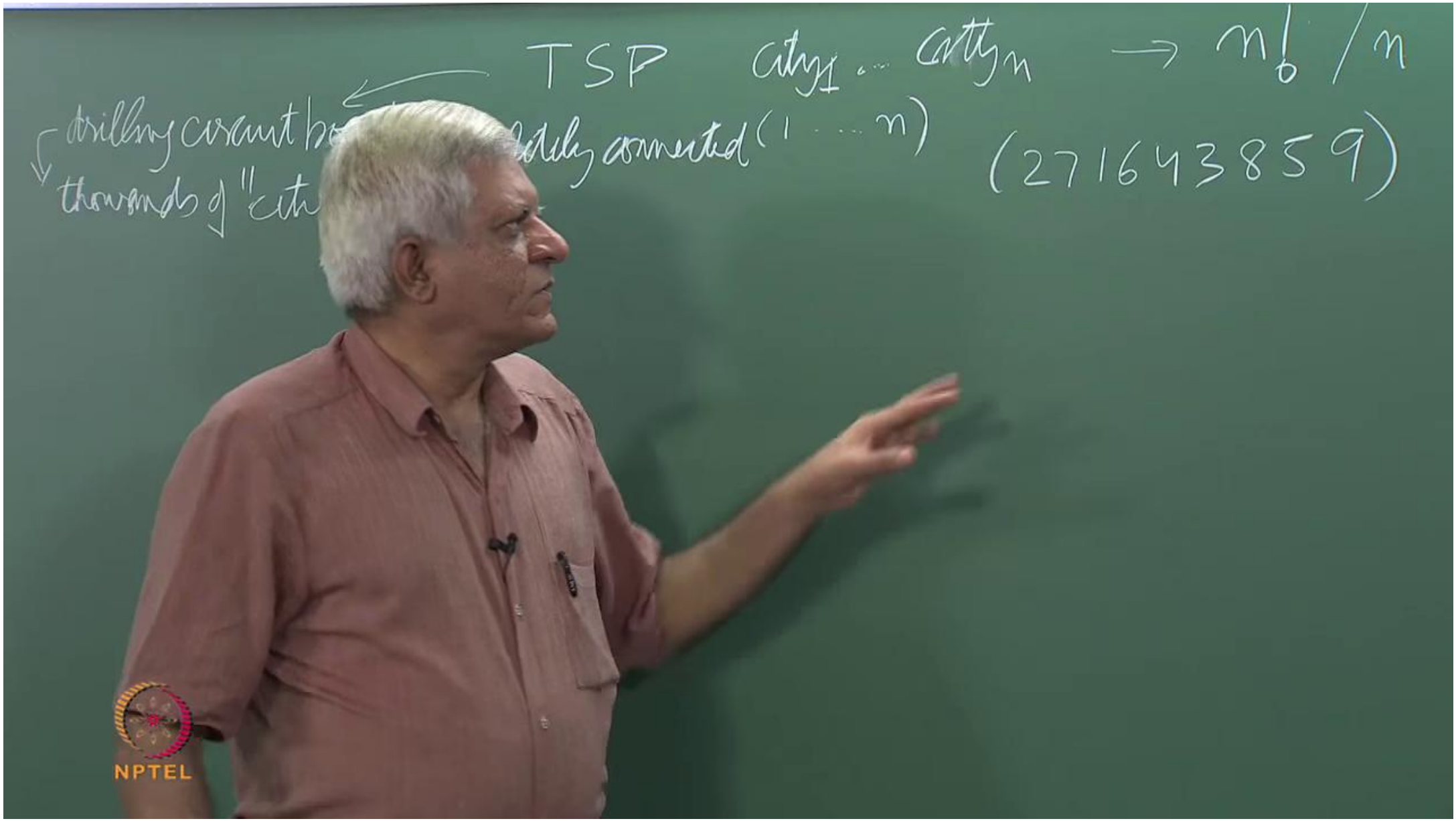
drilling circuit boards

thousands of "cities"


TSP
city1 ... cityn → n!
drilling circuit boards
completely connected (1 ... n)
thousands of "cit
NPTEL


TSP
drilling circuit boards
thousands of "cities"
(271643859)
NPTEL


TSP
drilling circuit boards
thousands of "cities"
(271643859)
NPTEL


TSP
drilling circuit board
thousands of "cities"
fully connected (1 ... n)
(271643859)
NPTEL

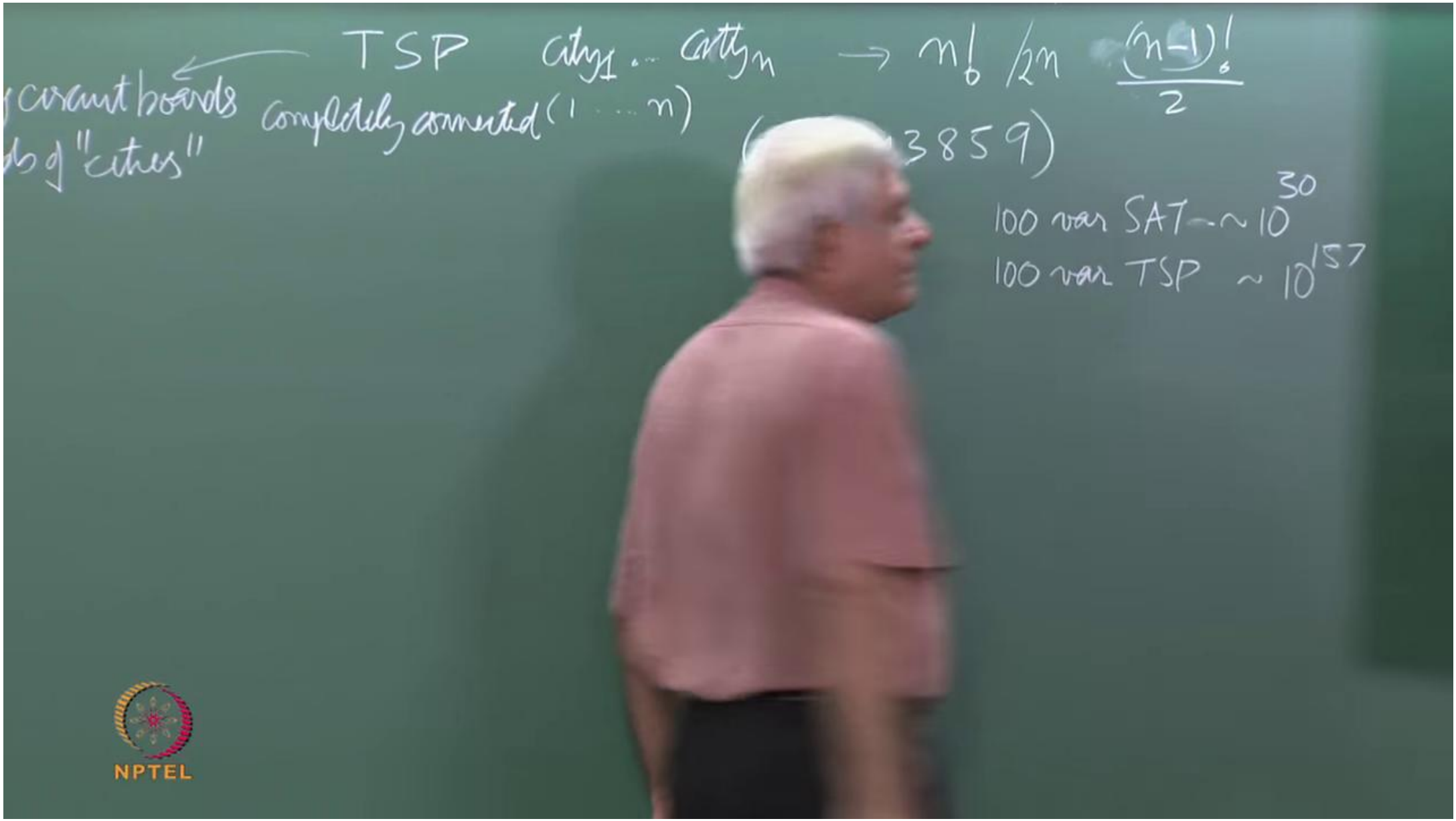
$\#y_n \longrightarrow n!_0 / 2n \quad \frac{(n-1)!_0}{2}$

(271643859)

$\#_{S_n} \rightarrow n! / 2n \quad \frac{(n-1)!}{2}$

(271643859)

100 var SAT - $\sim 10^{30}$


TSP
$city_1 \ldots city_n \rightarrow n!/2n \quad \frac{(n-1)!}{2}$
circuit boards
completely connected (1 ... n)
3859)
100 var SAT ~ 10^{30}
100 var TSP ~ 10^{157}
NPTEL

$\#_{S_n} \rightarrow n! / 2n \quad \frac{(n-1)!}{2}$

(27164385 9)

100 var SAT $\sim 10^{30}$

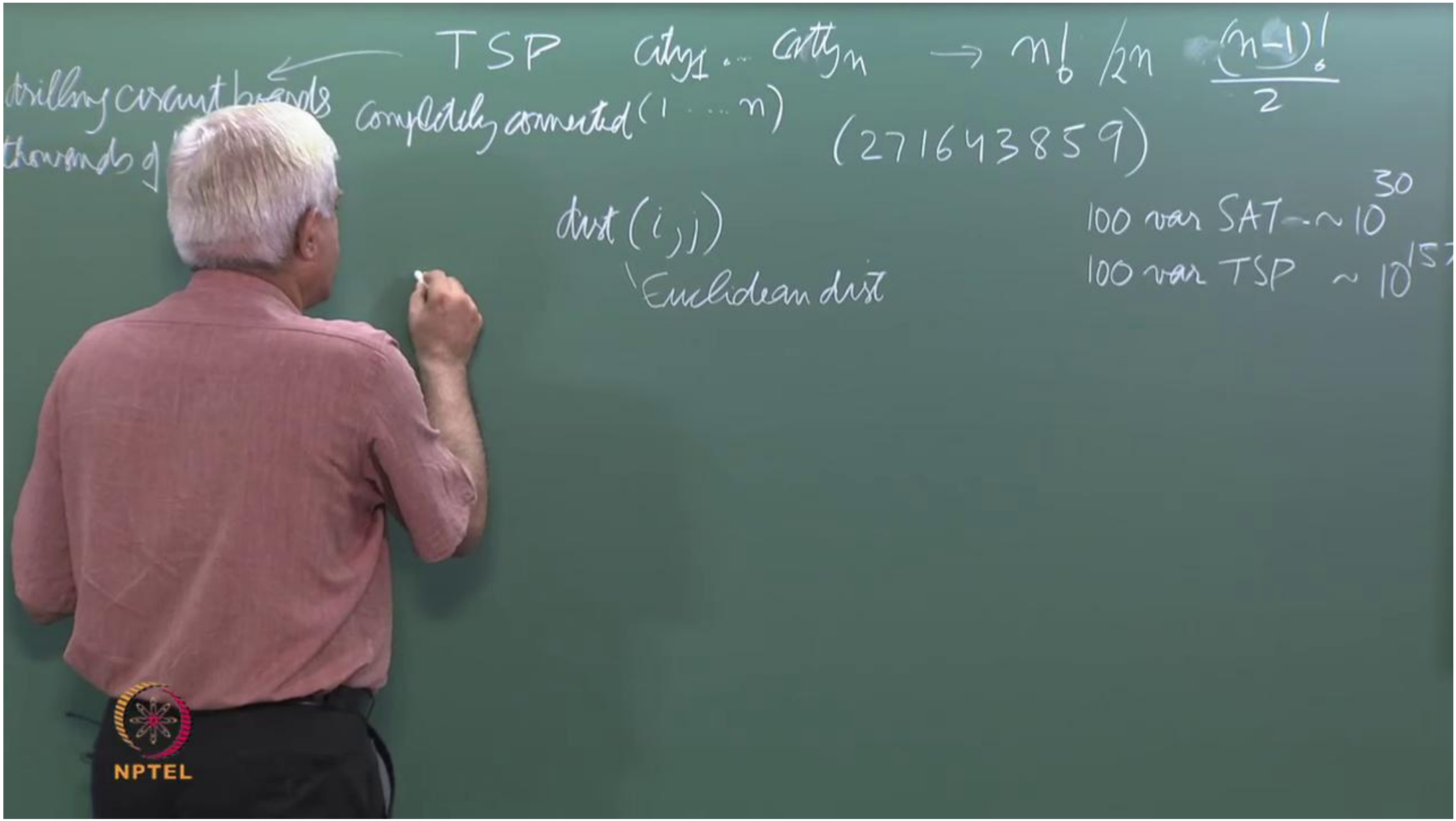
100 var TSP $\sim 10^{157}$

$\text{city}_n \rightarrow n! / 2n \quad \frac{(n-1)!}{2}$

(27164385 9)

100 var SAT $\sim 10^{30}$

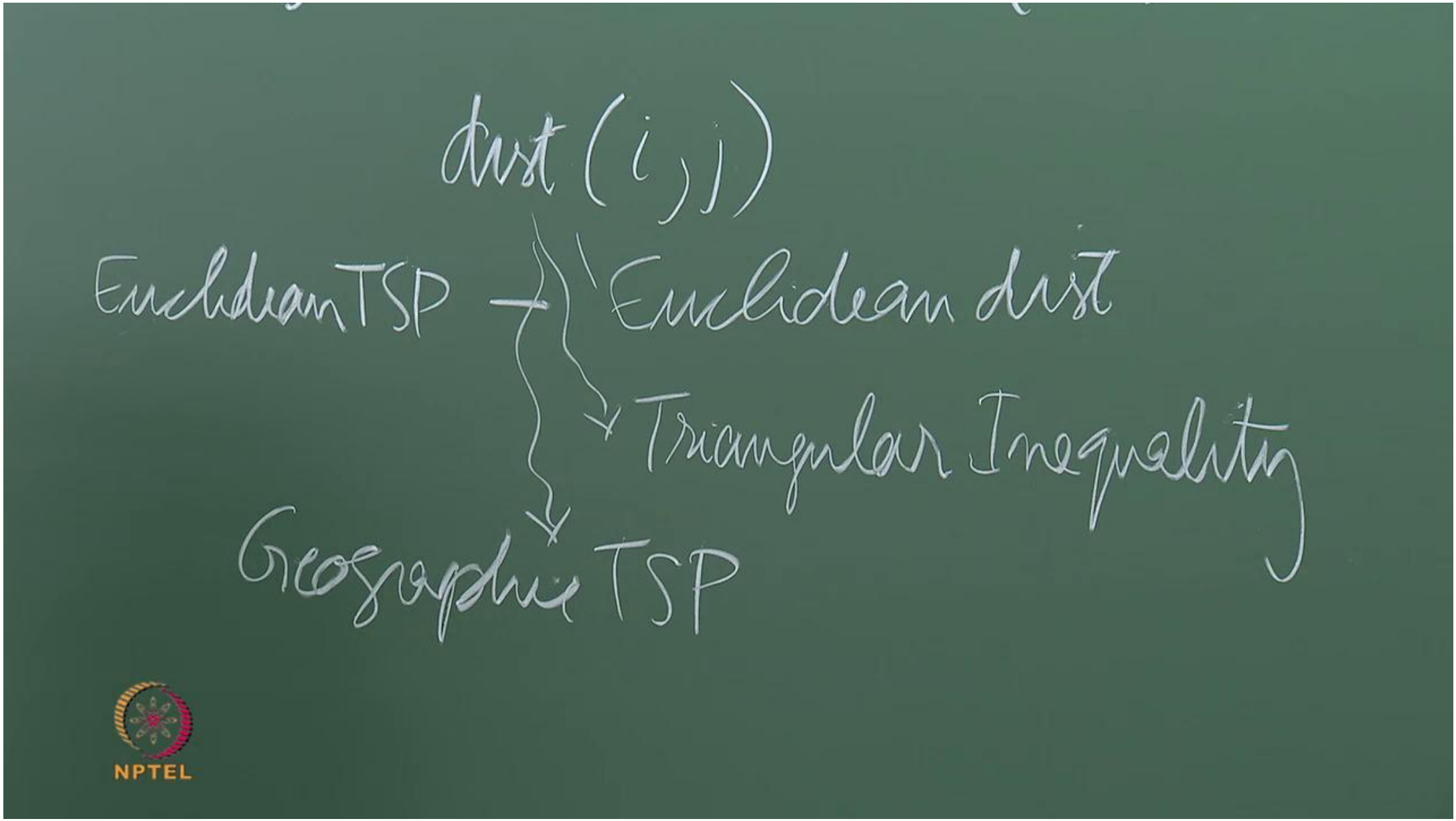
100 var TSP $\sim 10^{157}$


TSP city1 ... cityn → n! / 2n (n-1)! / 2
drilling circuit boards
completely connected (1 ... n)
(271643859)
dist (i, j)
Euclidean dist
100 var SAT ~ 10^30
100 var TSP ~ 10^157
NPTEL

dist (i, j)

Euclidean TSP → Euclidean dist

→ Triangular Inequality


dist (i, j)
Euclidean TSP
Euclidean dist
Triangular Inequality
Geographic TSP

Completely connected (1 ... n)

(27164385 9)

dist (i, j)

