Video Lectures On

Artificial Intelligence

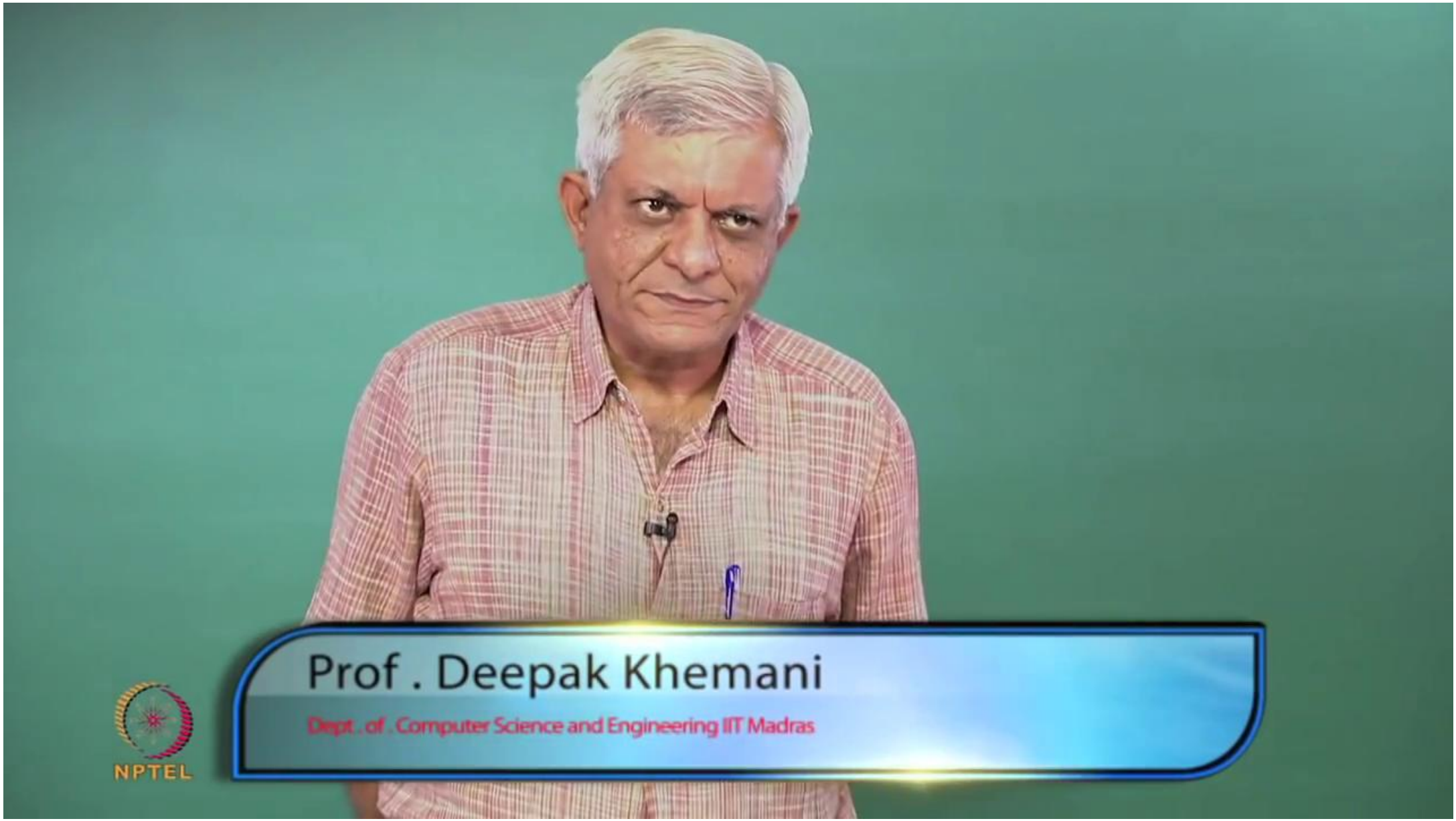
Lecture 06

State Space Search Intro

Prof. Deepak Khemani

Department of Computer Science and Engineering

IIT Madras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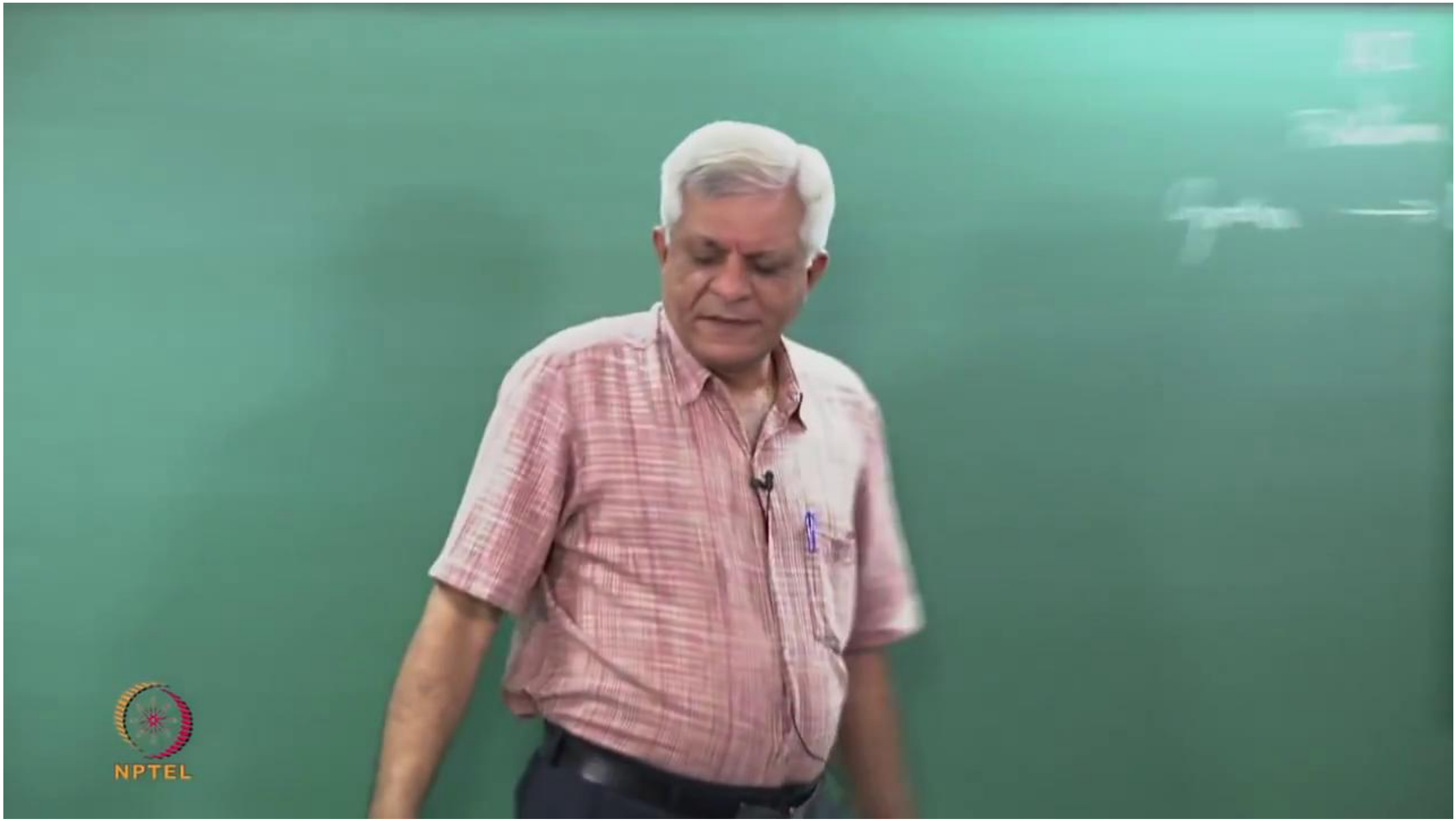
Dept . of . Computer Science and Engineering IIT Madras