EuclideanTSP → Euclidean dist

→ Triangular Inequality

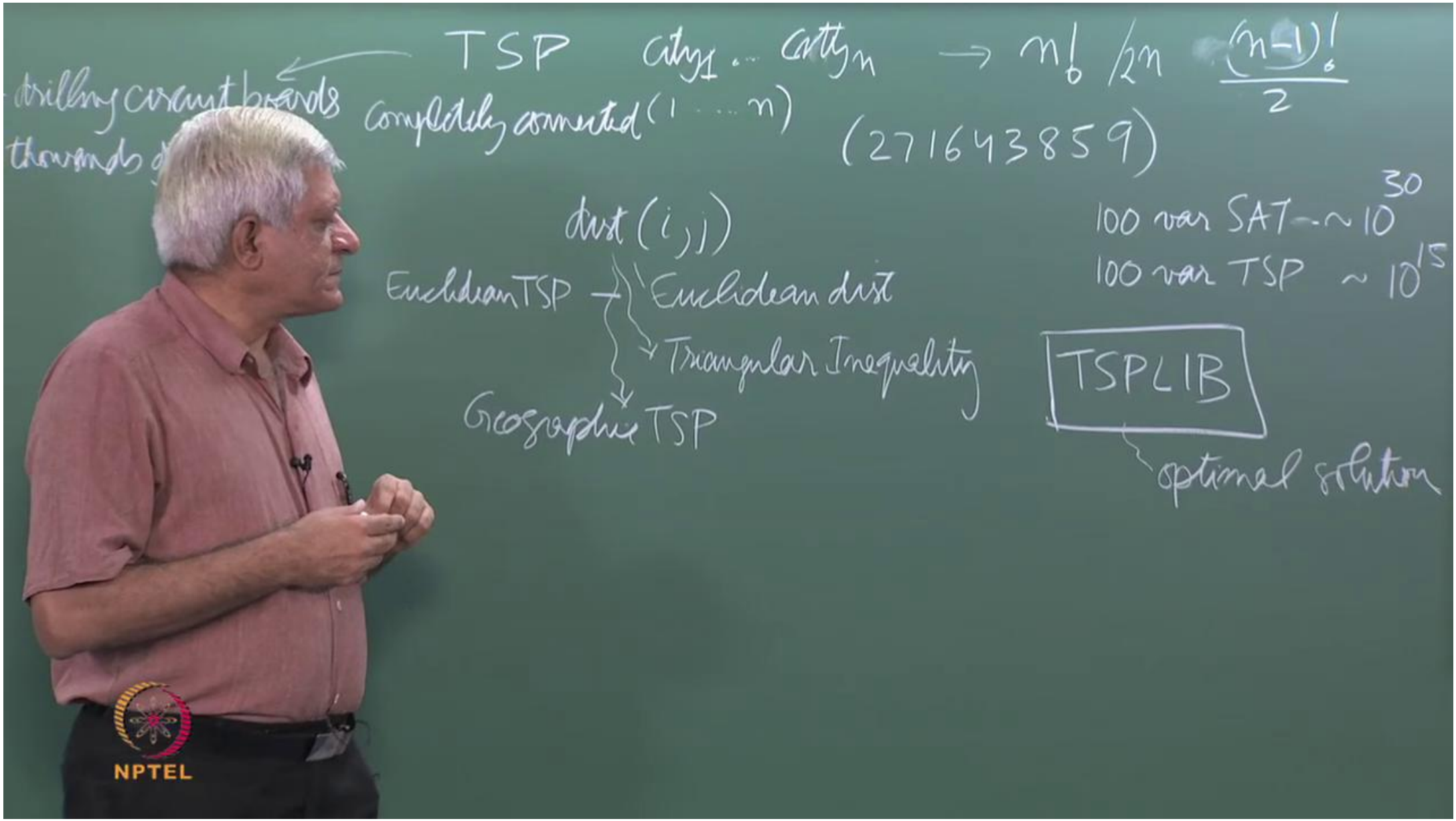
Geographic TSP

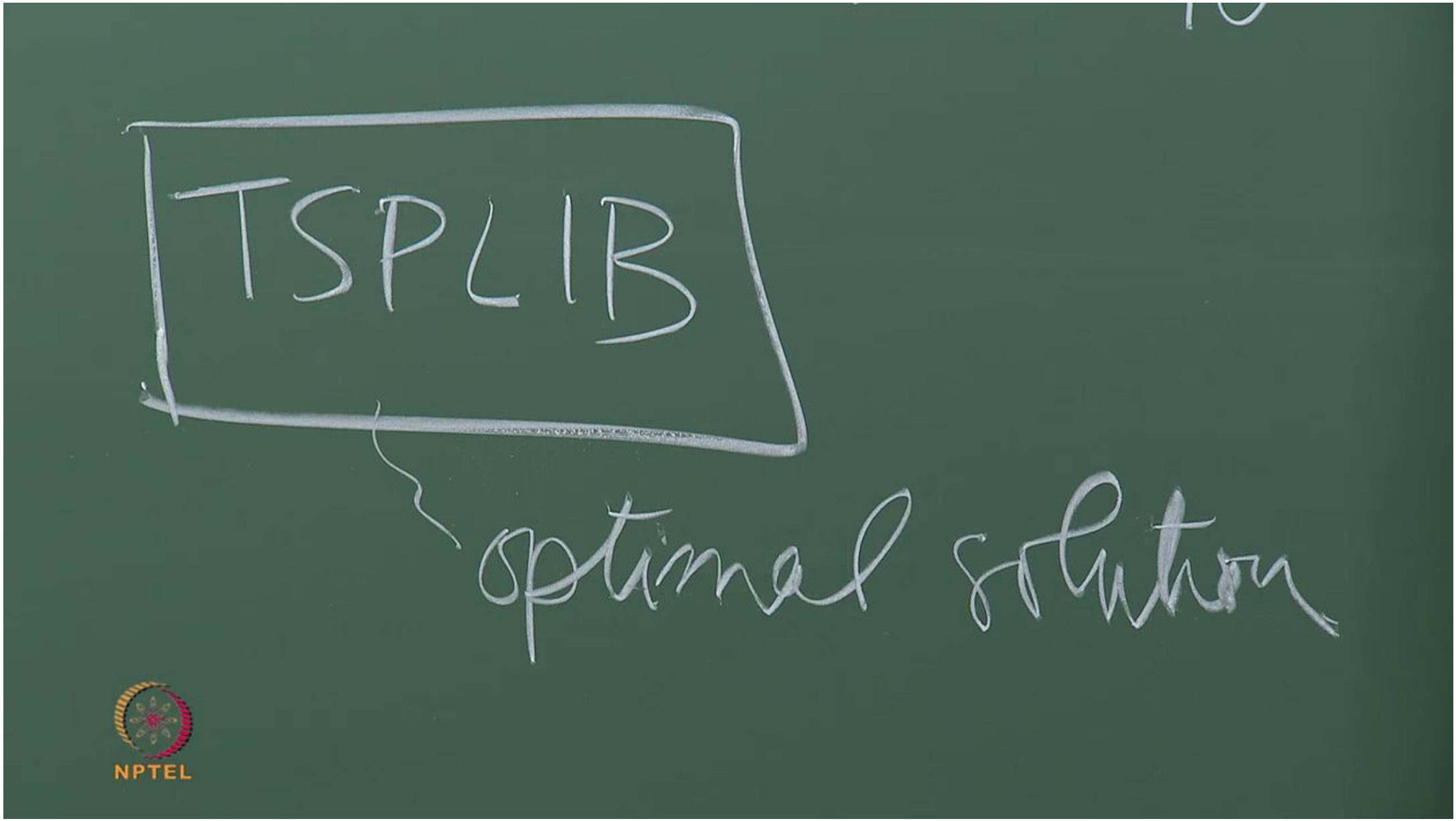
100 var SAT - $\sim 10^{30}$

100 var TSP $\sim 10^{157}$

TSPLIB

https://www.iwr.uni-heidelberg.de/groups/comopt/software/TSPLIB95/

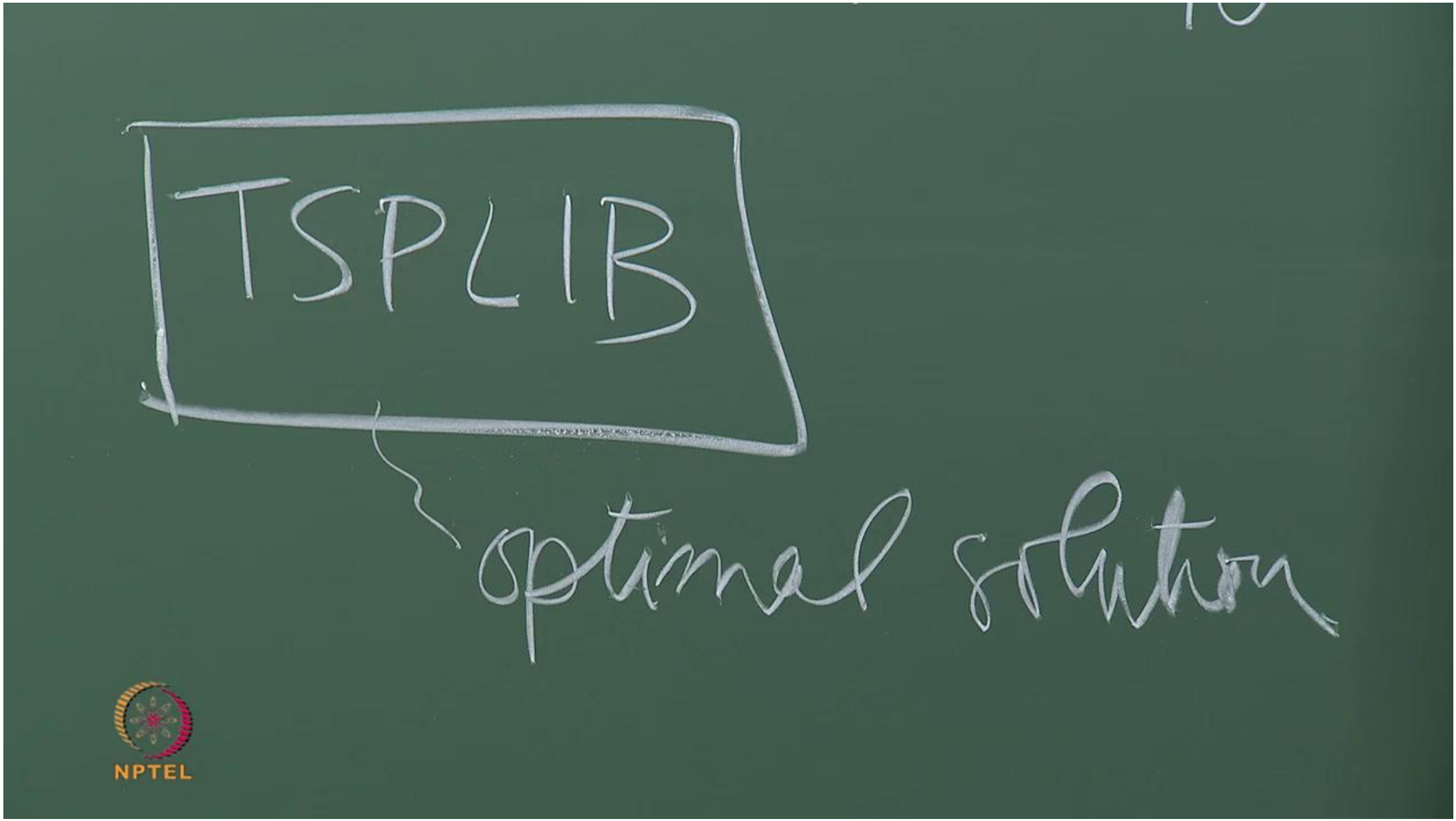

TSP
drilling circuit boards
completely connected (1 ... n)
(271643859)
dist (i, j)
Euclidean TSP
Euclidean dist
Triangular Inequality
Geographic TSP
100 var SAT ~ 10^30
100 var TSP ~ 10^15
TSPLIB
optimal solution
NPTEL

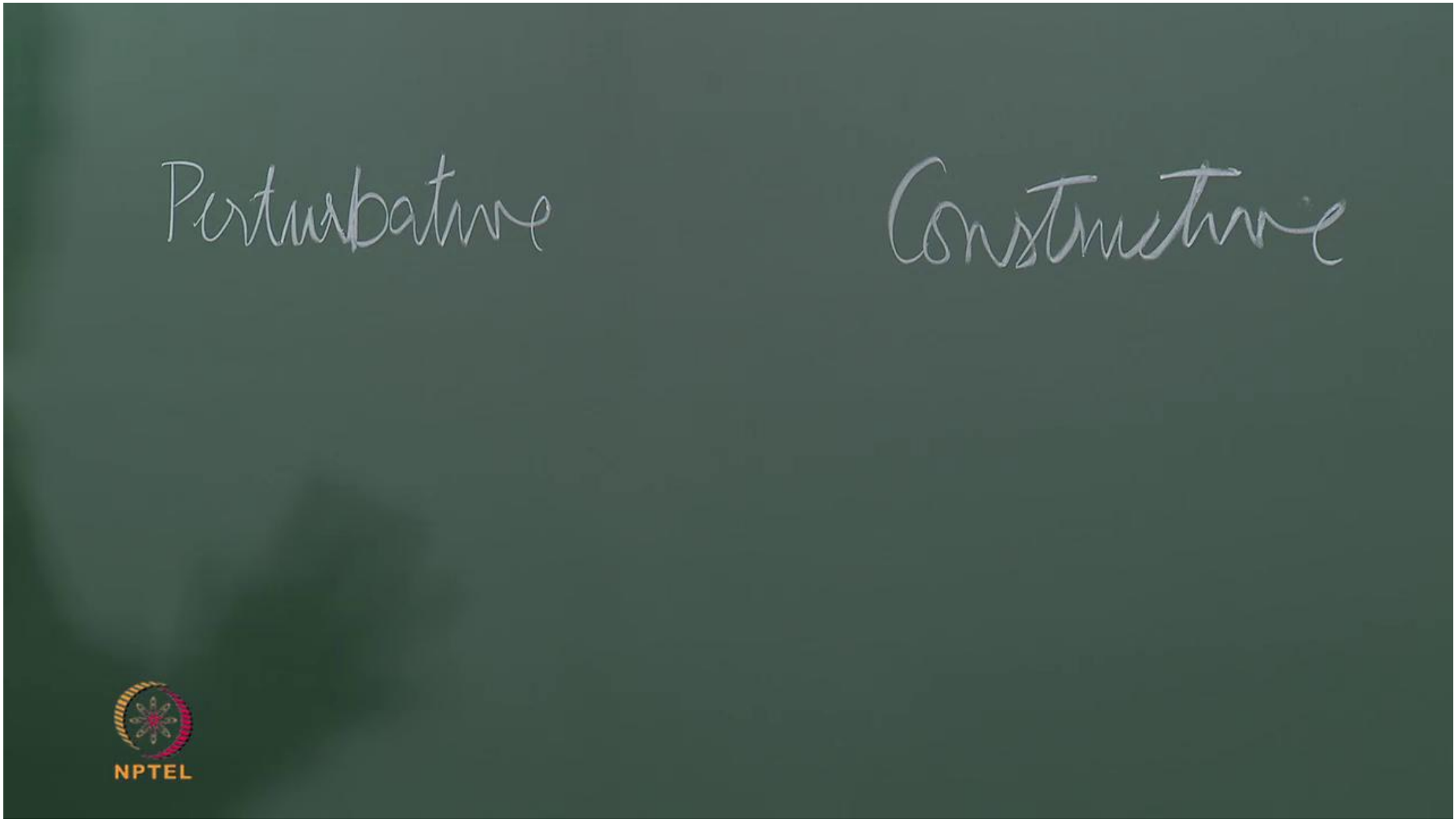

TSPLIB
optimal solution

dist (i, j)