NPTEL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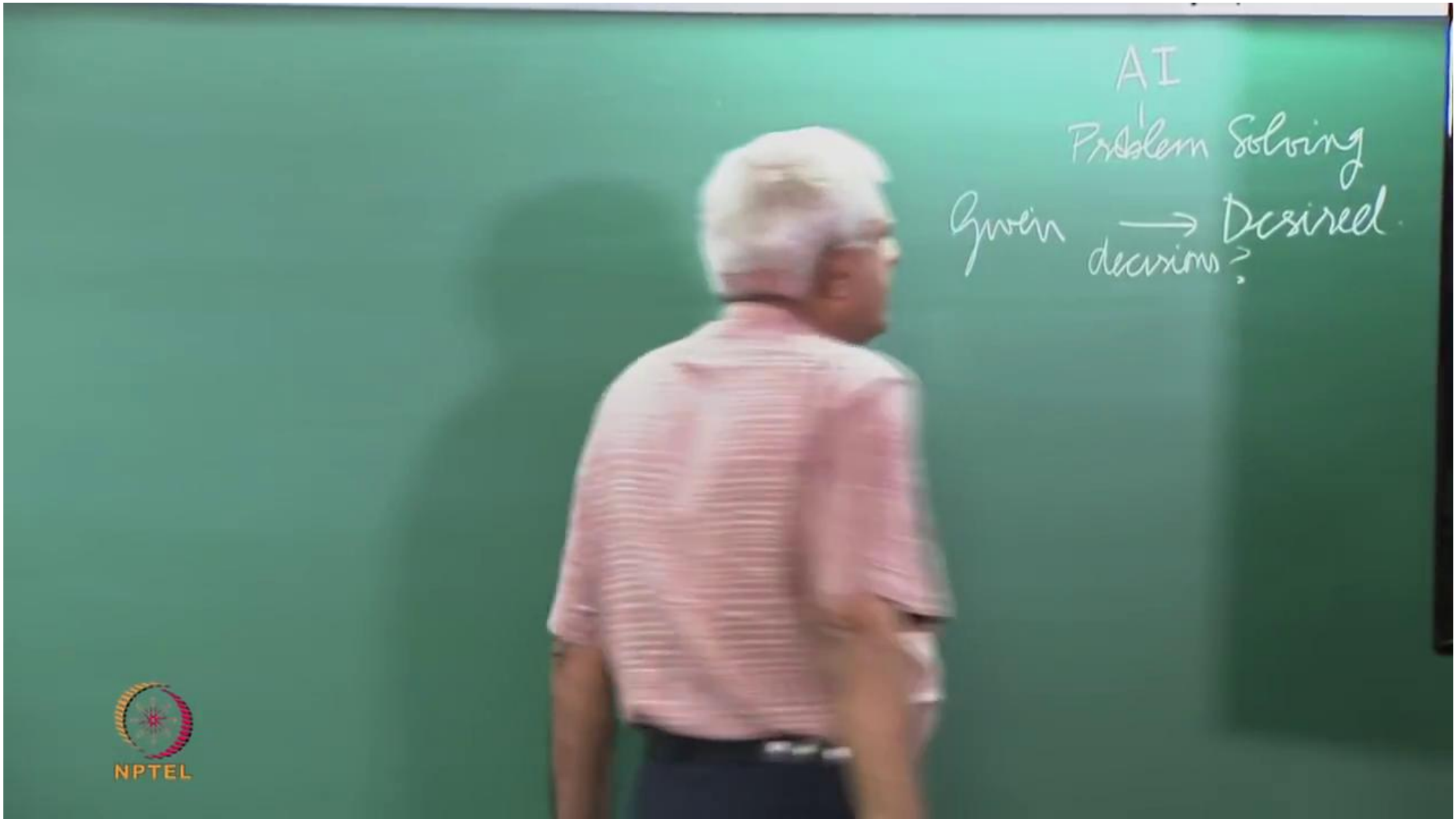
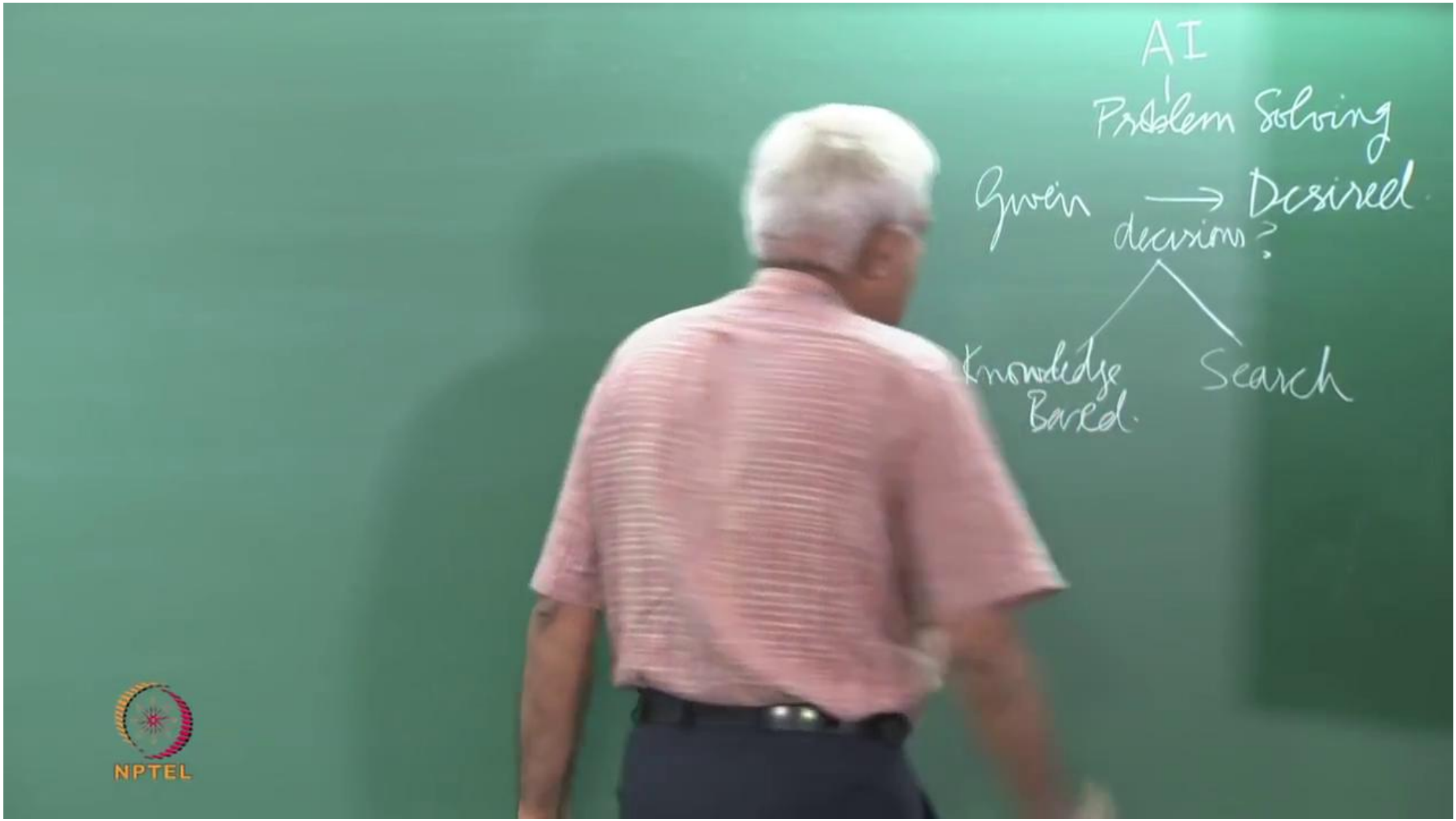
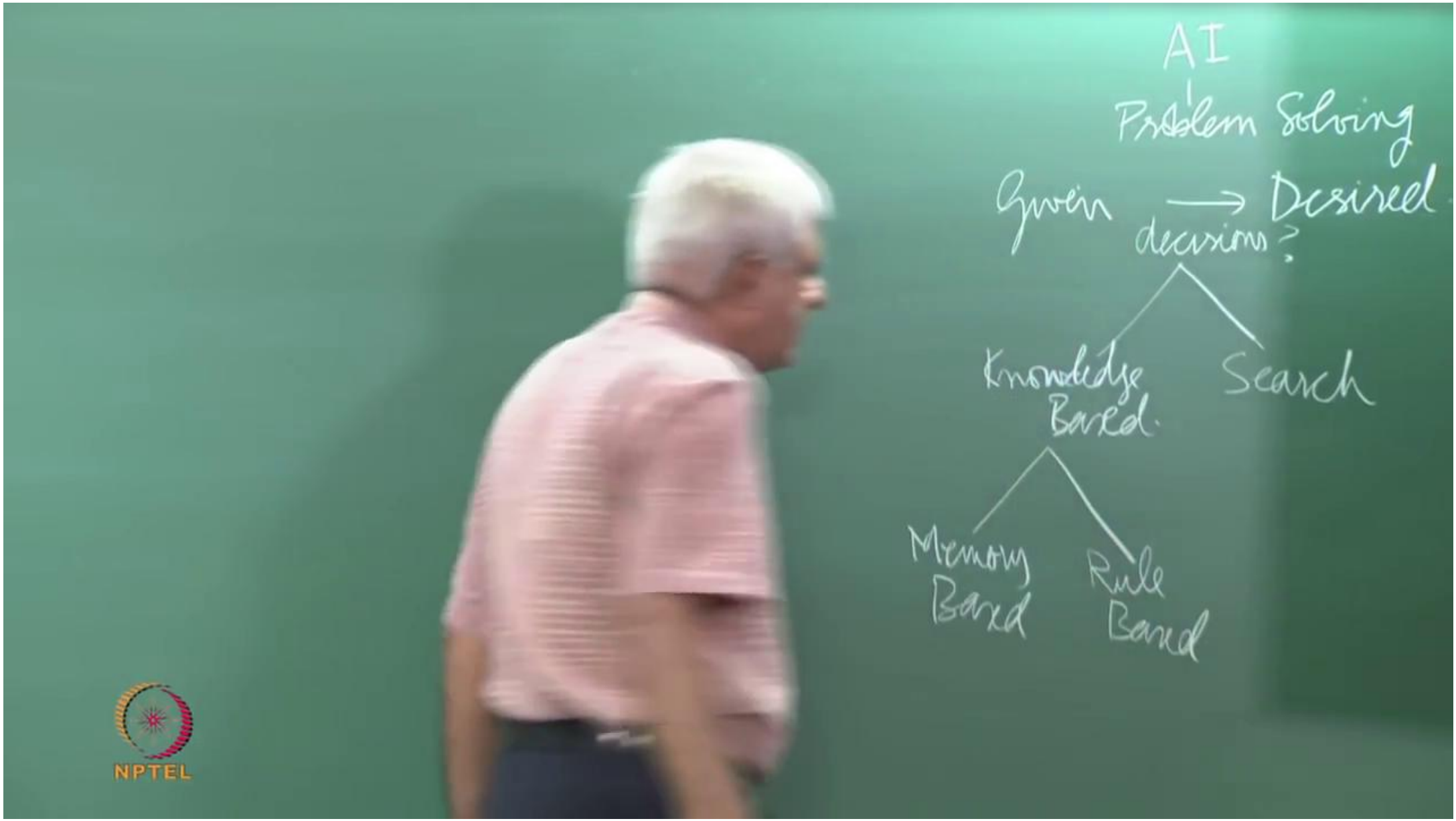
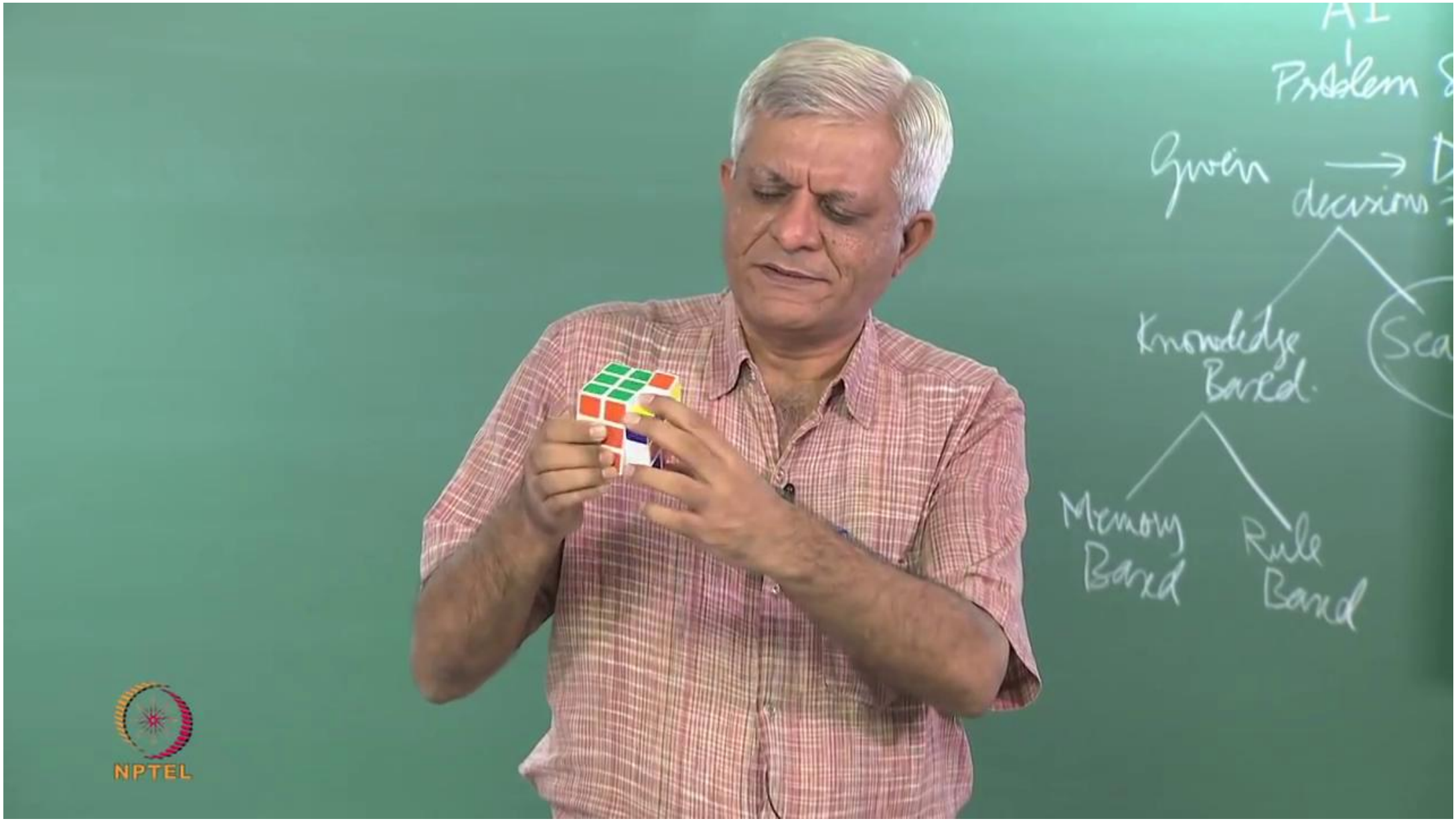
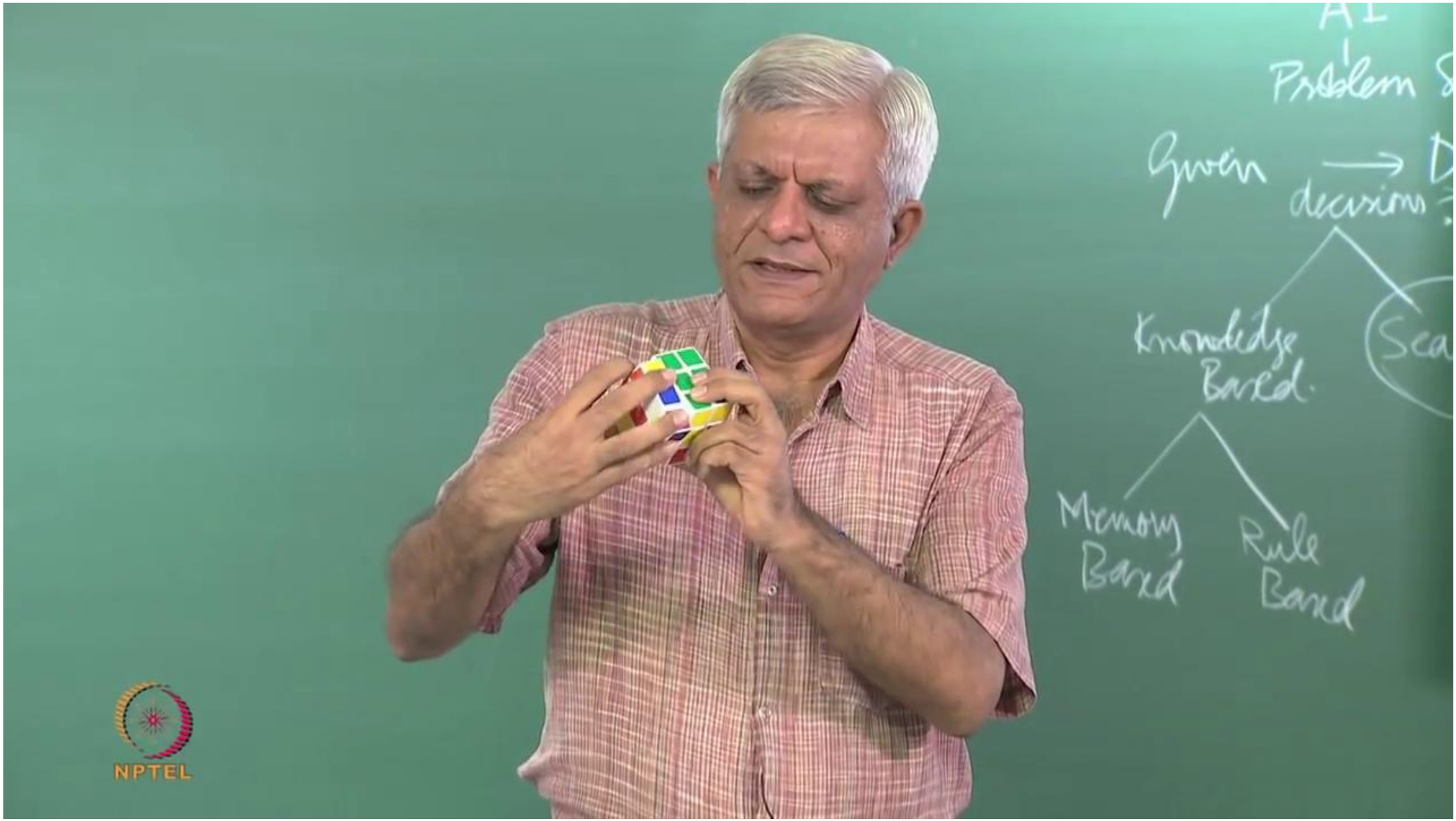
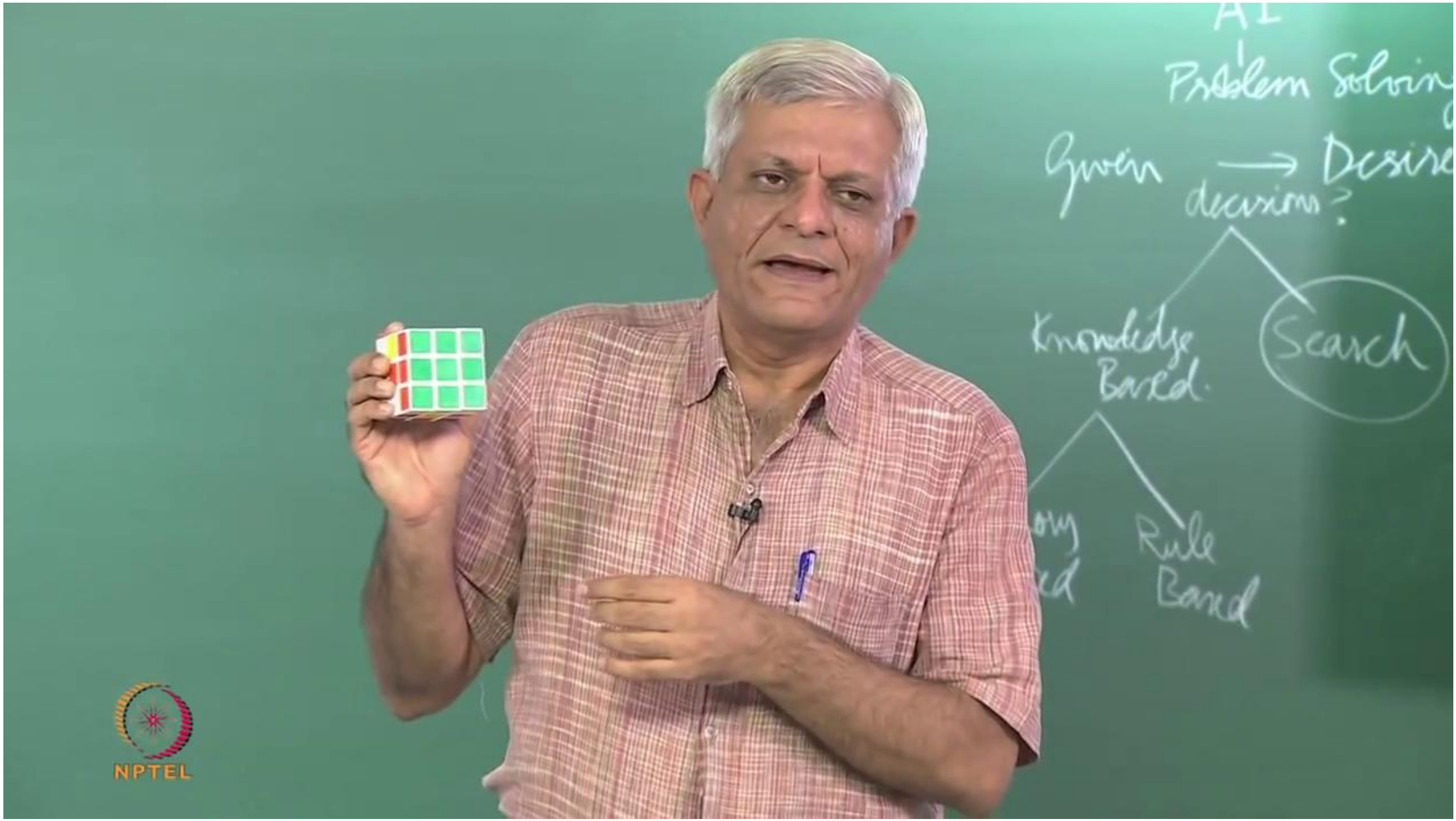

AI
Problem Solving
Given → Desired
decisions?