Euclidean TSP — Euclidean dist

→ Triangular Inequality


TSPLIB
optimal solution


Perturbative
Constructive
NPTEL

batative

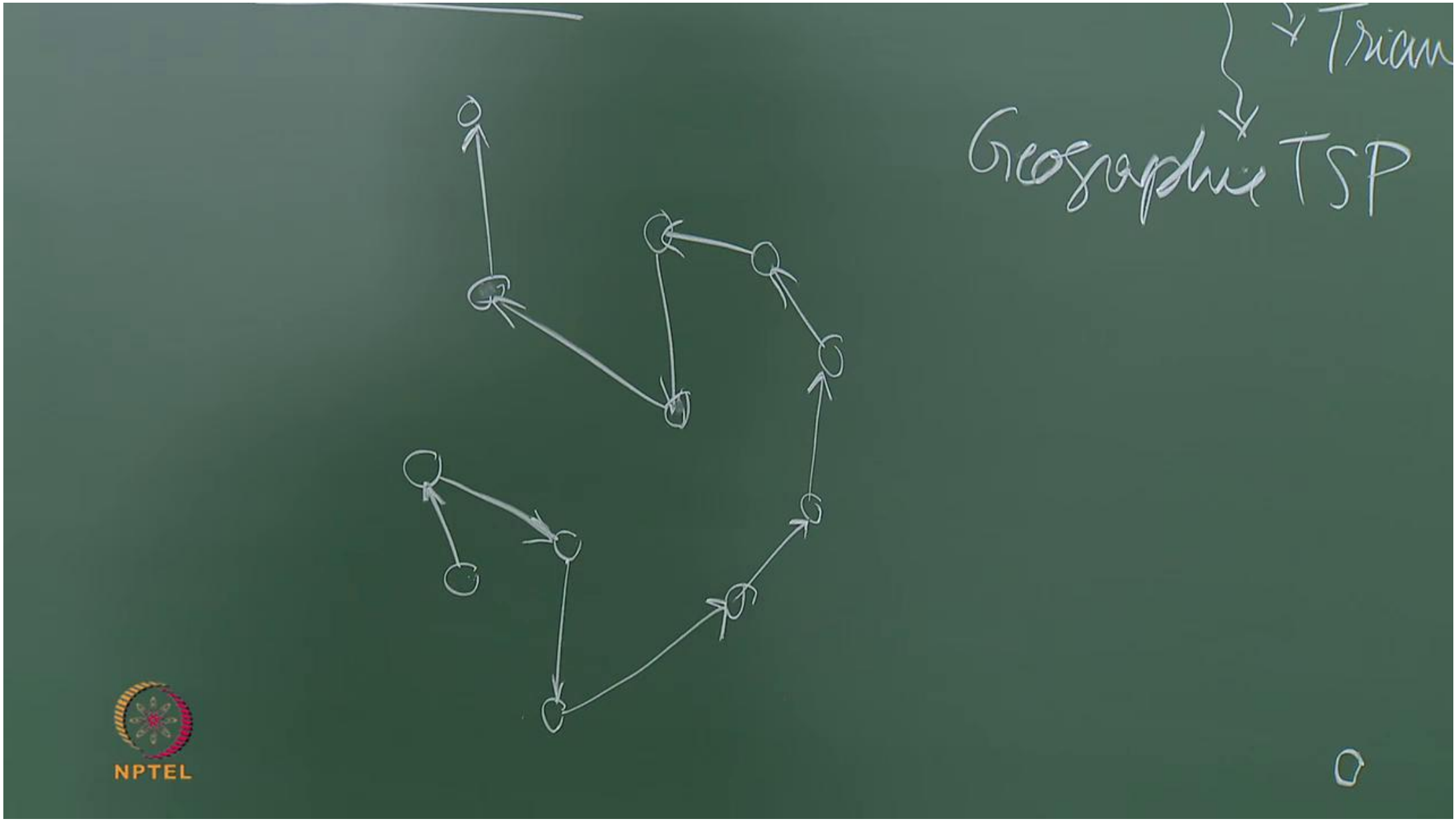
Constructive

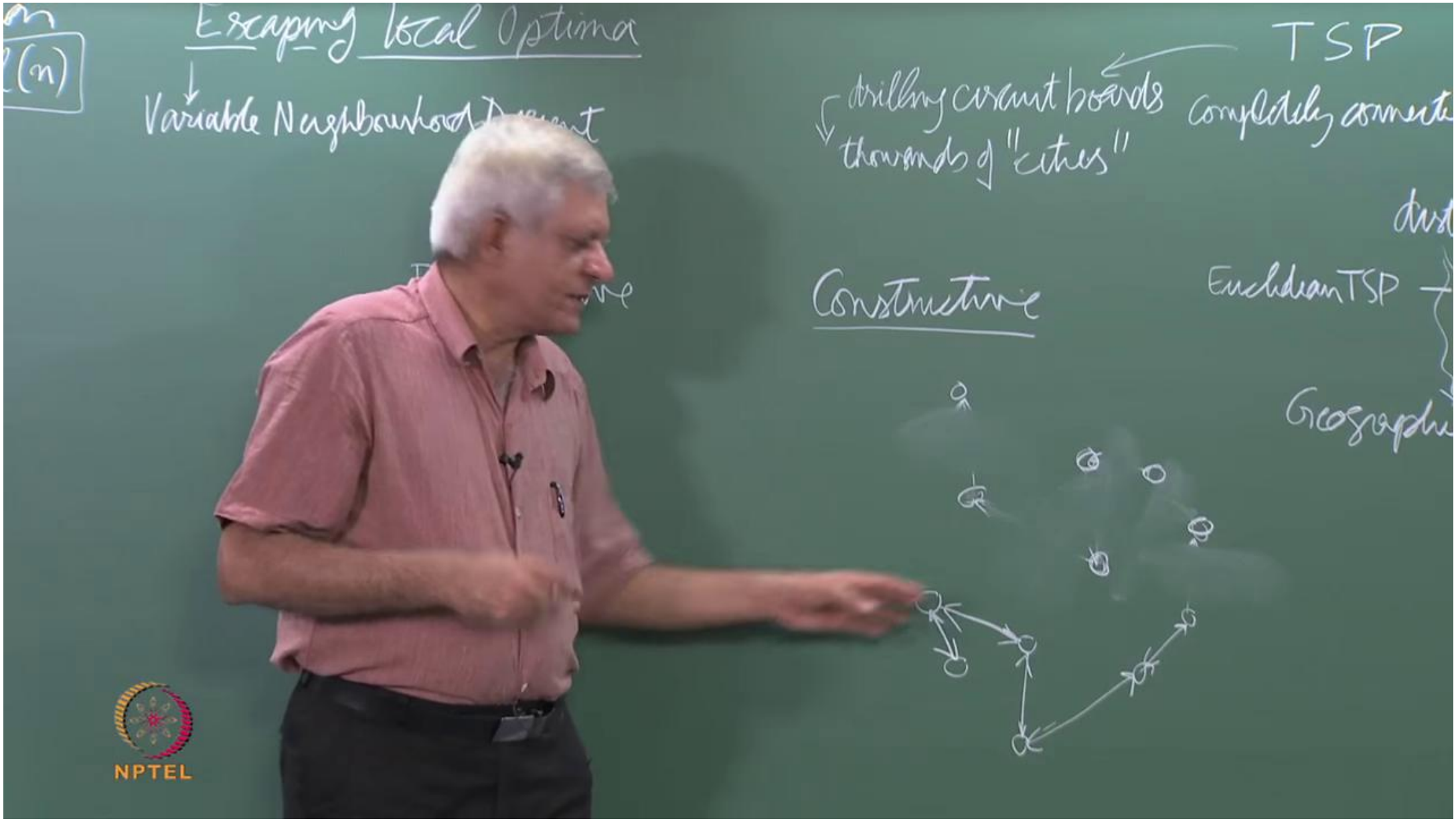
Euclidean TSP

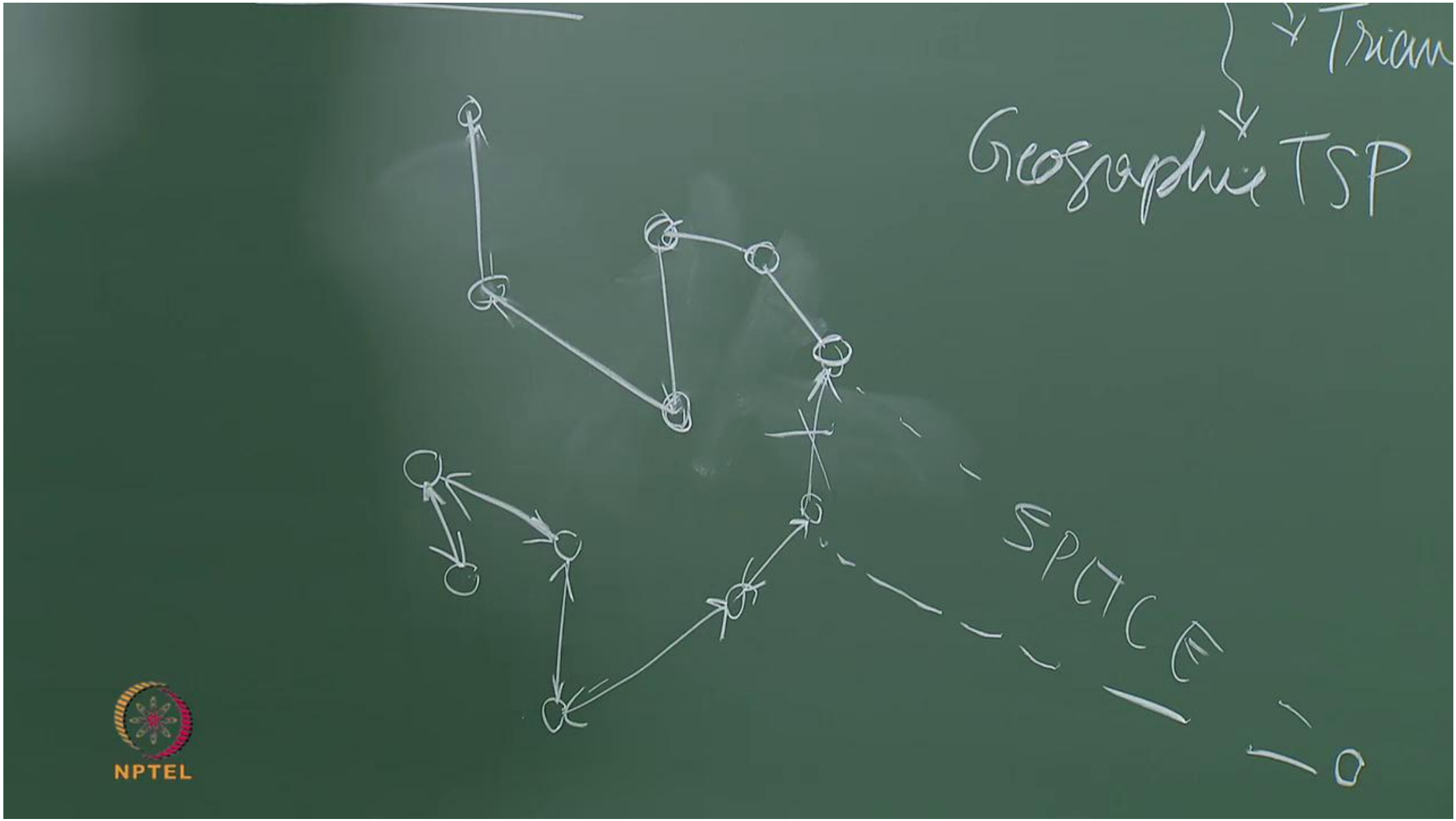
Euc

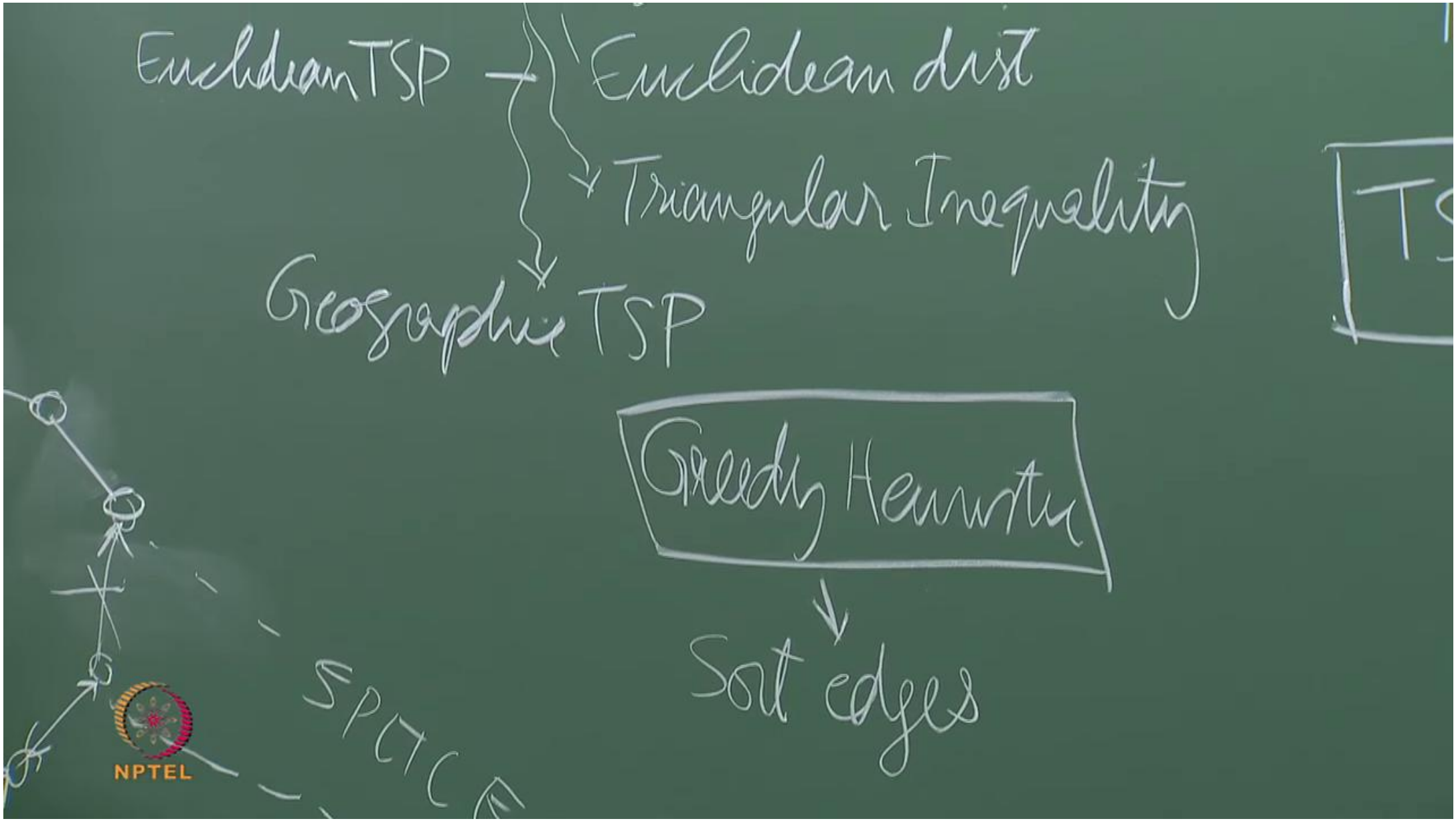
Tria

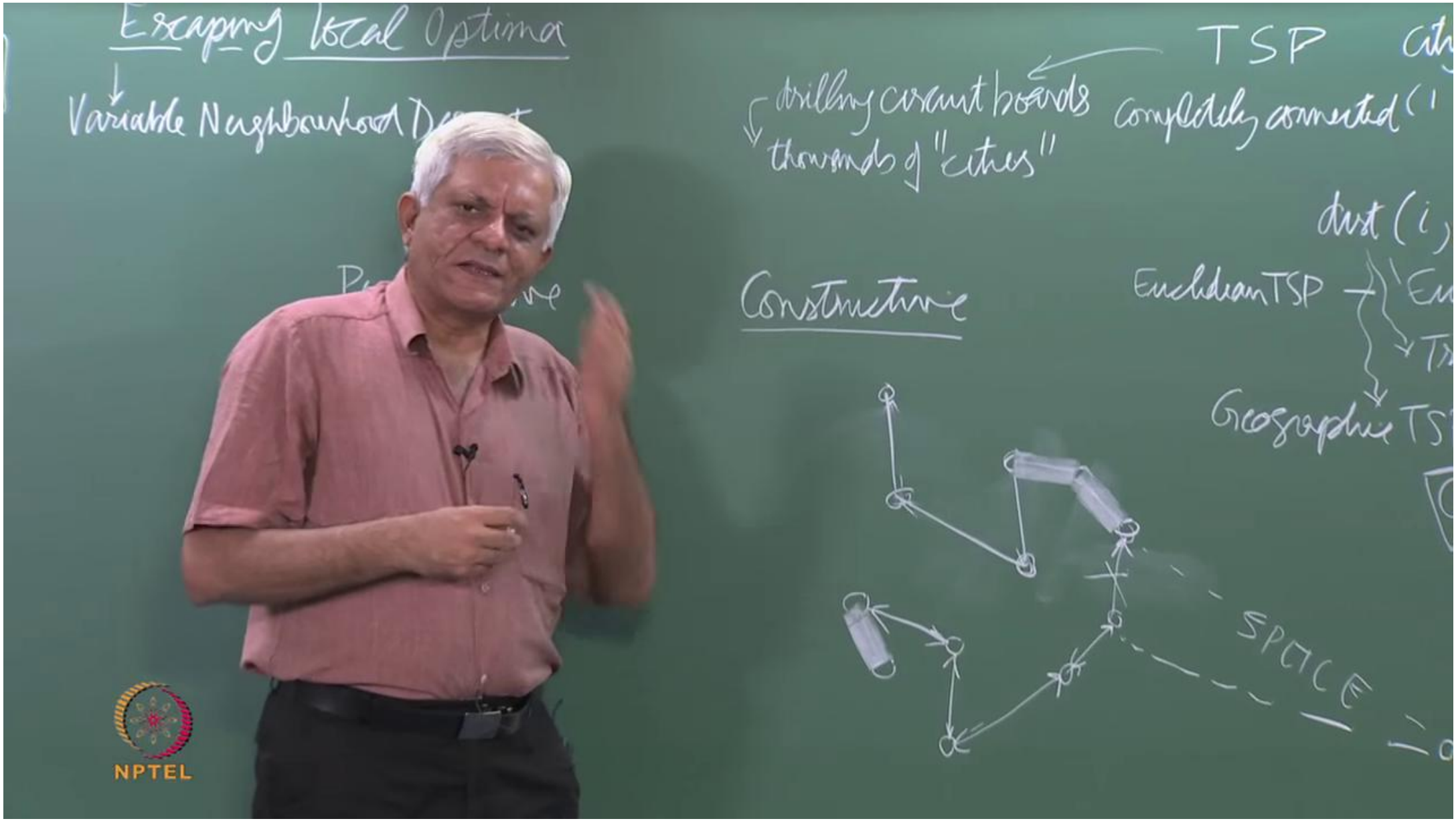
Geographic TSP

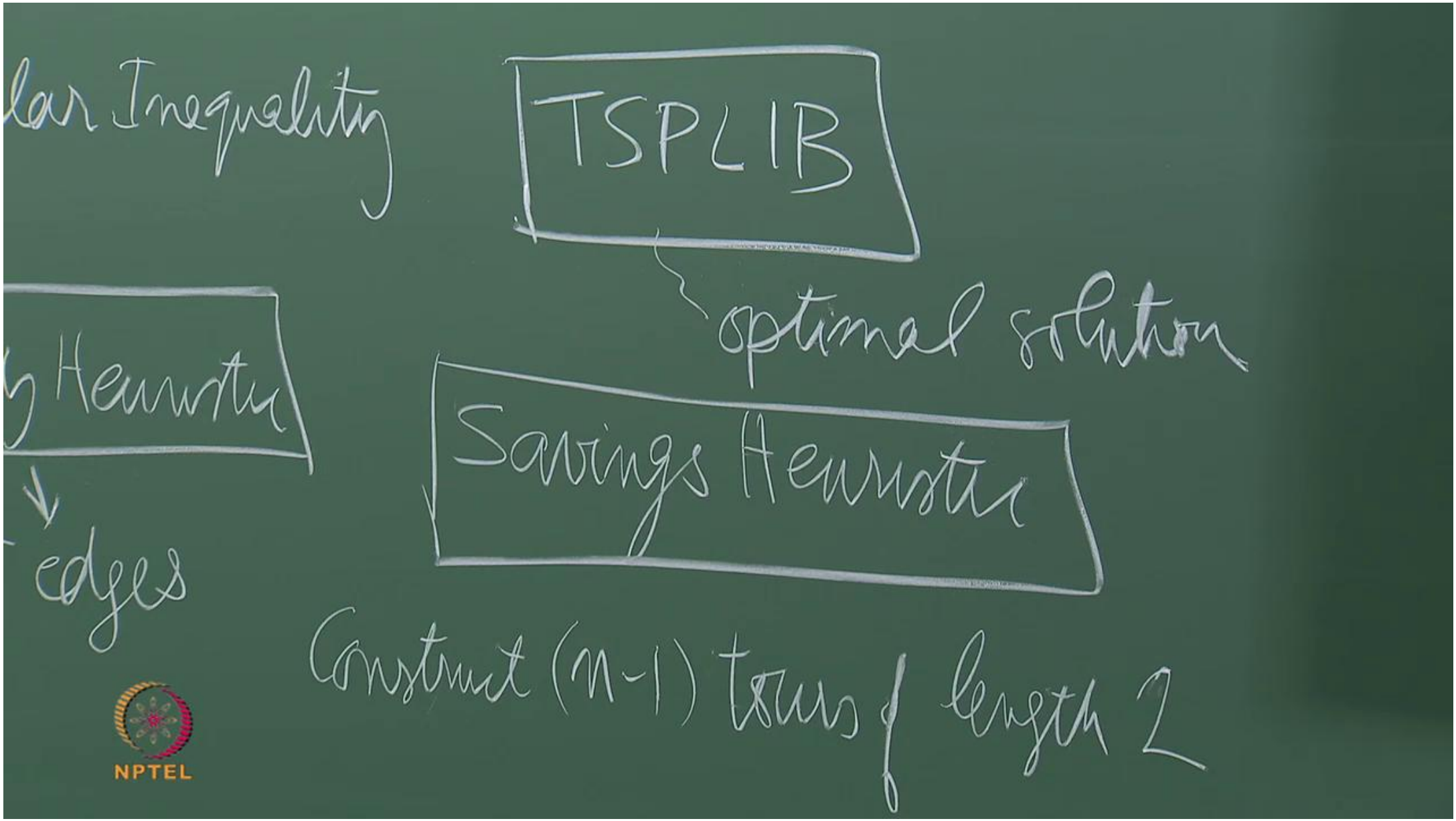

Triam
Geographic TSP

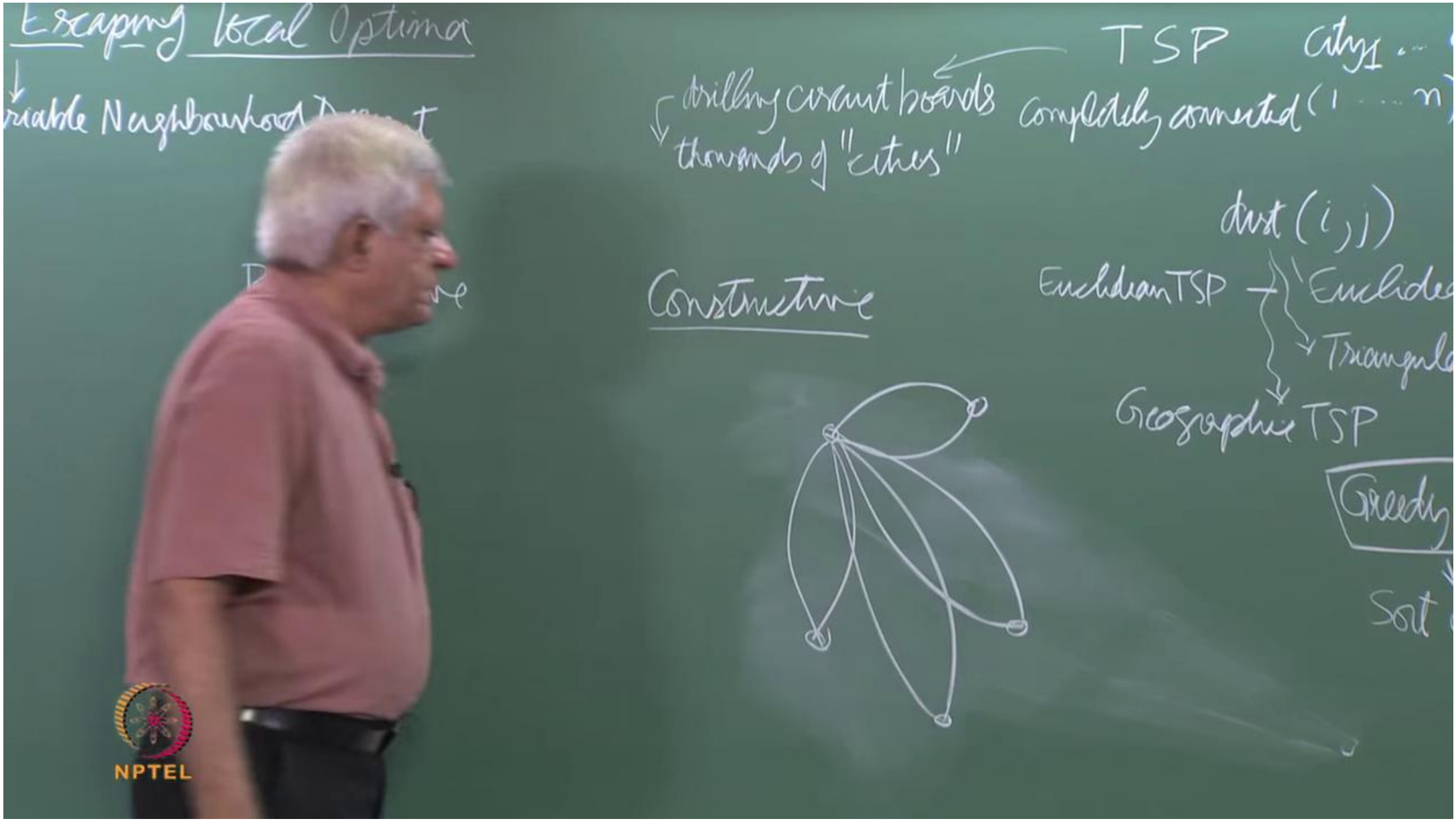

Escaping local Optima
Variable Neighbourhood
TSP
drilling circuit boards
thousands of "cities"
Constructive
Euclidean TSP
Geographi
NPTEL