NPTEL

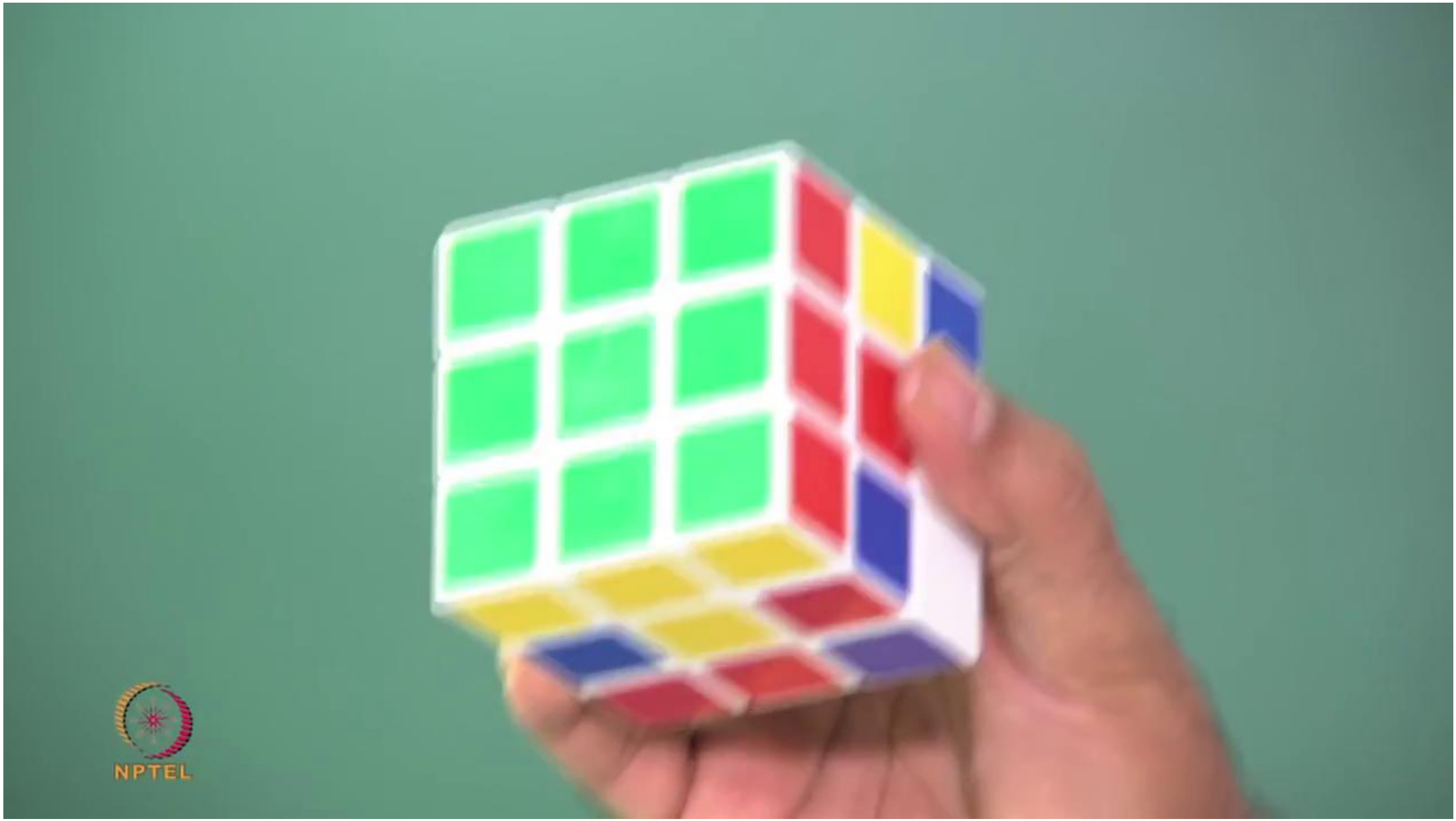

AI
Problem Solving
Given → Desired
decisions?
Knowledge Based
Search


AI
Problem Solving
Given → Desired
decisions?
Knowledge Based
Search
Memory Based
Rule Based
NPTEL


AI
Problem
Given
decisions
Knowledge
Based
Memory
Based
Rule
Based
NPTEL


AI
Problem S
Given
decision
Knowledge
Based
Memory
Based
Rule
Based
NPTEL


AI
Problem Solving
Given → Desired
decisions?
Knowledge Based
Search
Rule Based
NPTEL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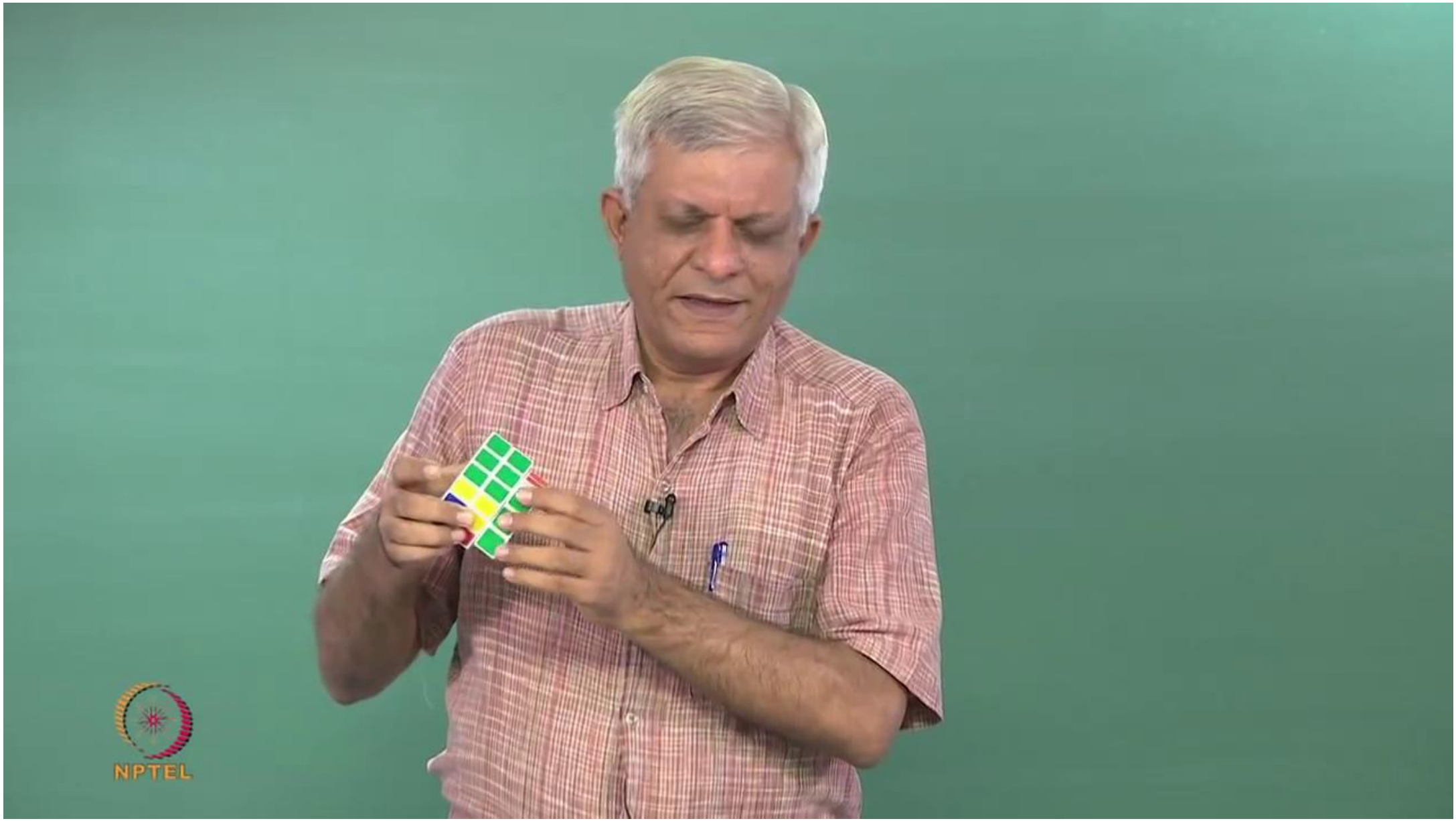