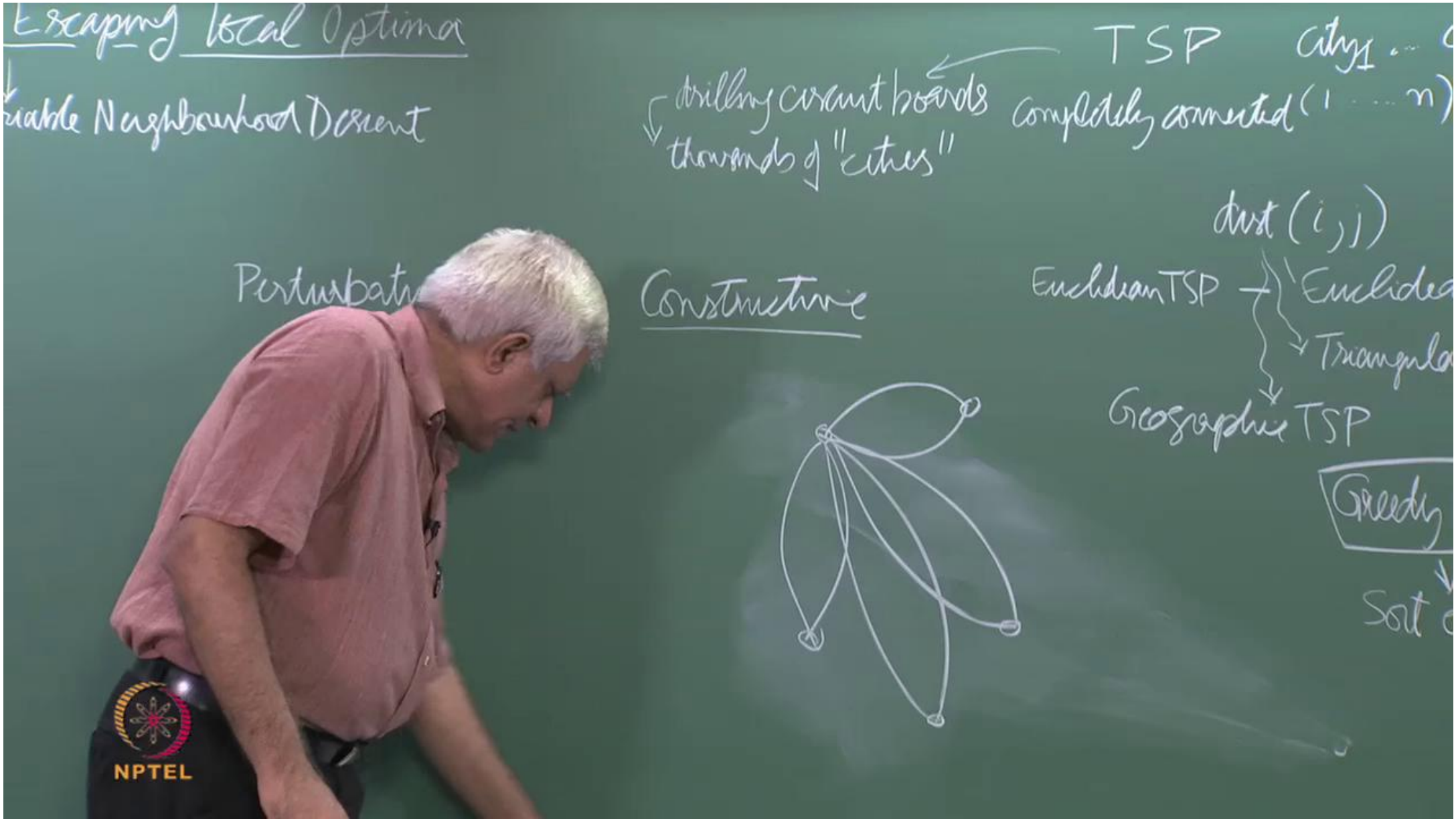

Triang
Geographic TSP
SPACE
NPTEL

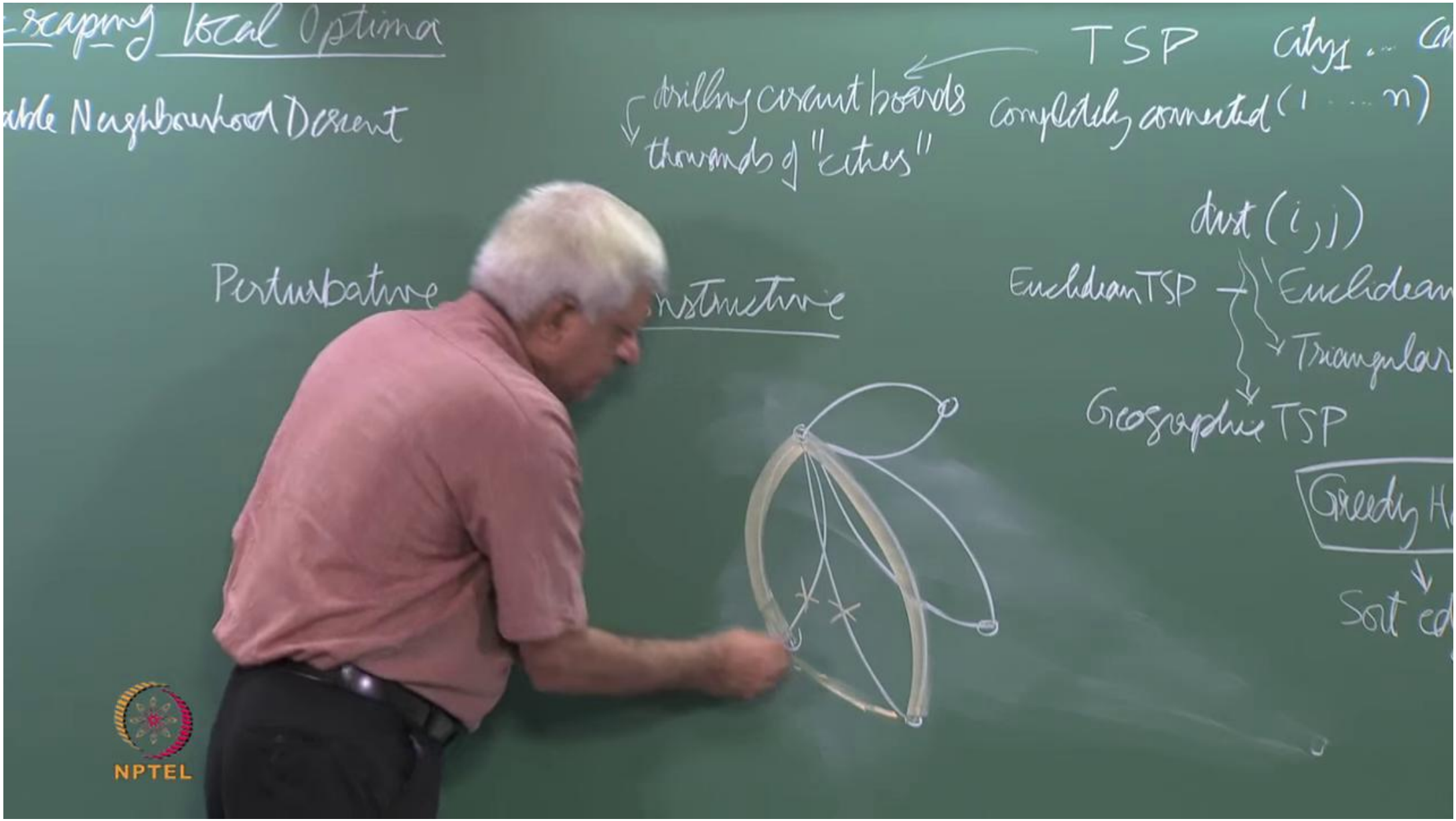

Euclidean TSP
Euclidean dist
Triangular Inequality
Geographic TSP
Greedy Heuristic
Sort edges
NPTEL

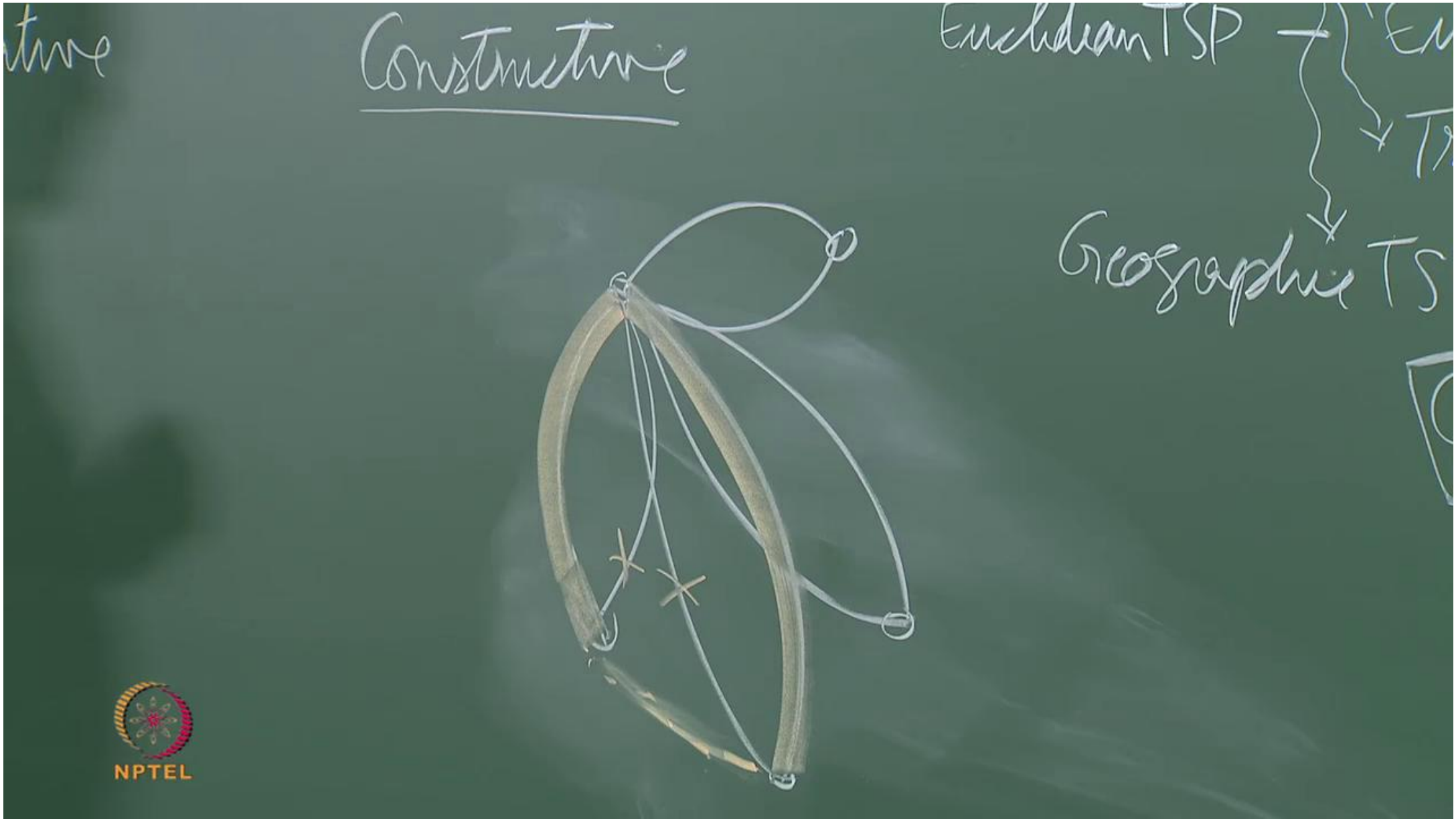

Escaping local Optima
Variable Neighbourhood
TSP
drilling circuit boards
thousands of "cities"
Constructive
EuclideanTSP
SPACE

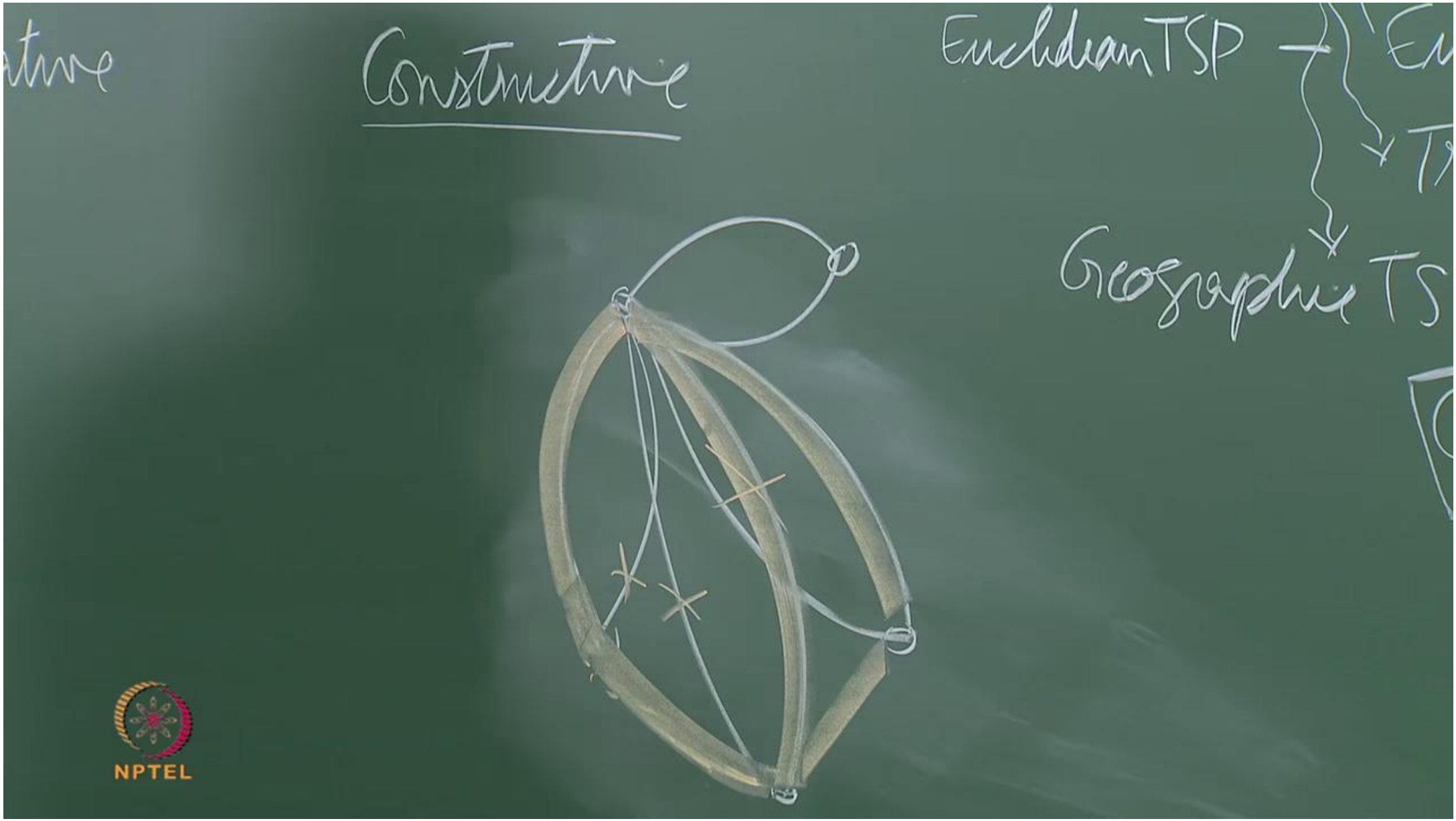

lar Inequality
TSPLIB
optimal solution
y Heuristic
Savings Heuristic
edges
Construct (n-1) tours of length 2
NPTEL

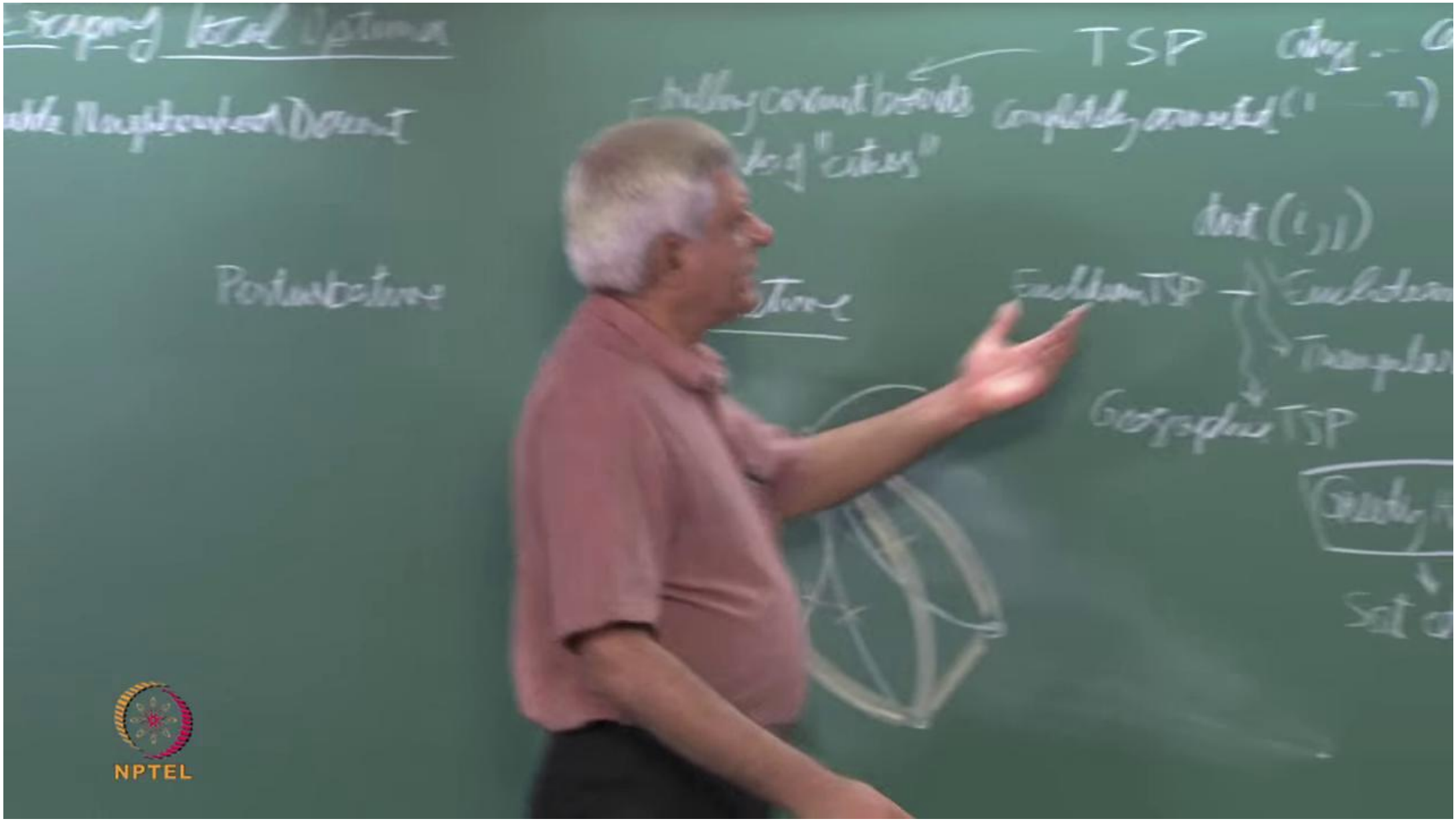

Escaping local Optima
TSP
drilling circuit boards
thousands of "cities"
completely connected
dist (i, j)
Euclidean TSP
Constructive
Geographic TSP
Greedy
NPTEL

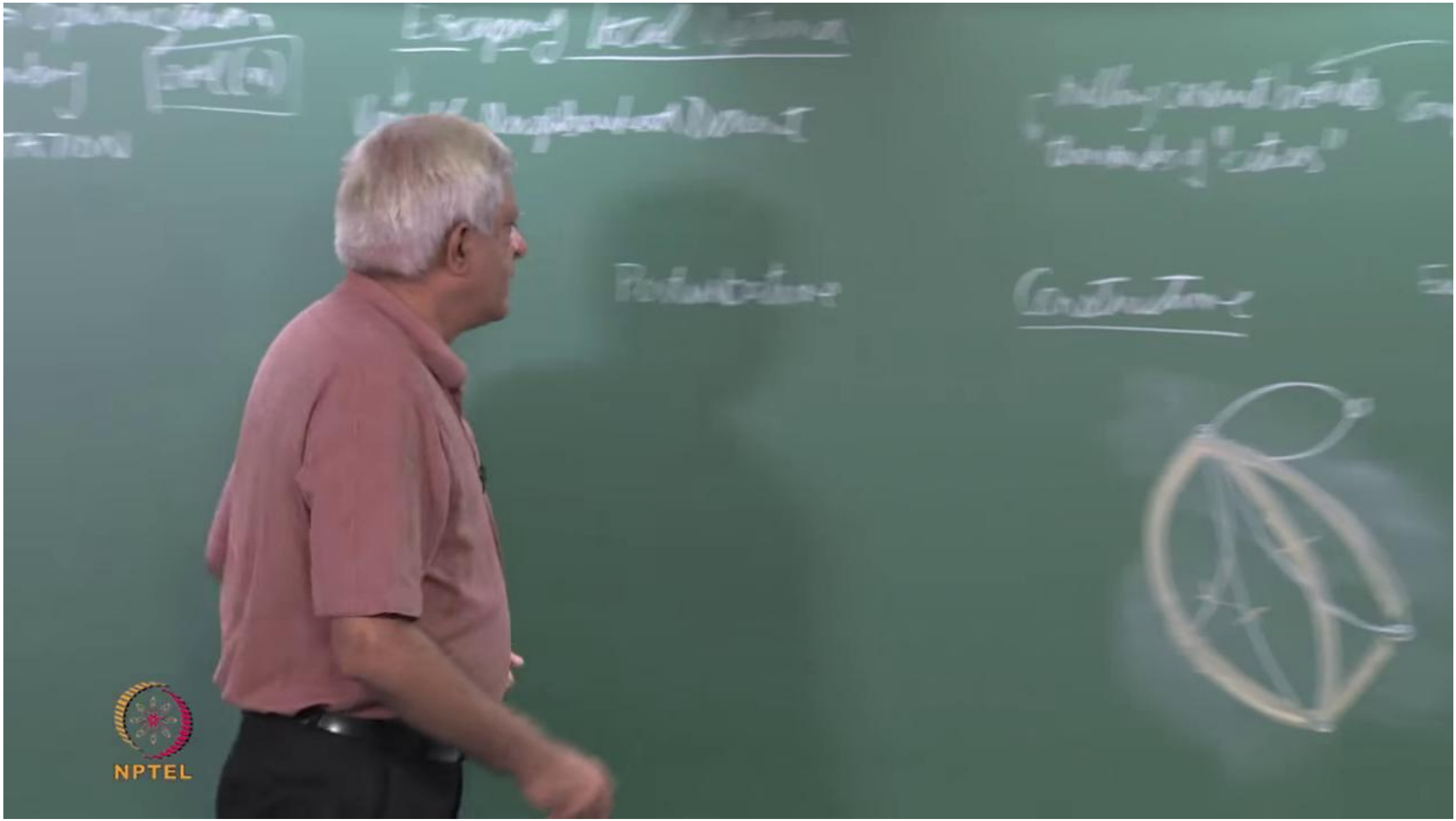

Escaping local Optima
TSP
drilling circuit boards
thousands of "cities"
completely connected
dist (i, j)
Euclidean TSP
Geographic TSP
Constructive
Greedy
NPTEL

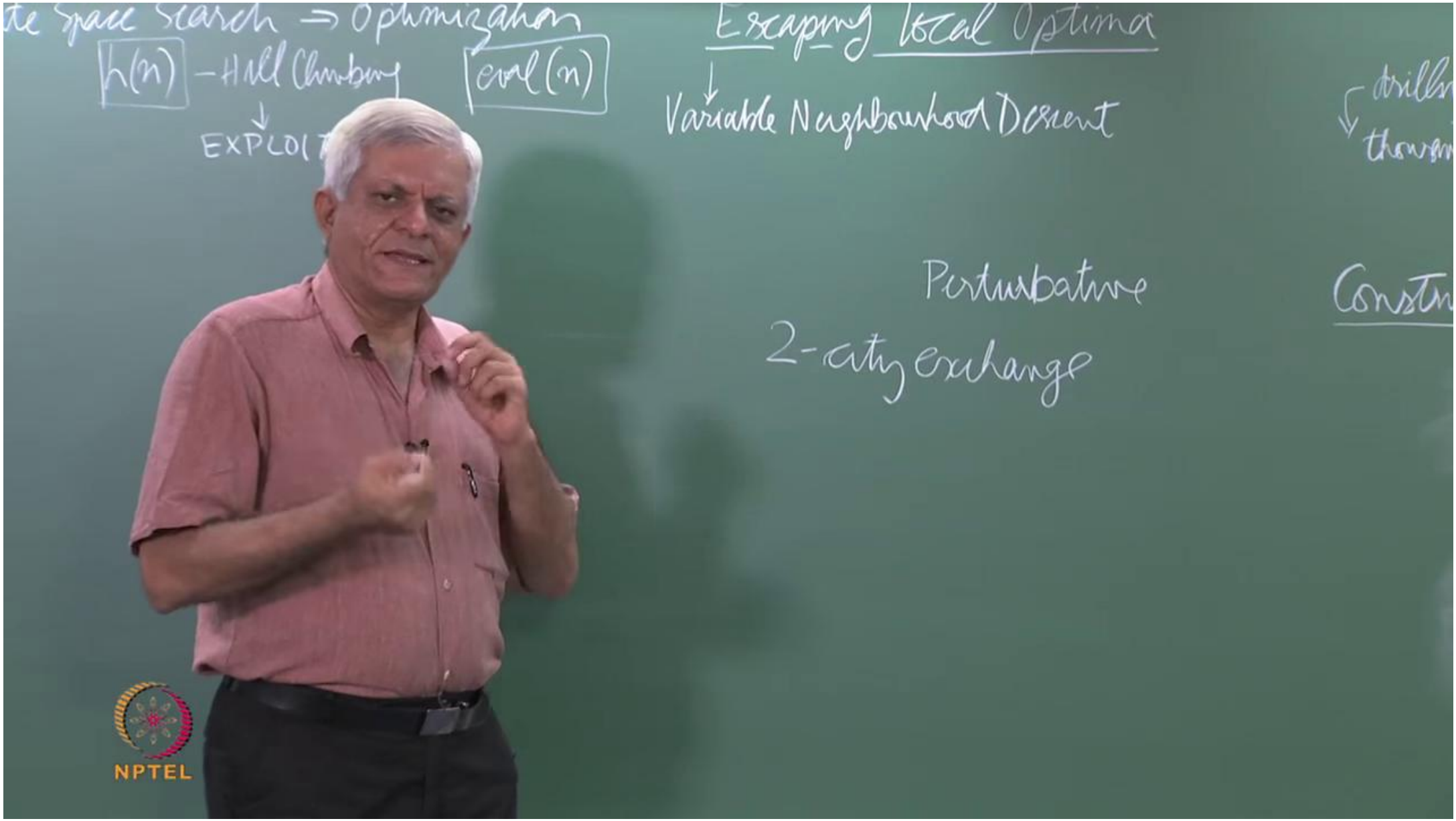

Escaping local Optima
able Neighbourhood Descent
TSP
drilling circuit boards
thousands of "cities"
Perturbative
Constructive
dist (i, j)
Euclidean TSP
Euclidean
Triangular
Geographic TSP
Greedy H
Sort ed
NPTEL

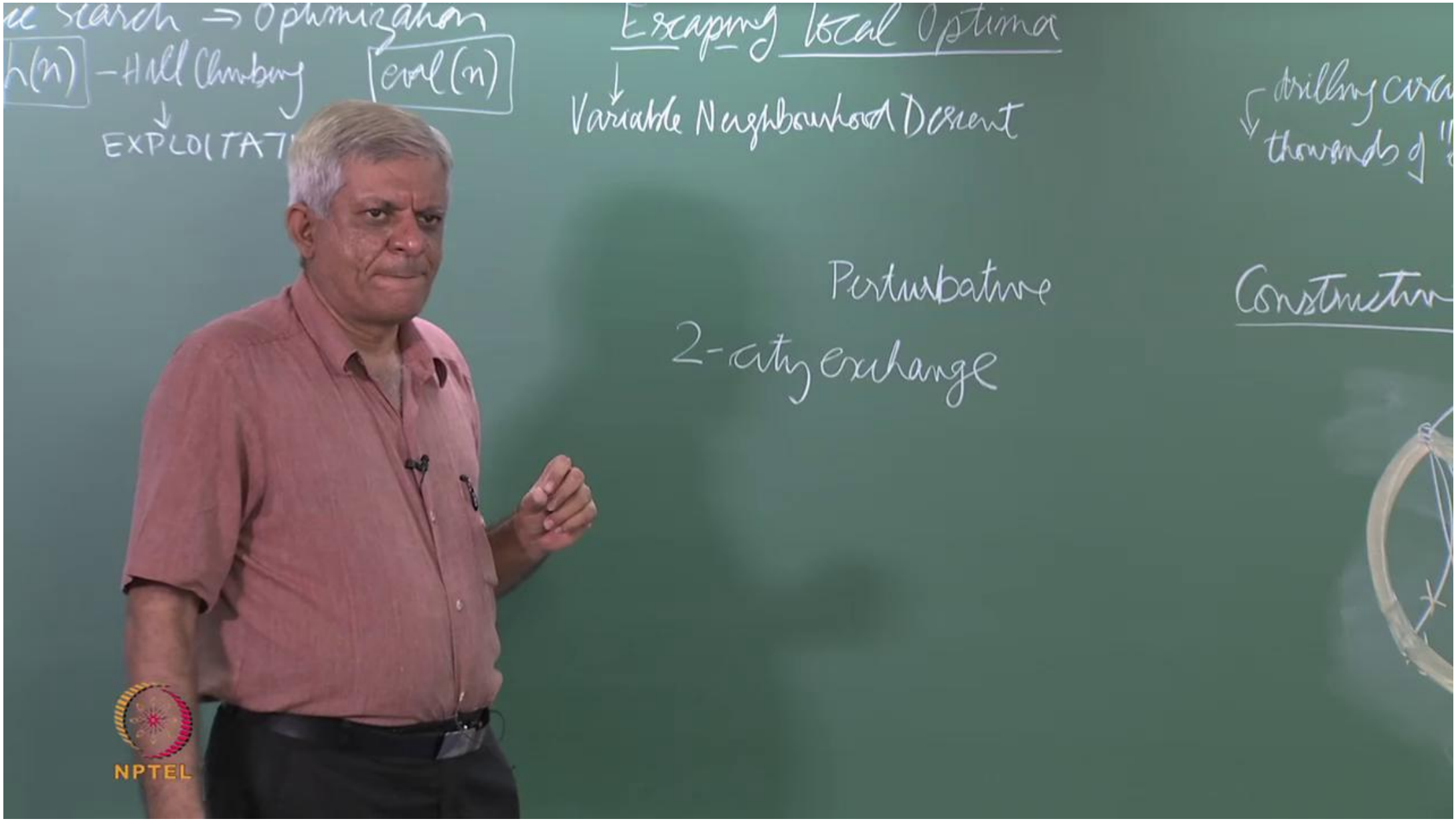

Constructive
Euclidean TSP
Geographic TS


Constructive
Euclidean TSP
Geographic TS
NPTEL


TSP
NPTEL


NPTEL

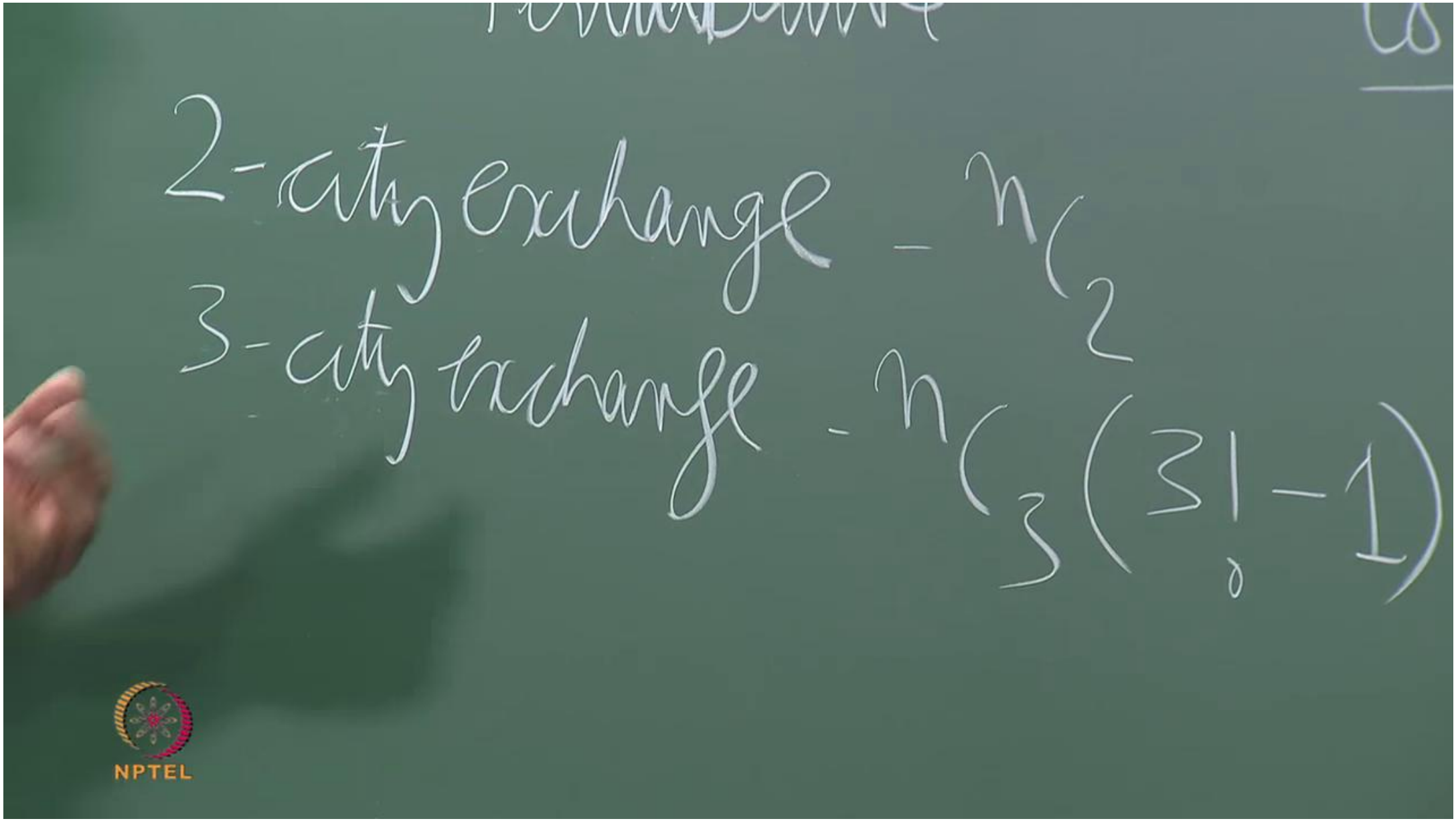

te space search ⇒ Optimization
h(n) - Hill Climbing
eval(n)
EXPLOI
Escaping local Optima
Variable Neighbourhood Descent
drill
Perturbative
2-city exchange
Constr
NPTEL

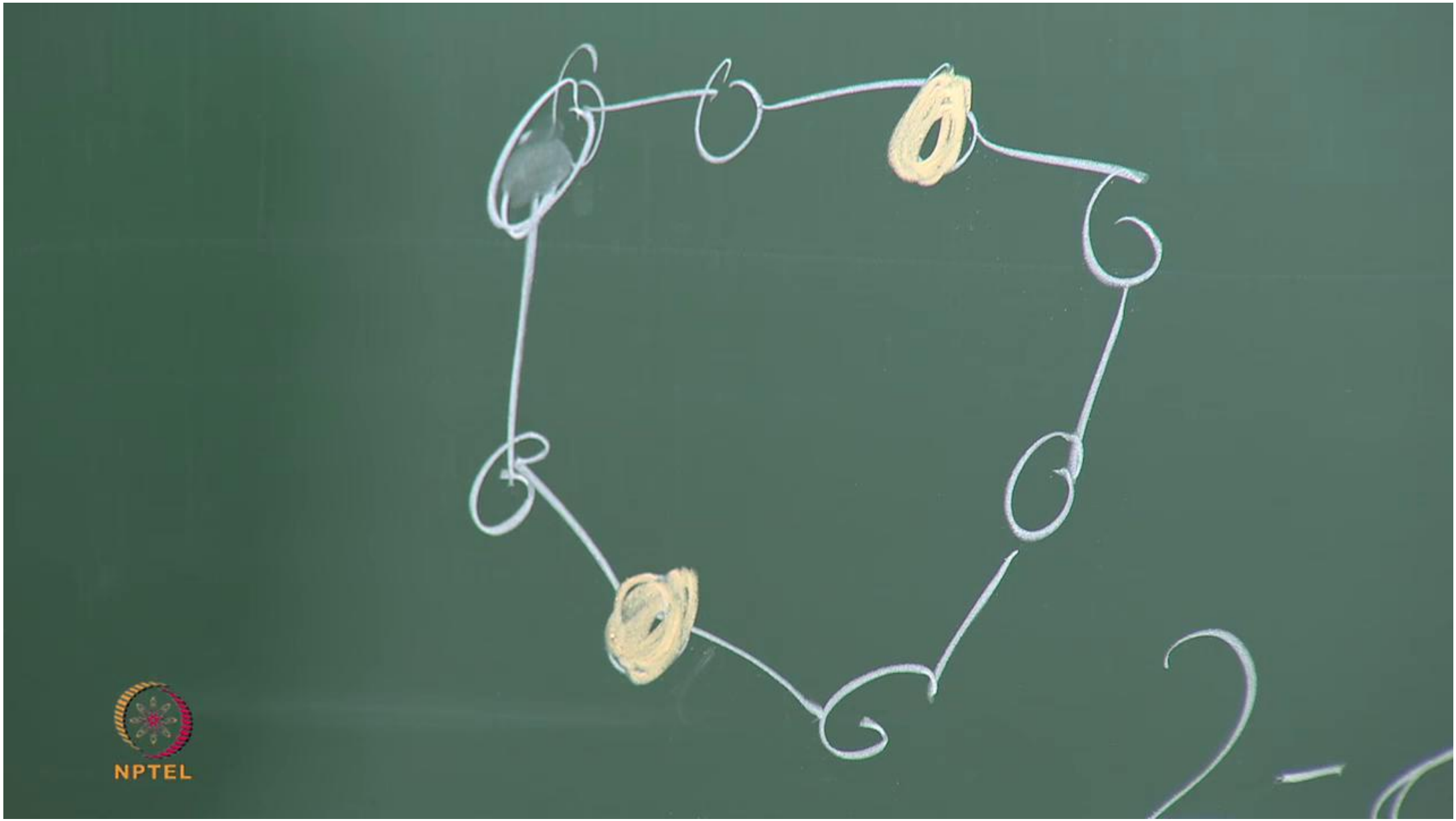

Escaping local Optima
Variable Neighbourhood Descent
Perturbative
2-city exchange
Constructive
NPTEL