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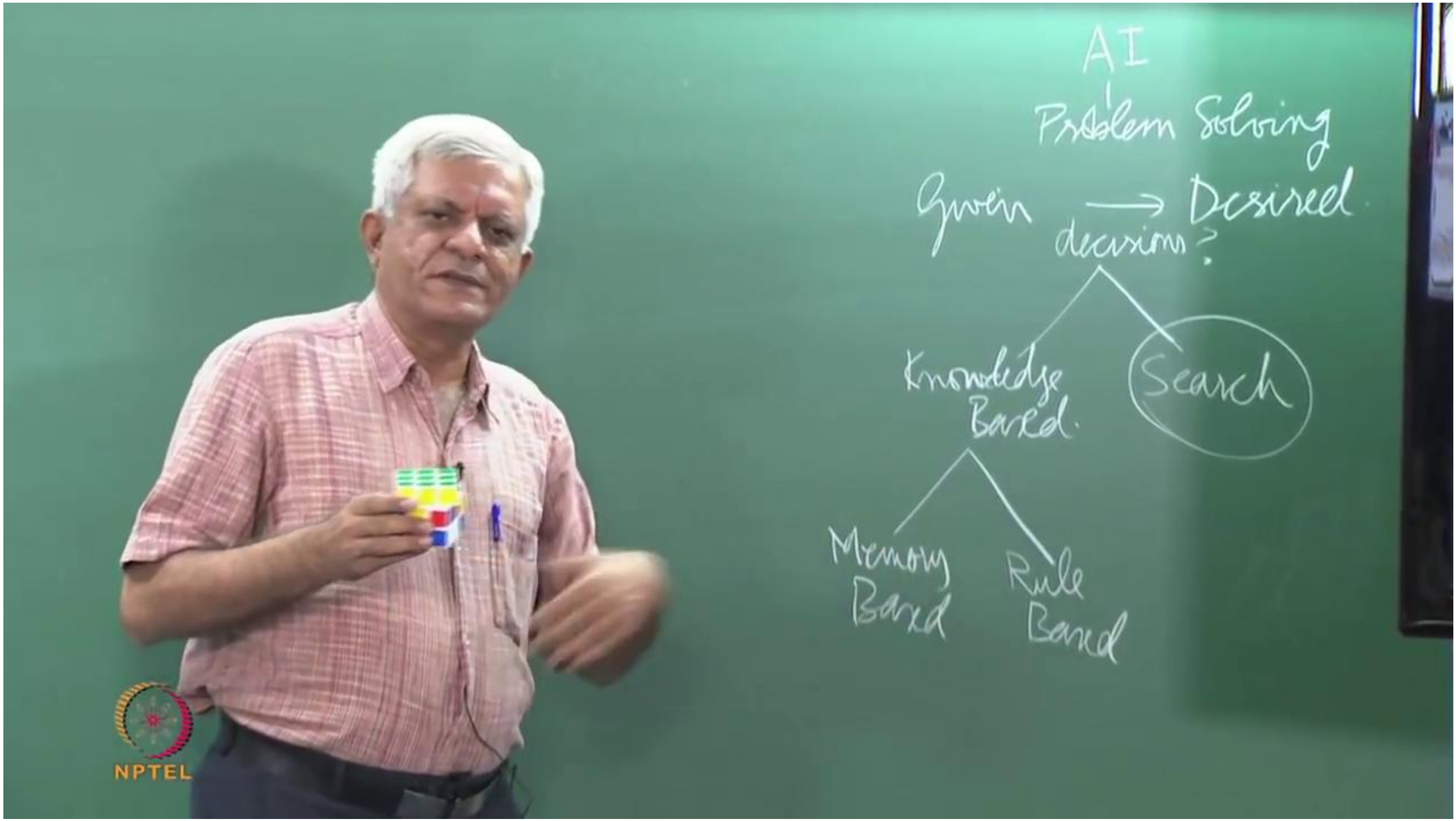
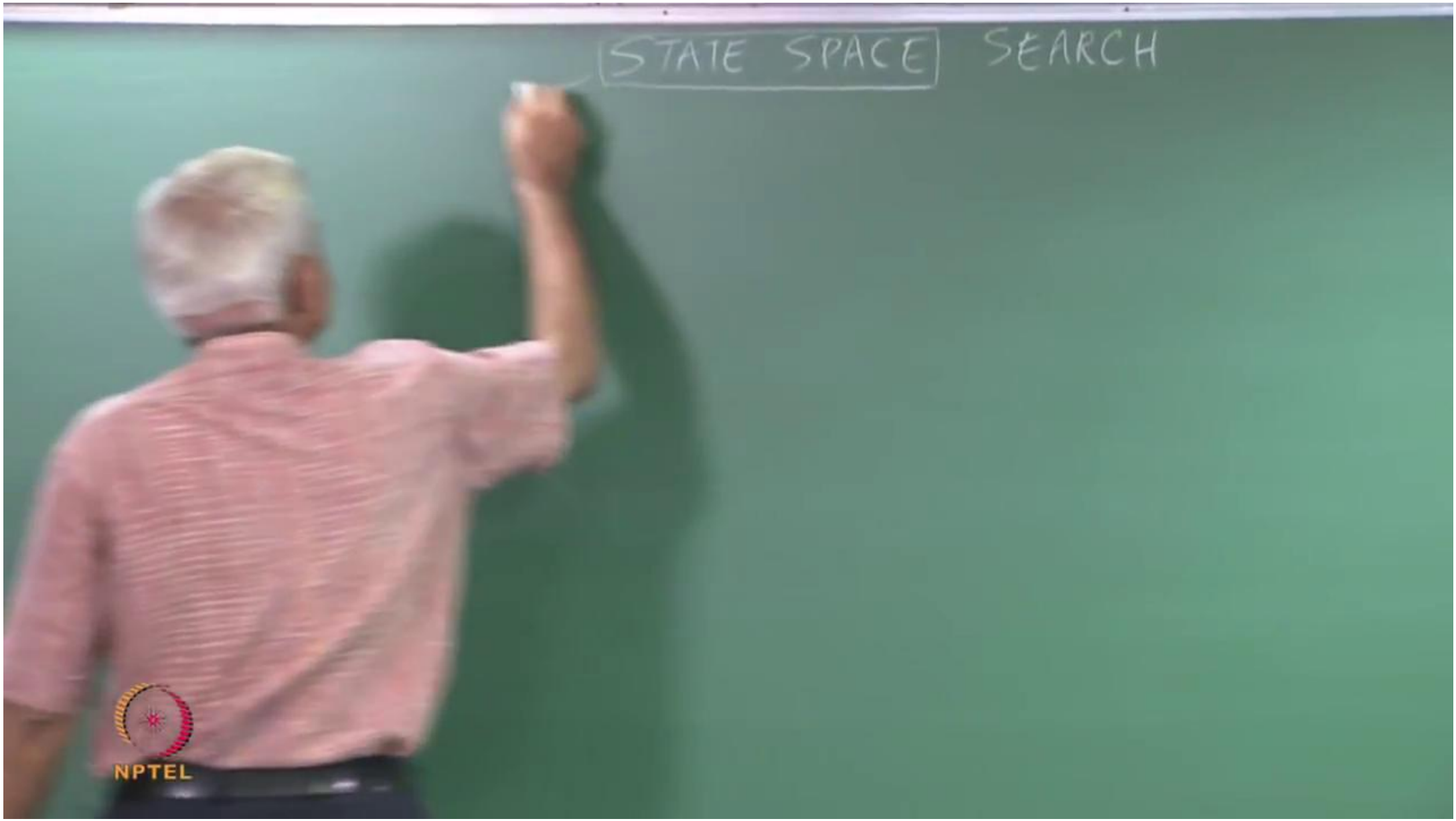