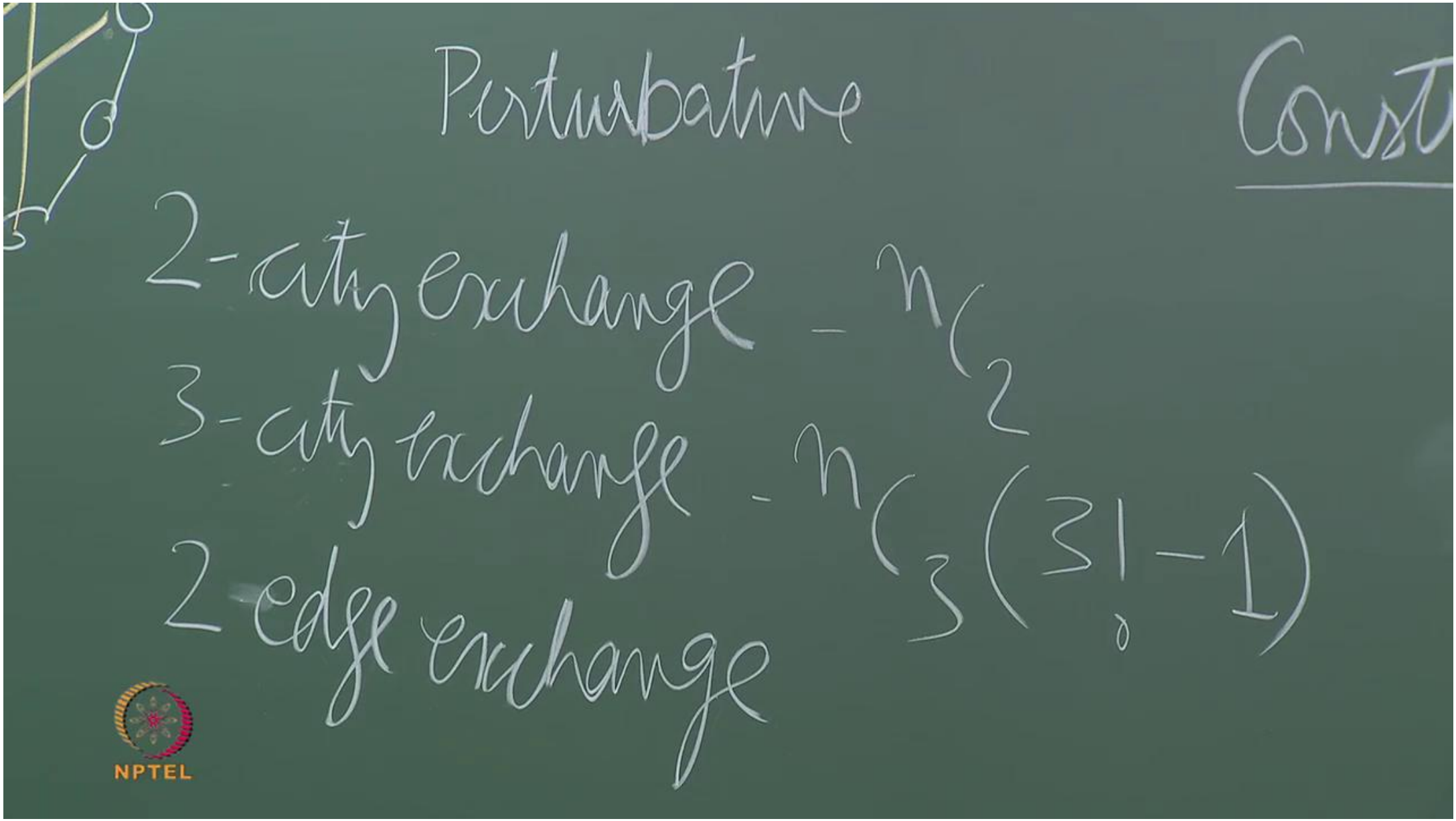
Perturbature

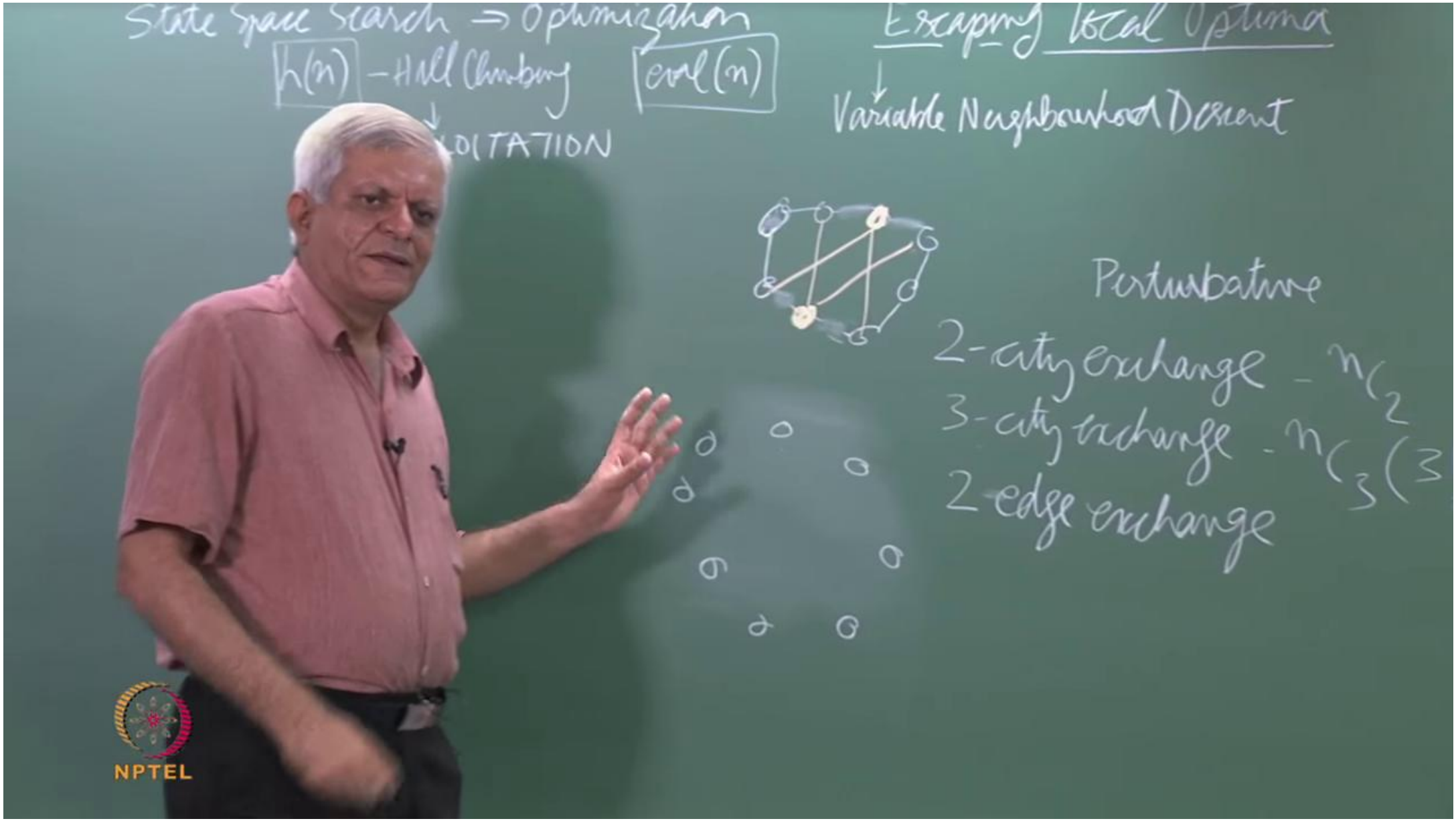
2-city exchange — n_{C_2}

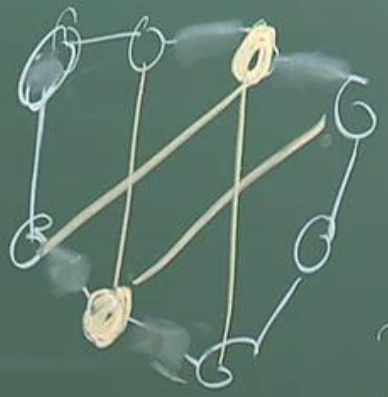
3-city exchange


2-city exchange - n_{C_2}
3-city exchange - $n_{C_3}(3!-1)$
NPTEL


NPTEL


Perturbative
Const
2-city exchange - n(2
3-city exchange - n(3(3!-1)
2 edge exchange


State space search ⇒ Optimization
h(n) - Hill Climbing
eval(n)
Escaping local Optima
Variable Neighbourhood Descent
Perturbative
2-city exchange
3-city exchange
2-edge exchange
NPTEL

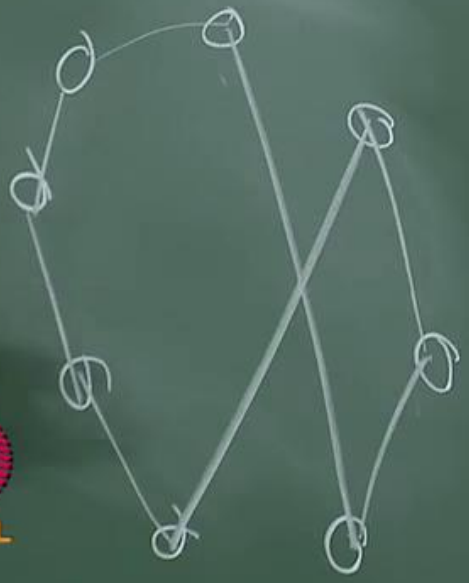


Perturbative

2-city exchange $- n_{C_2}$

3-city exchange $- n_{C_3}(3! - 1)$

2-edge exchange



State space search ⇒ Optimization

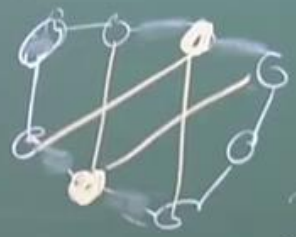
h(n) – Hill Climbing

EXPLOITATION

eval(n)

Escaping local Optima

Variable Neighbourhood Descent

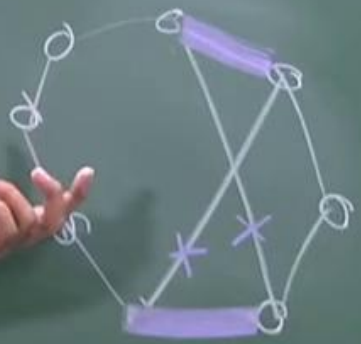


Perturbative

2-city exchange – n(

3-city exchange – n(3

2-edge exchange



State Space Search ⇒ Optimization

h(n) – Hill Climbing

eval(n)

EVALUATION

Escaping local Optima

↓

Variable Neighbourhood Descent

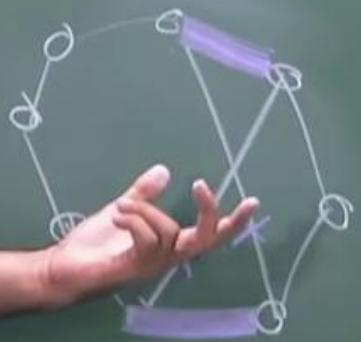
Perturbative

2-city exchange – n(2

3-city exchange – n(3

2-edge exchange

(2765 41398)



NPTEL

State Space Search ⇒ Optimization

h(n) - Hill Climbing

↓

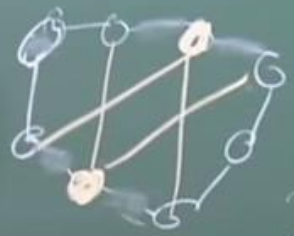
EXPLOITATION

eval(n)

Escaping local Optima

↓

Variable Neighbourhood Descent



Perturbative

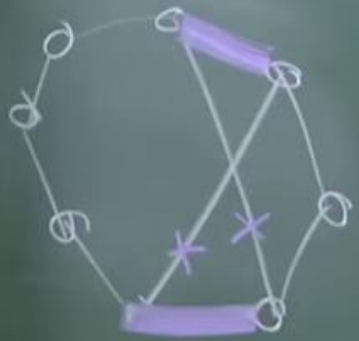
2-city exchange - n_{C_2}

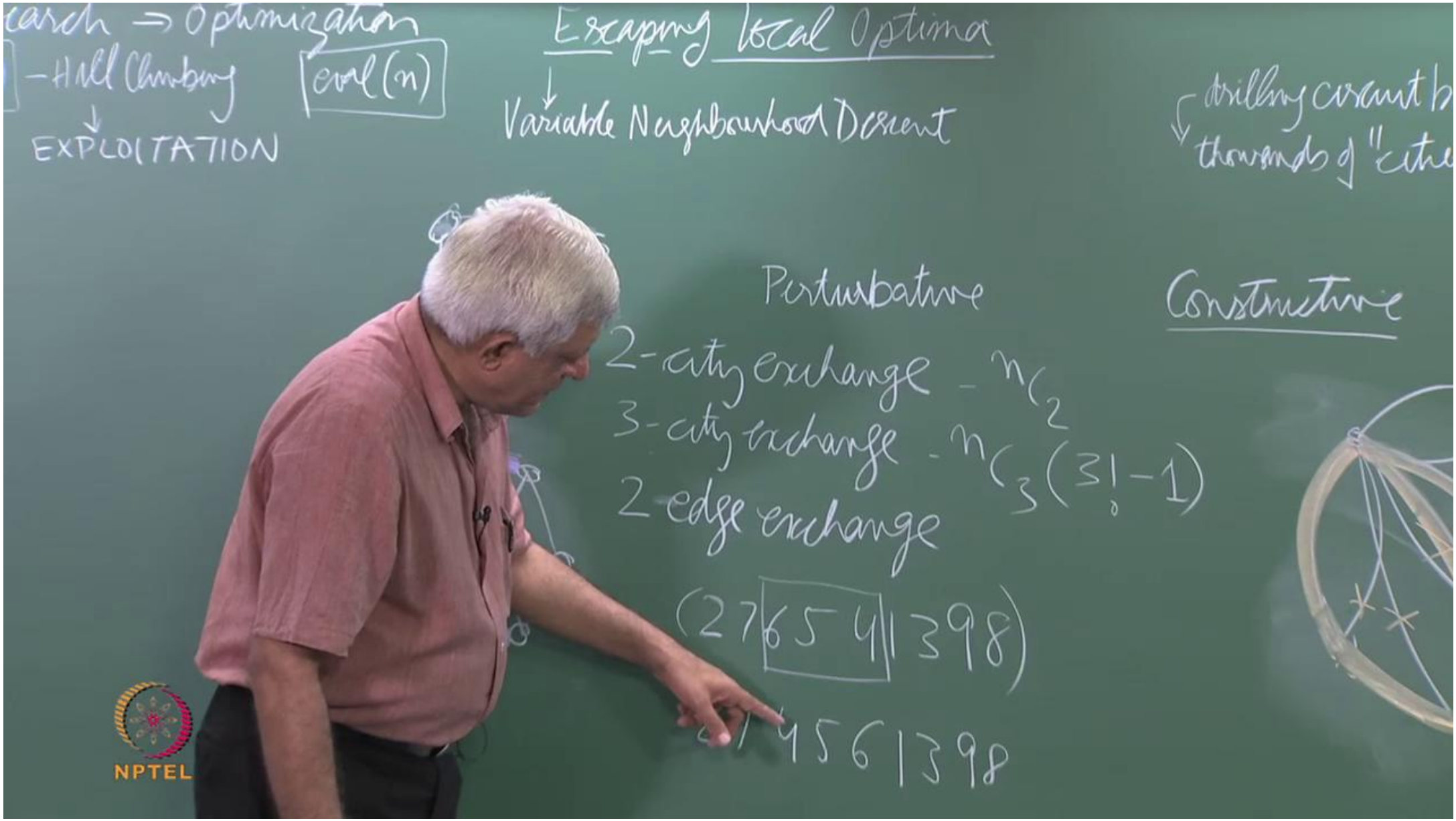
3-city exchange - $n_{C_3}(3!-1)$

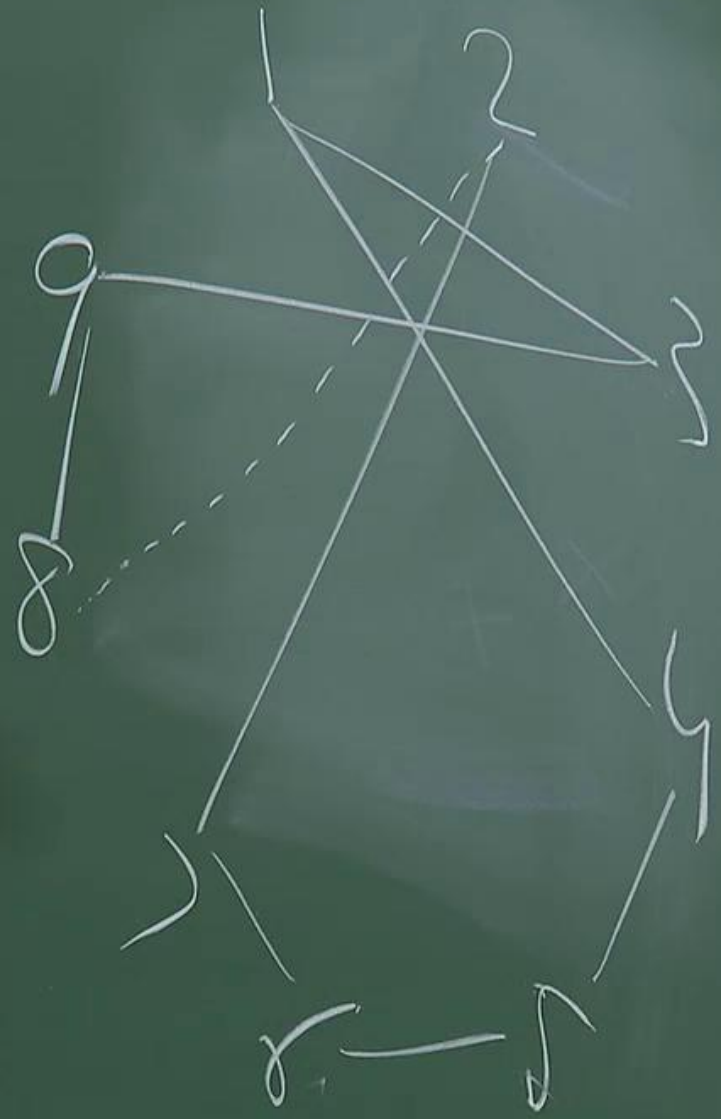
2-edge exchange

(27654|1398)

27456|1398




arch ⇒ Optimization
-Hill Climbing
EXPLOITATION
eval(n)
Escaping local Optima
Variable Neighbourhood Descent
drilling circuit b
thousands of "citie
Perturbative
Constructive
2-city exchange - n(2
3-city exchange - n(3(3!-1)
2-edge exchange
(27654|398)
27456|398
NPTEL

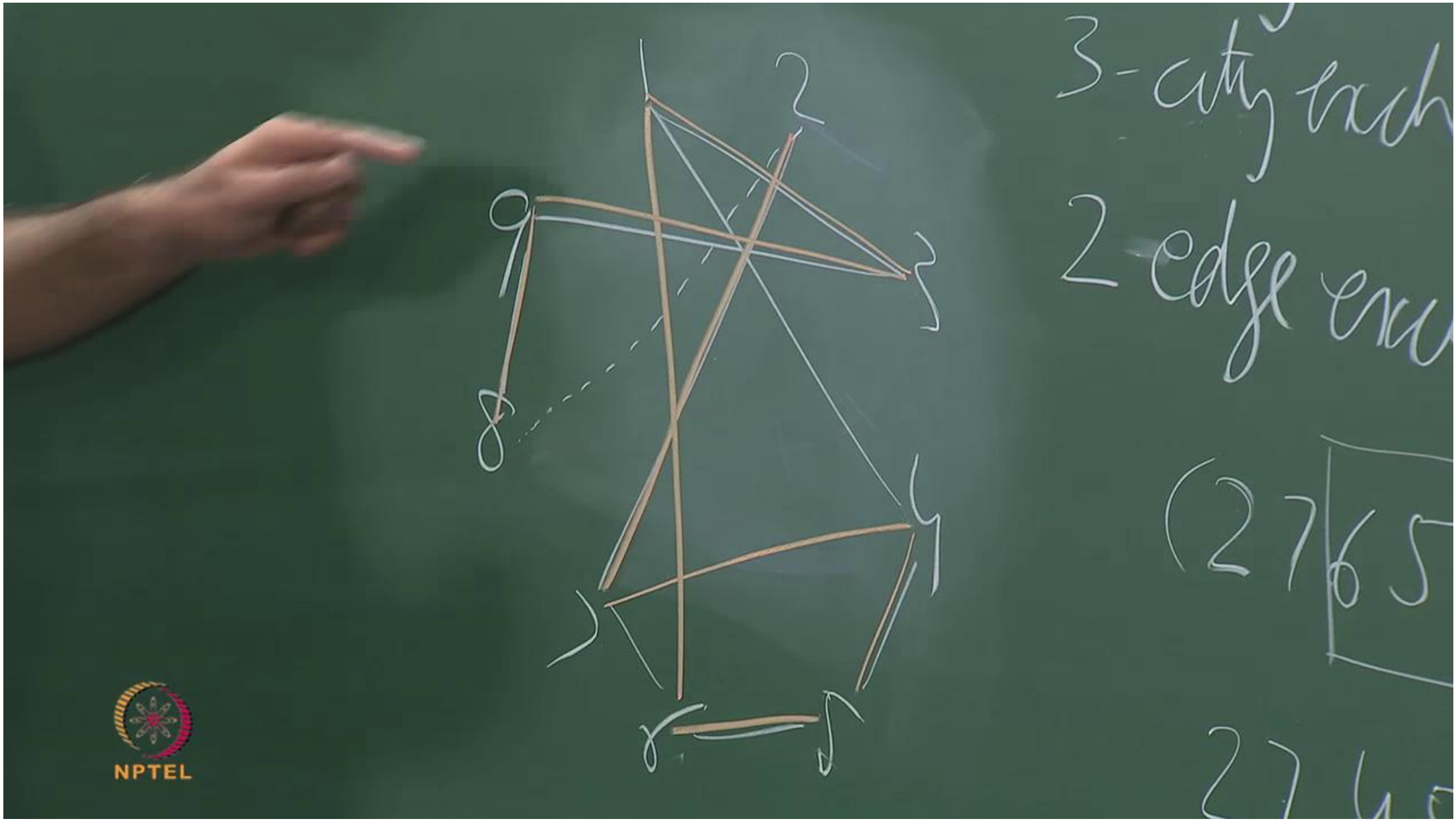


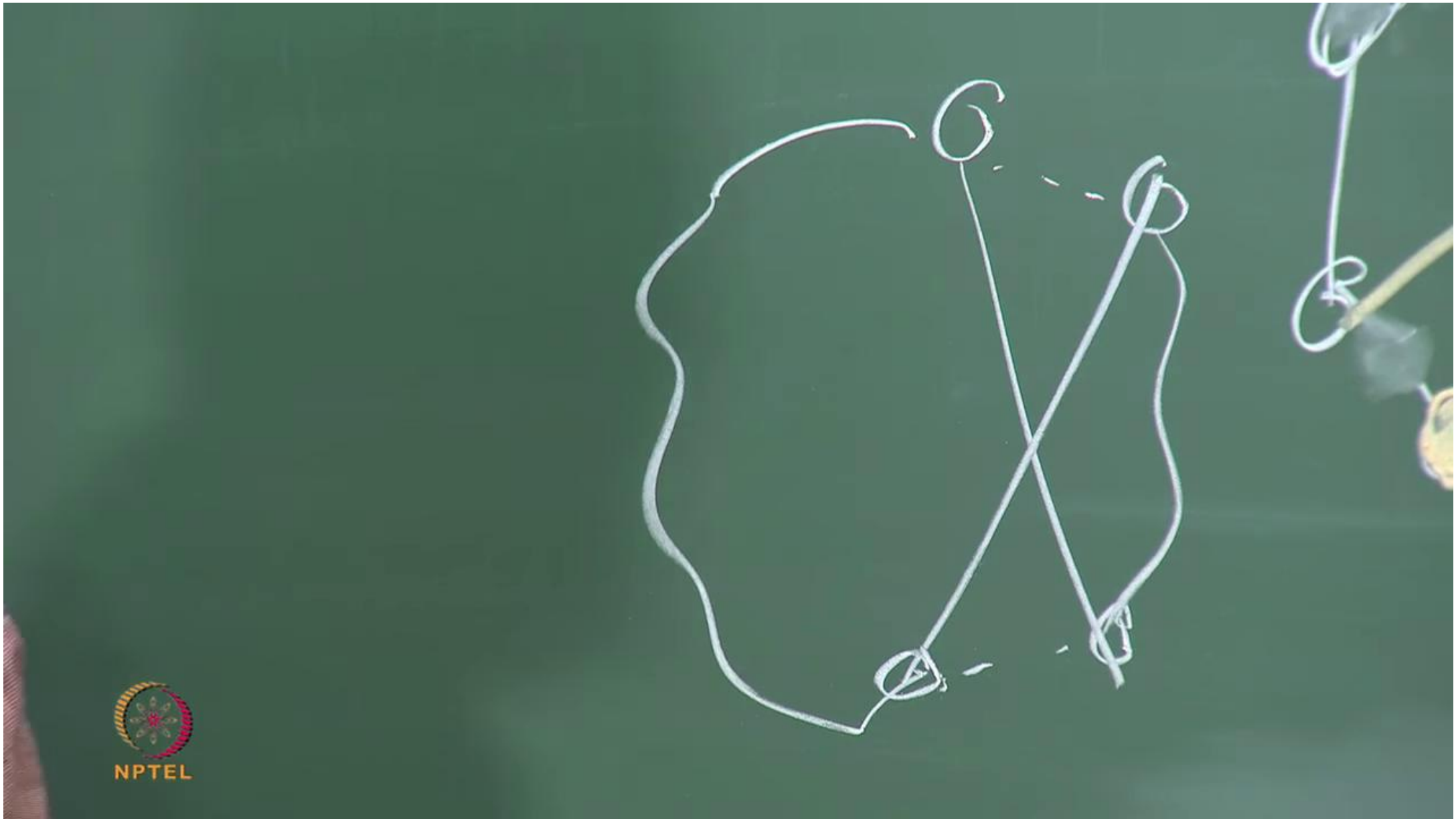
3-cut

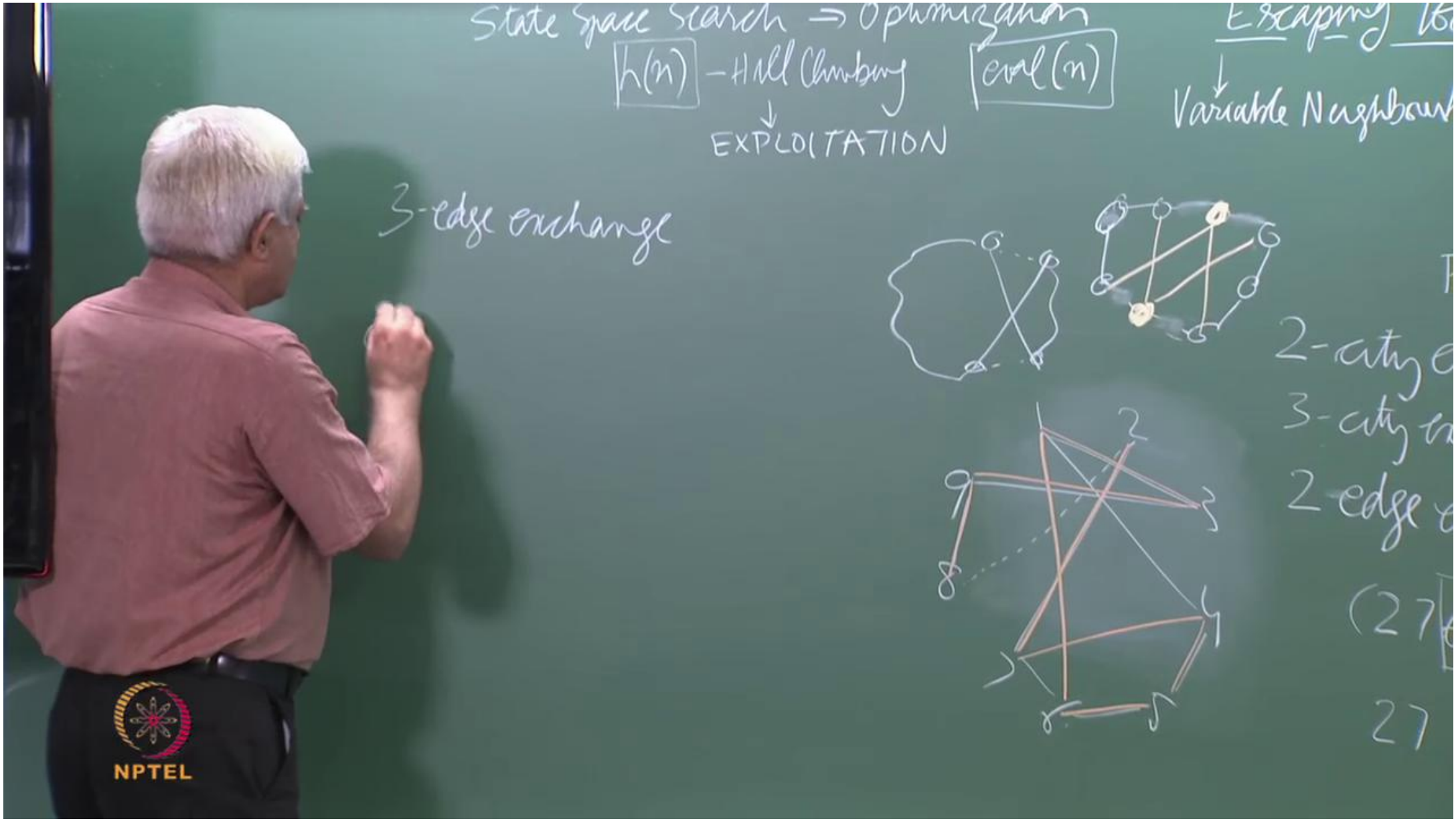
2-edge

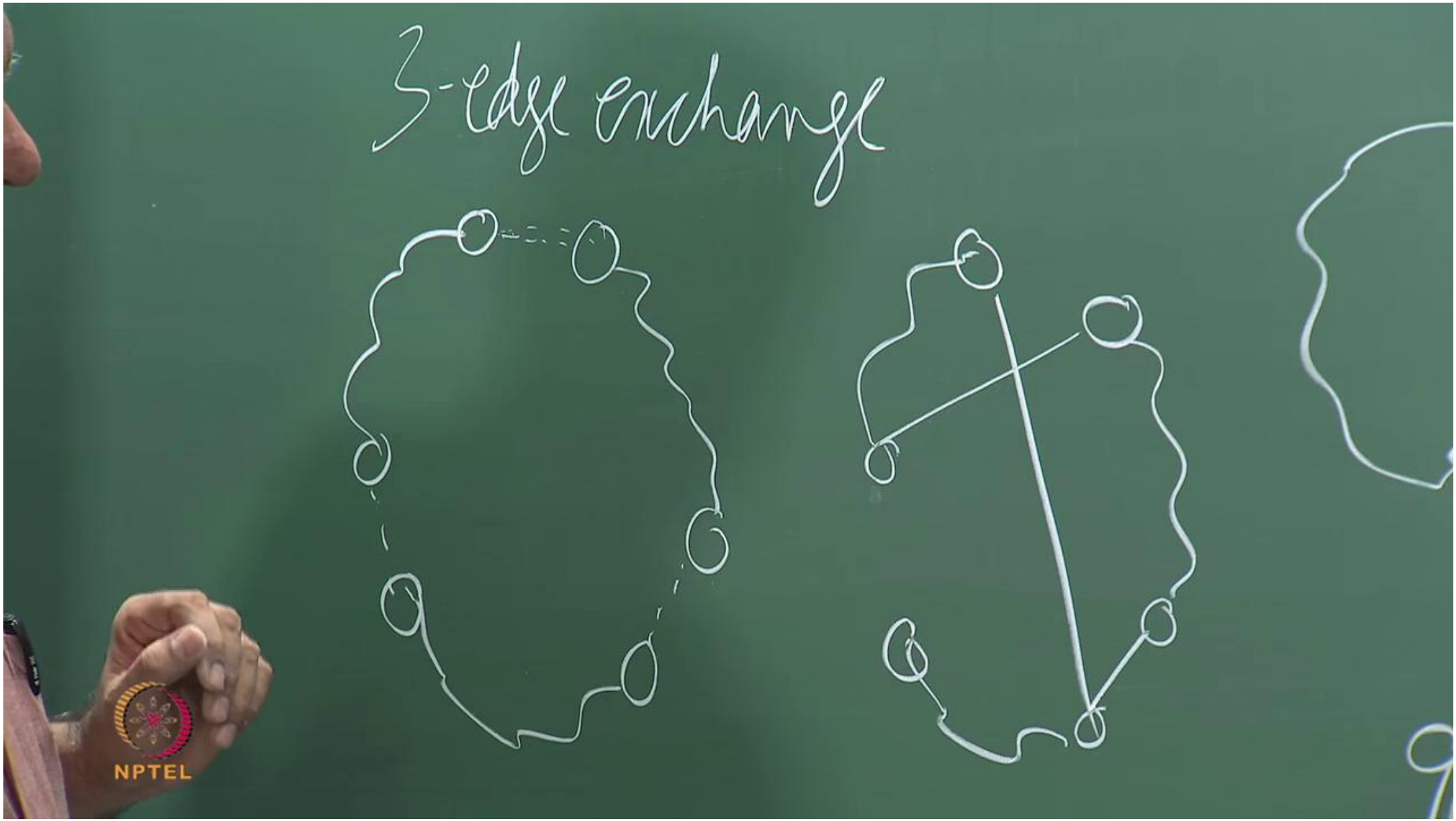
(2 7 6 5

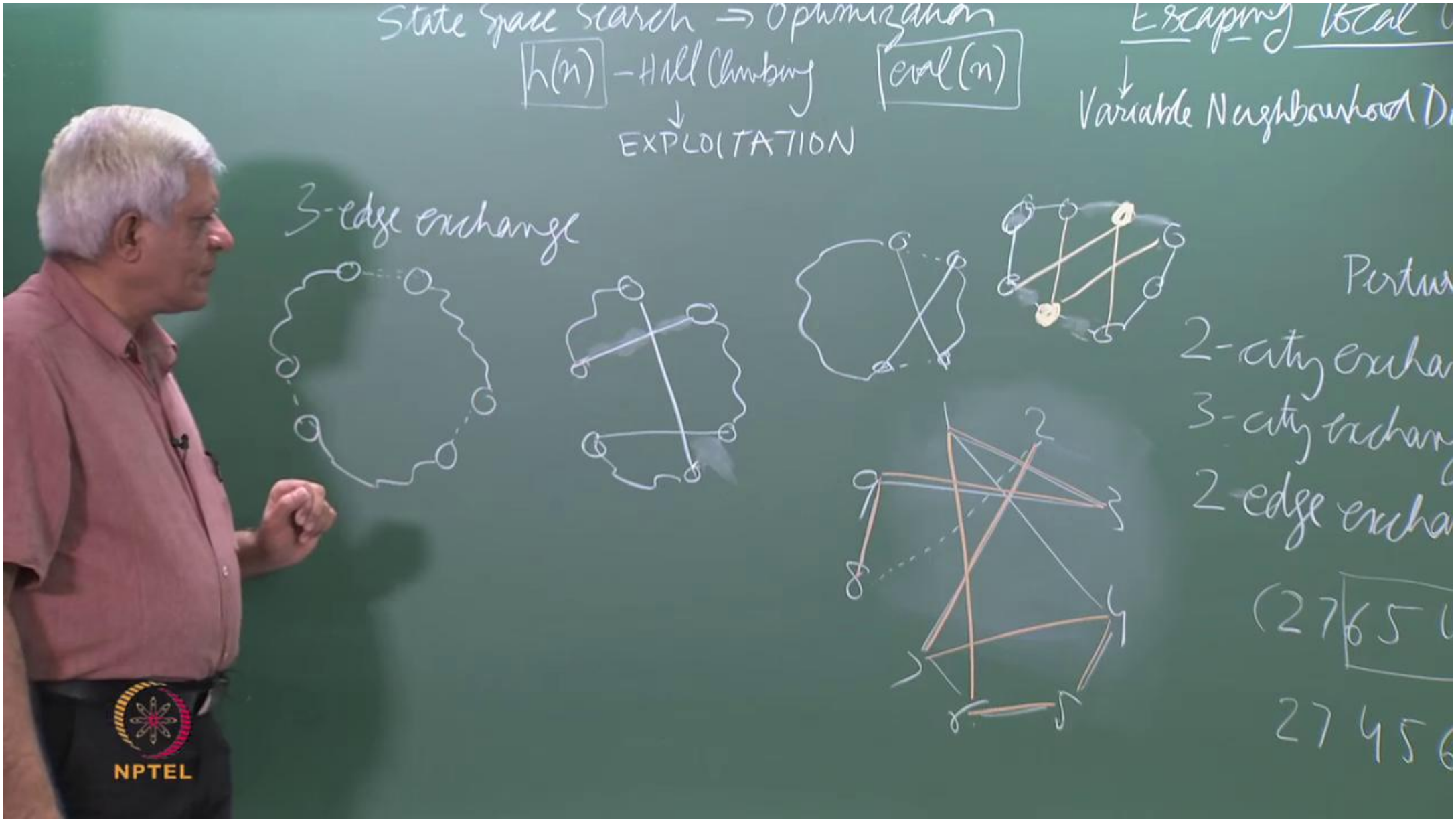
2 7 6 5

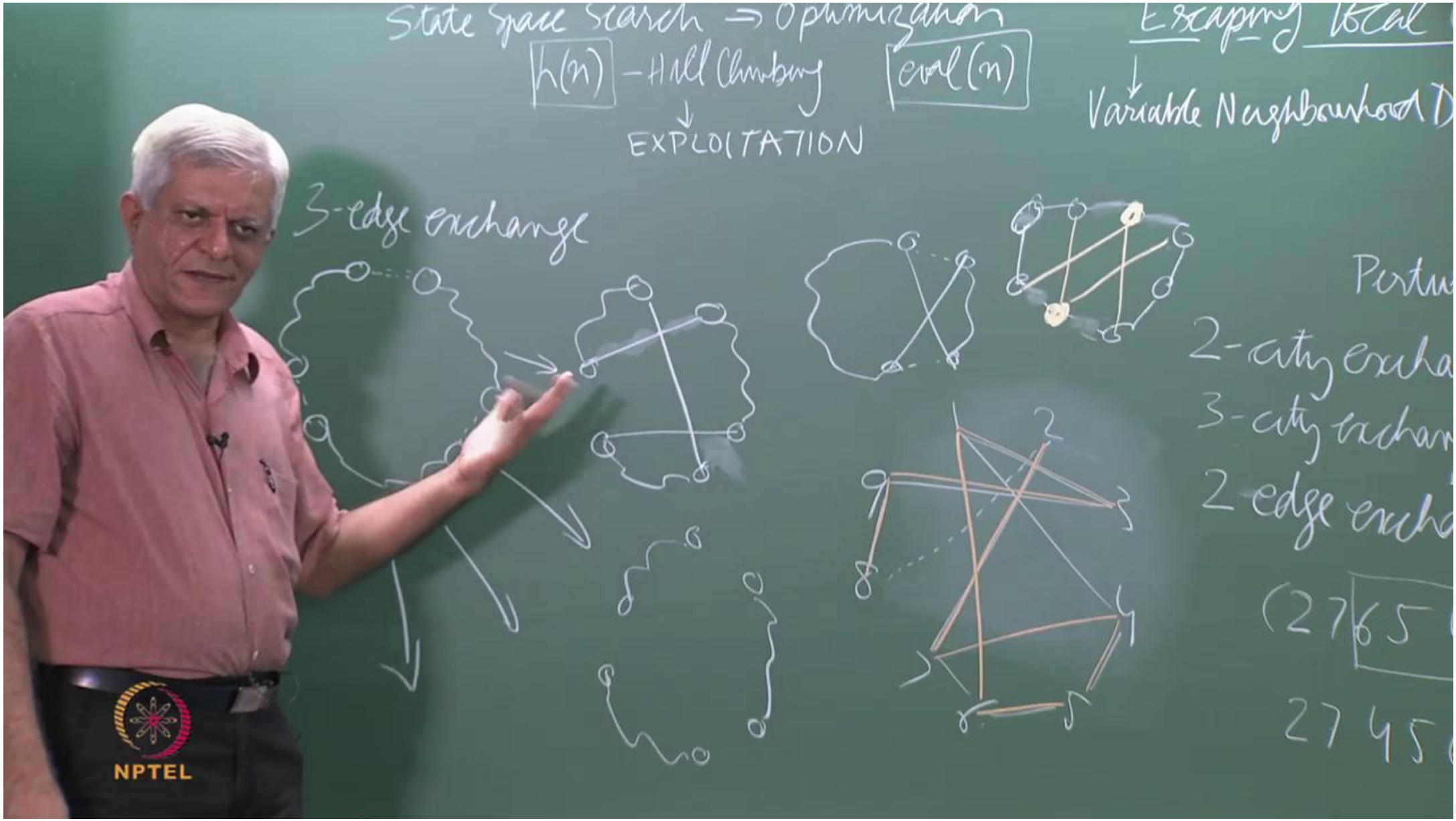

3-city
2-edge
(27
65
NPTEL

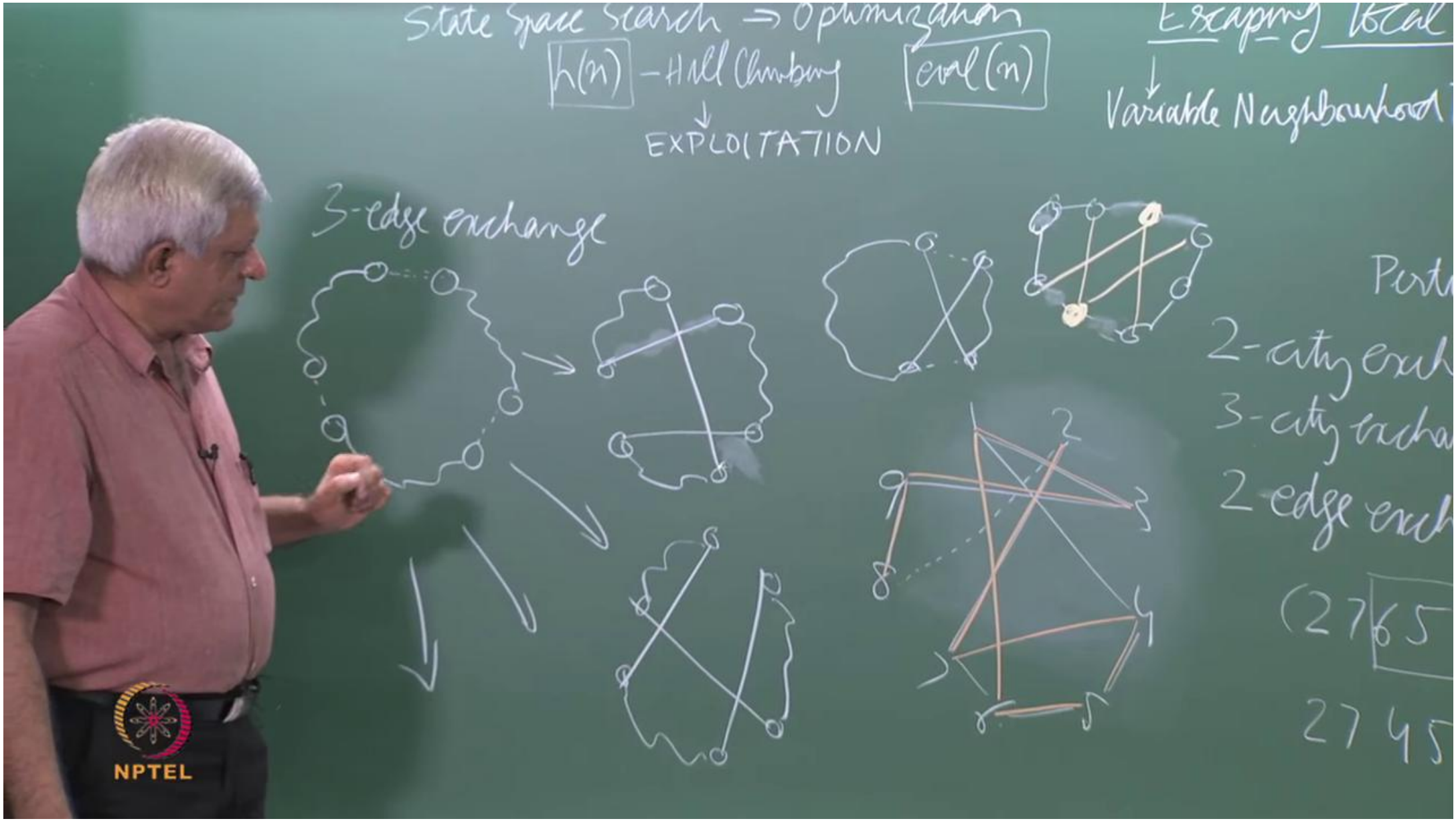

NPTEL

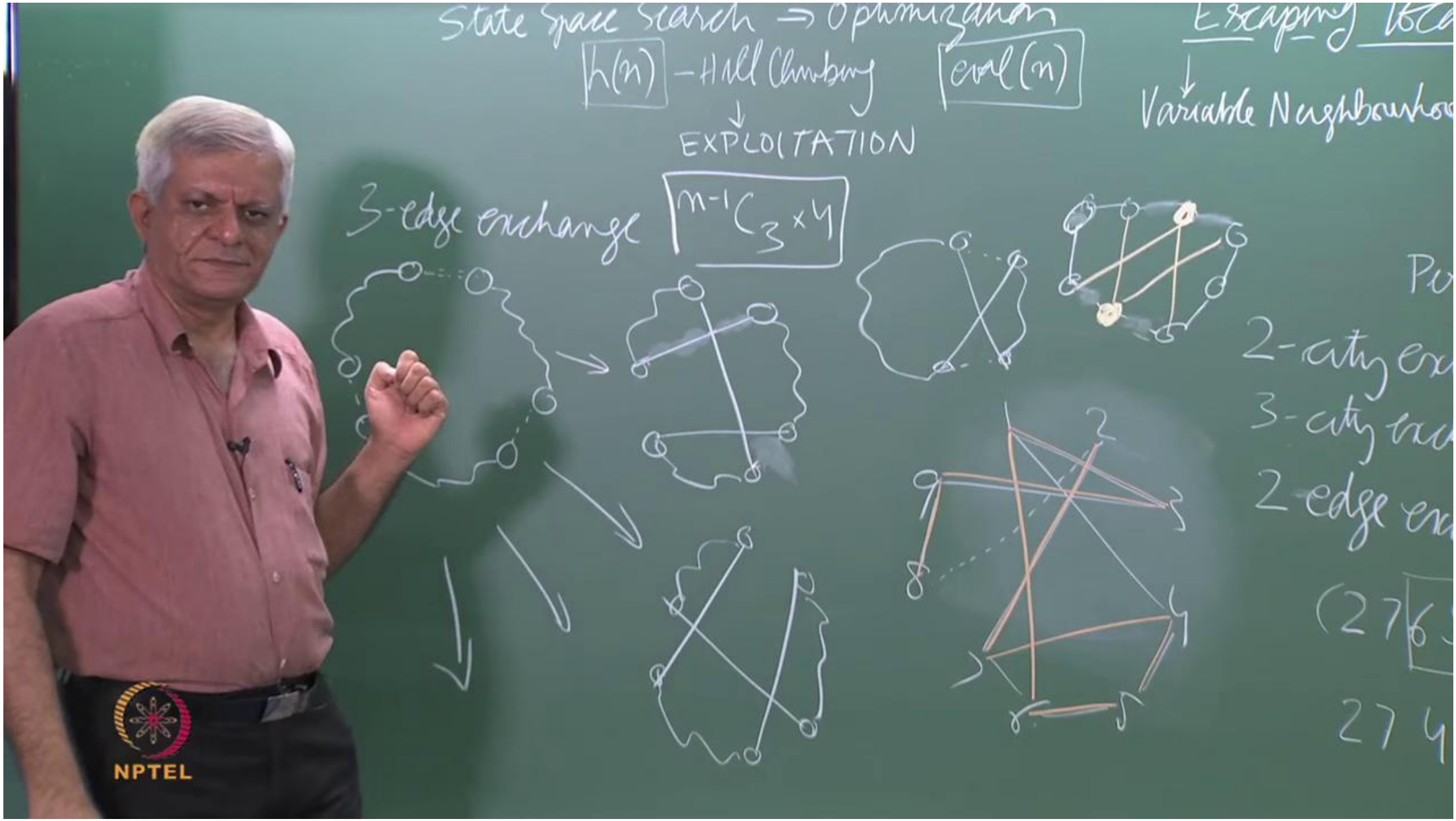

State space search ⇒ Optimization
h(n) - Hill Climbing
eval(n)
EXPLOITATION
Escaping
Variable Neighbour
3-edge exchange
2-city
3-city
2-edge
(27
27
NPTEL


3-edge exchange

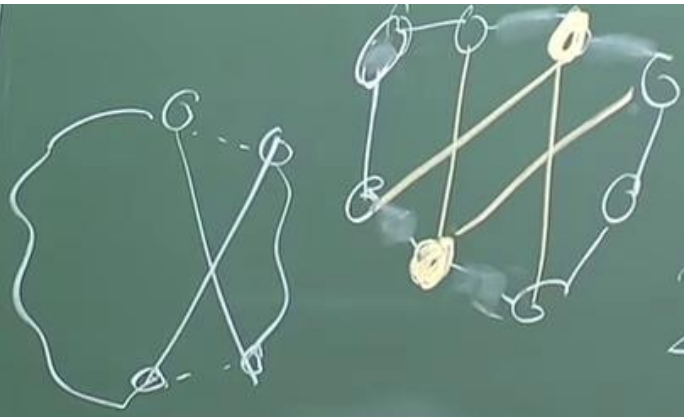

State space search ⇒ Optimization
h(n) - Hill Climbing
eval(n)
EXPLOITATION
Escaping local
Variable Neighbourhood
3-edge exchange
Pertur
2-city excha
3-city excha
2-edge excha
(27
27456
NPTEL

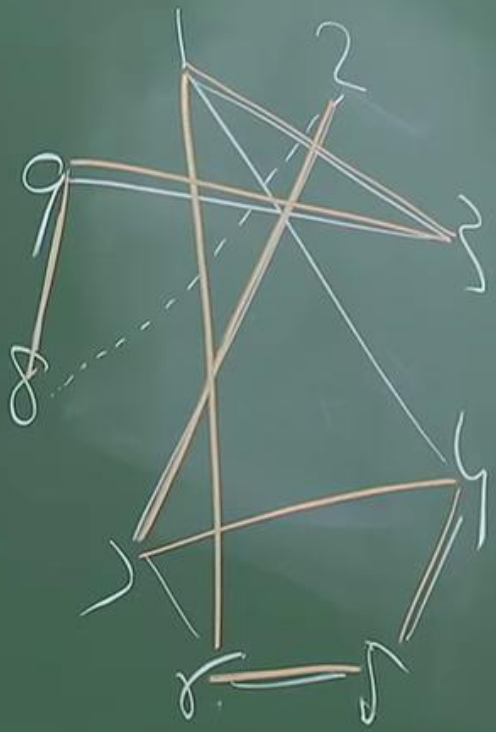

State space search ⇒ Optimization
h(n) - Hill Climbing
eval(n)
EXPLOITATION
Escaping local
Variable Neighbourhood
3-edge exchange
Pertu
2-city excha
3-city excha
2-edge excha
(27 65
27 45
NPTEL

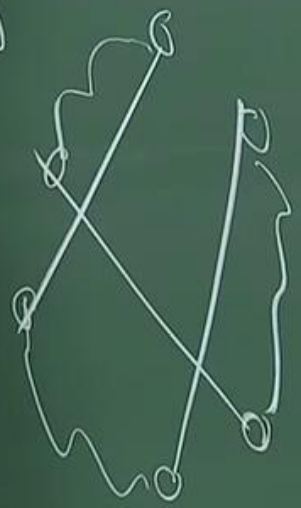

State space search ⇒ Optimization
h(n) - Hill Climbing
eval(n)
EXPLOITATION
Escaping local
Variable Neighbourhood
3-edge exchange
2-city exch
3-city excha
2-edge exch
(27
65
2745
NPTEL


State space search ⇒ Optimization
h(n) – Hill Climbing
eval(n)
EXPLOITATION
Escaping
Variable Neighbourhood
3-edge exchange
n-1C3 × 4
2-city ex
3-city ex
2-edge ex
(27
27 4
NPTEL

3-edge exchange $^{n-1}C_3 \times 4$







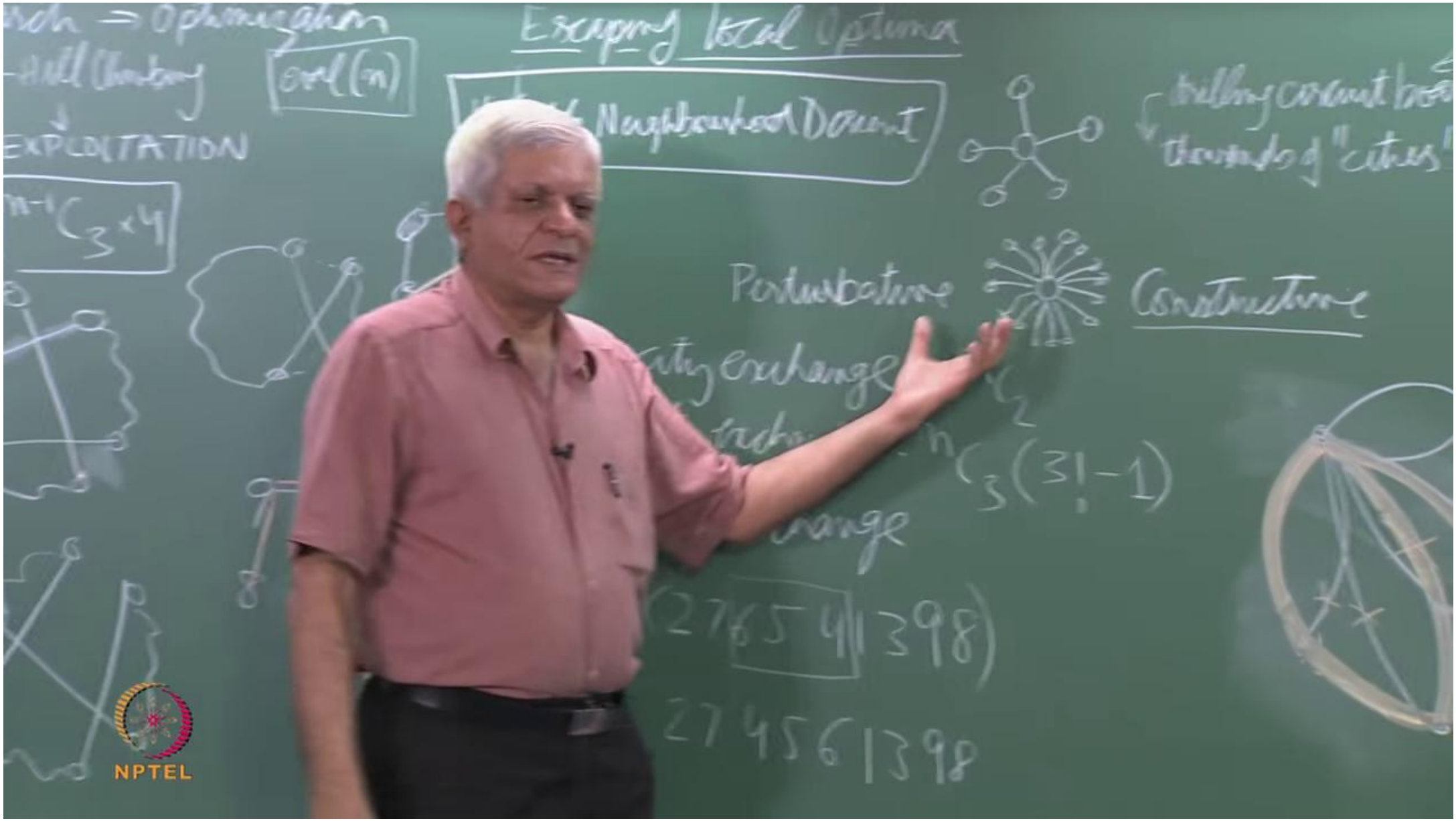
2-city e

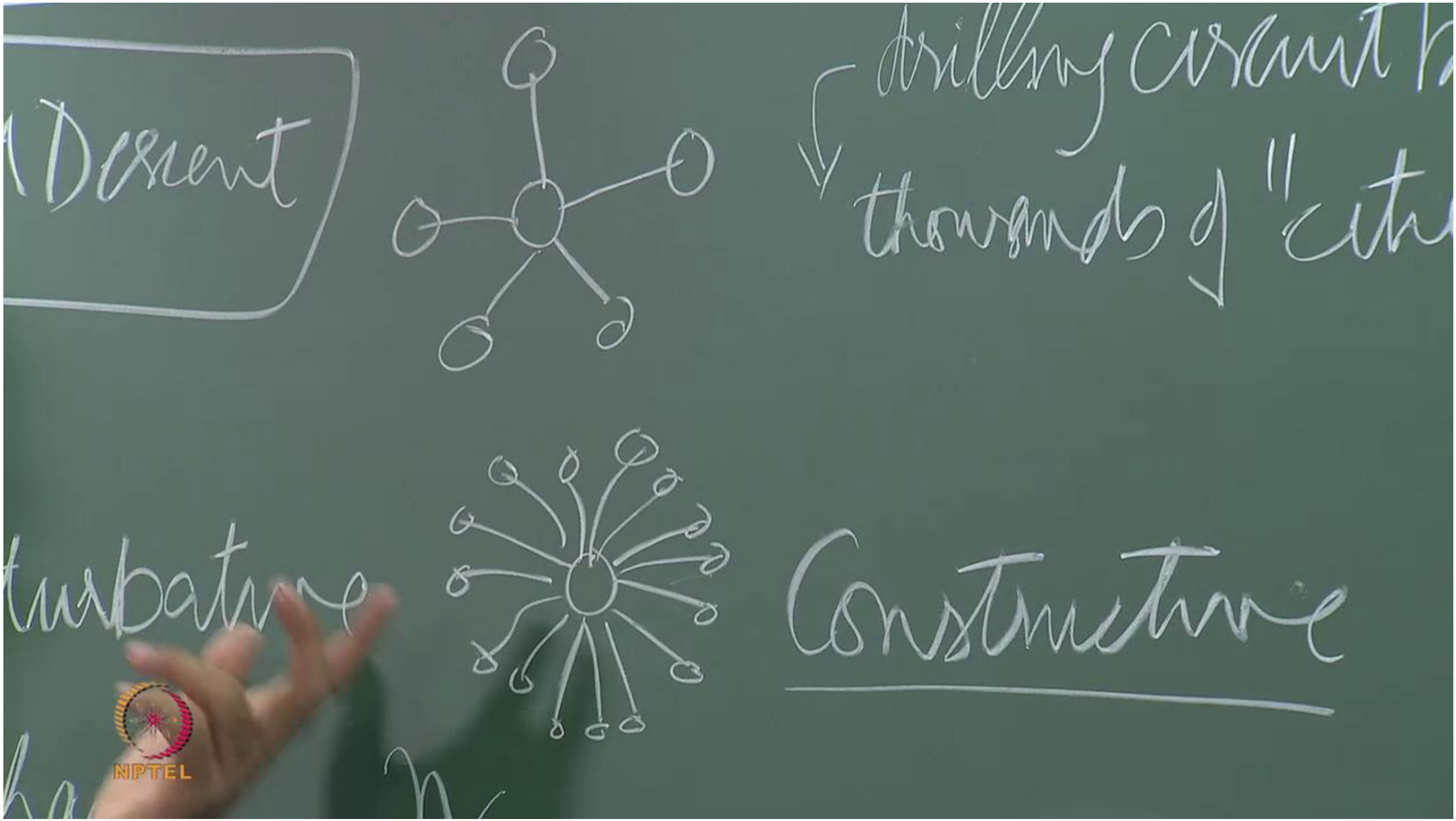
3-city tr

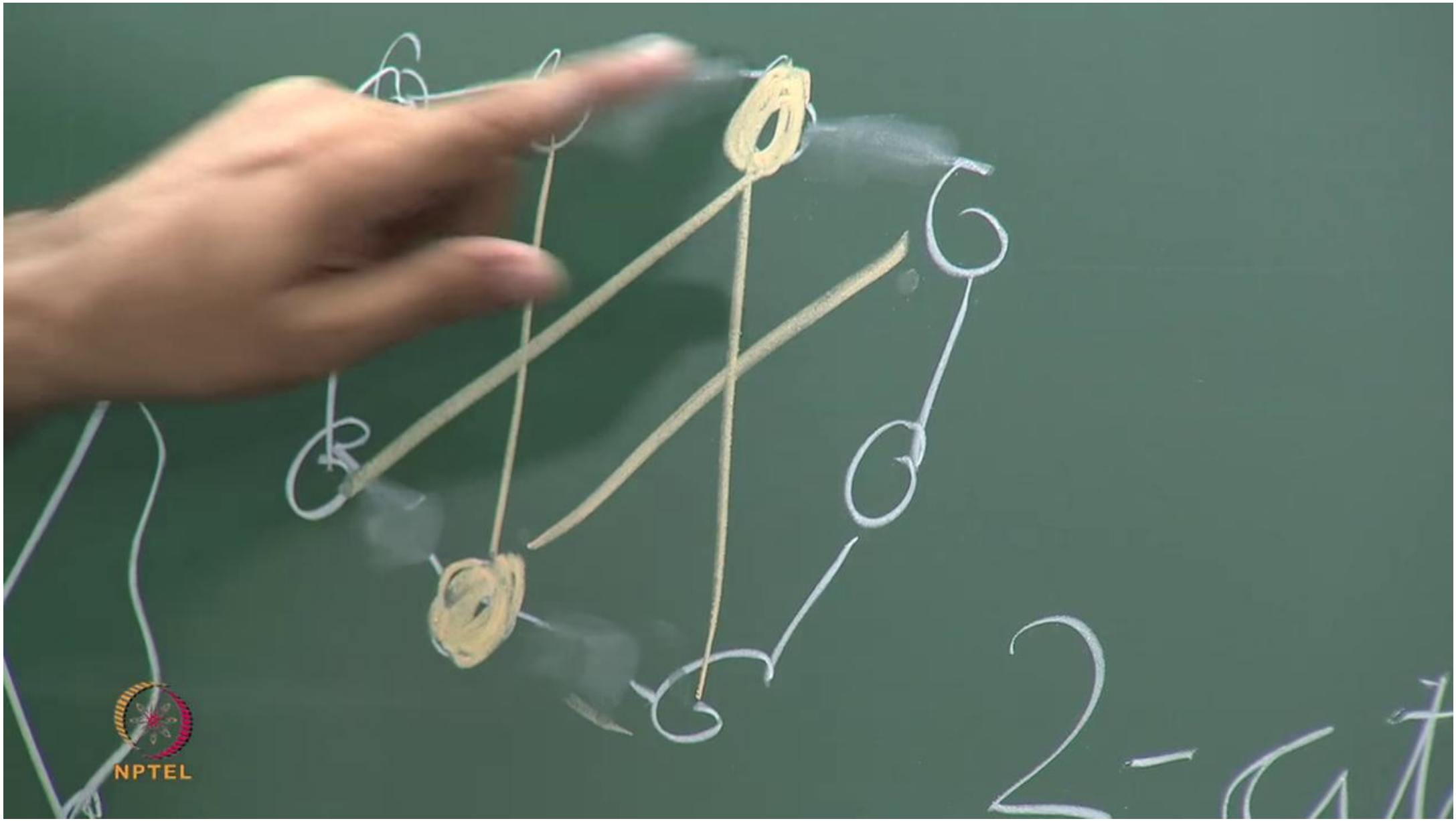
2 edge e

(27

27


Escaping local Optima
EXPLOITATION
Perturbations
Constructions
NPTEL


Descent
drilling circuit
thousands of
turbature
Constructive
NPTEL


NPTEL