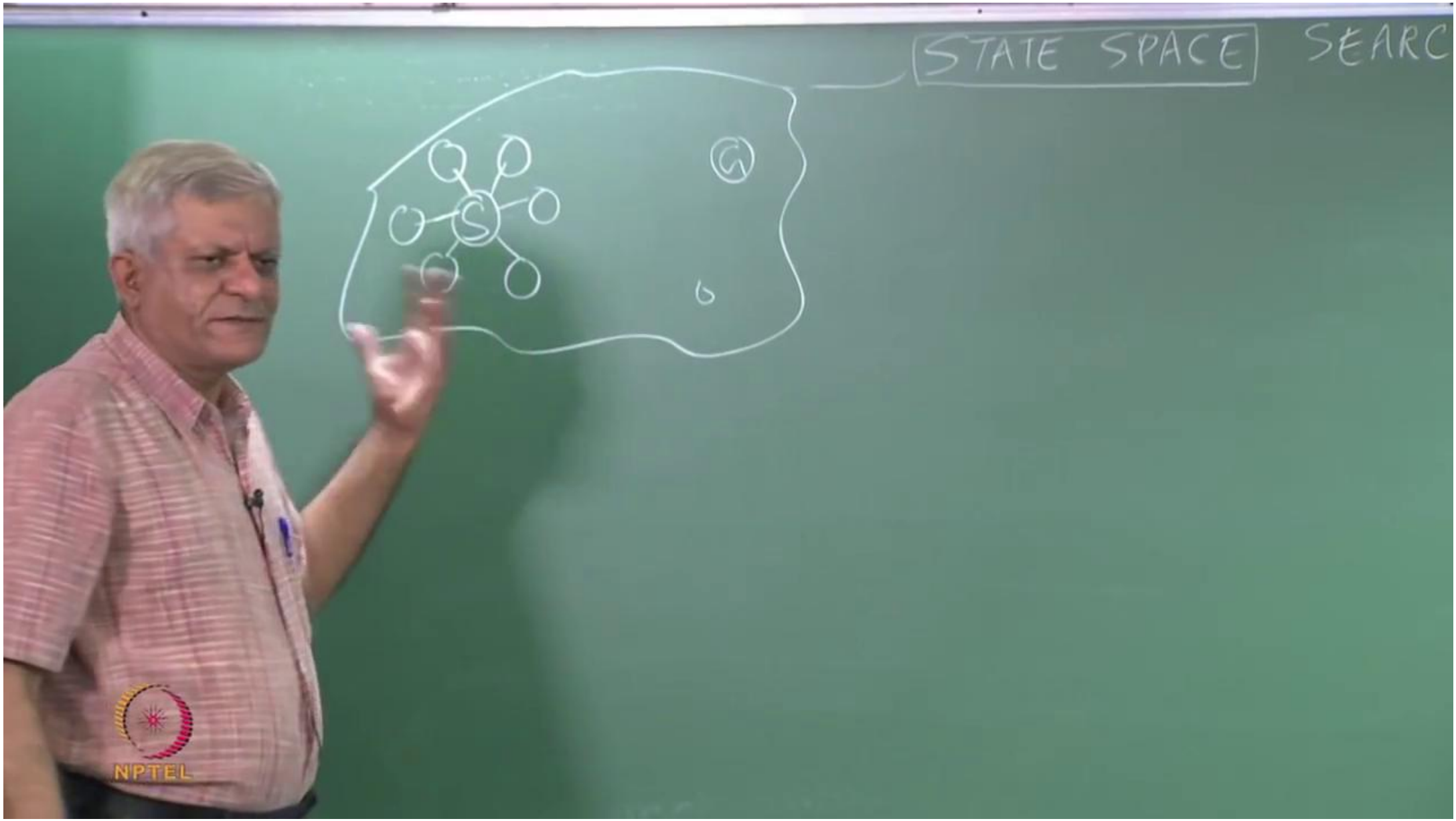
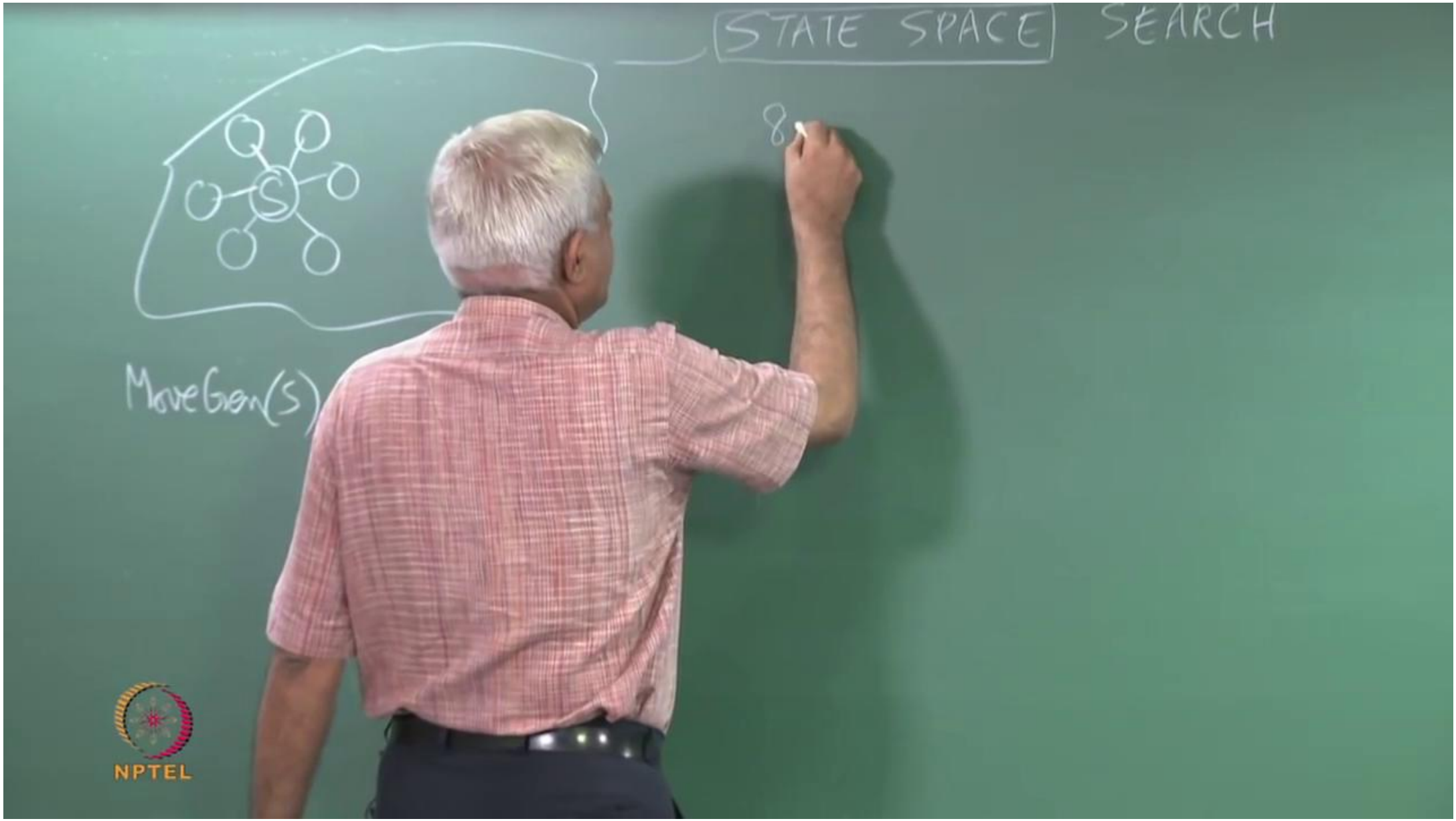
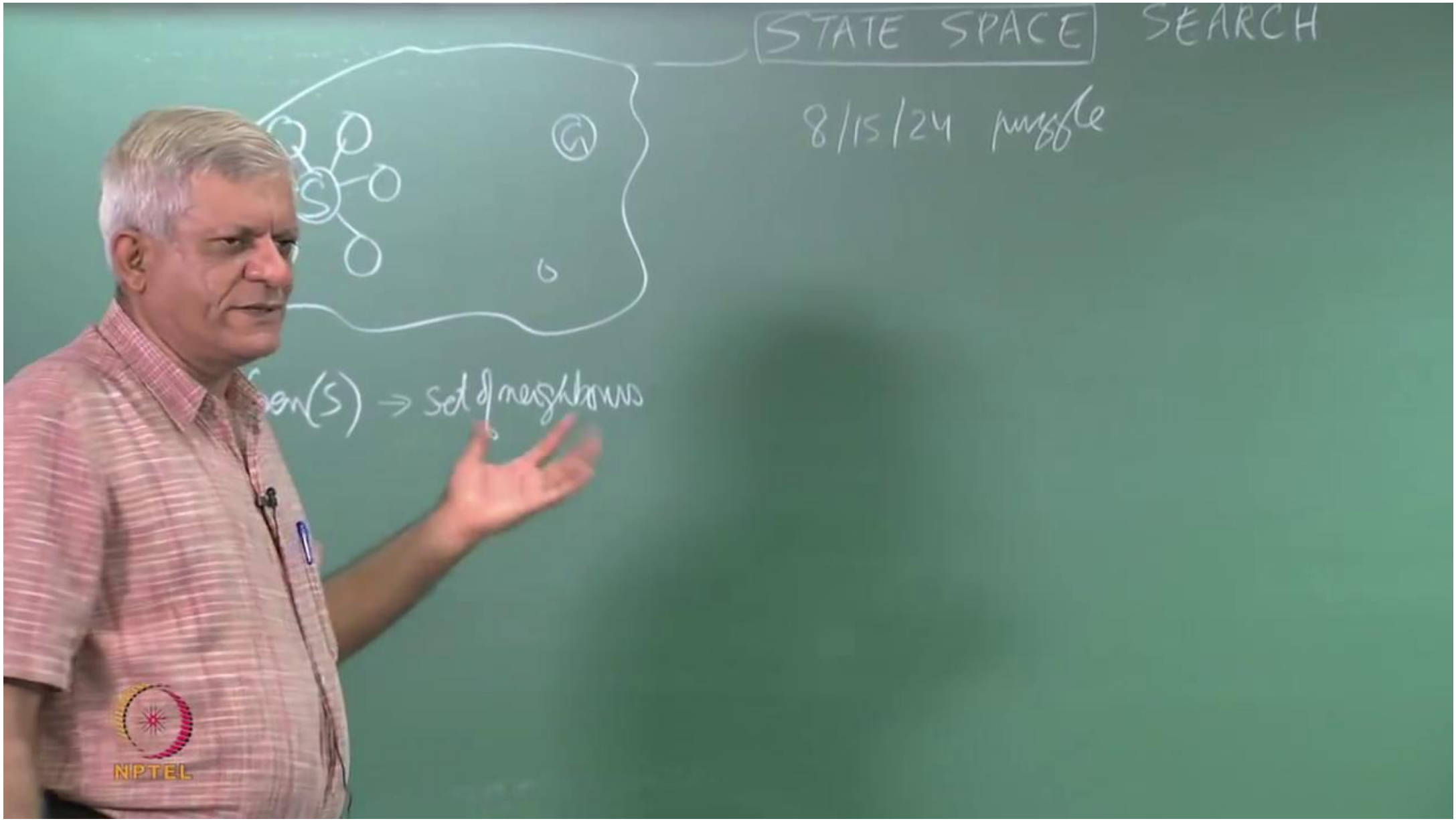
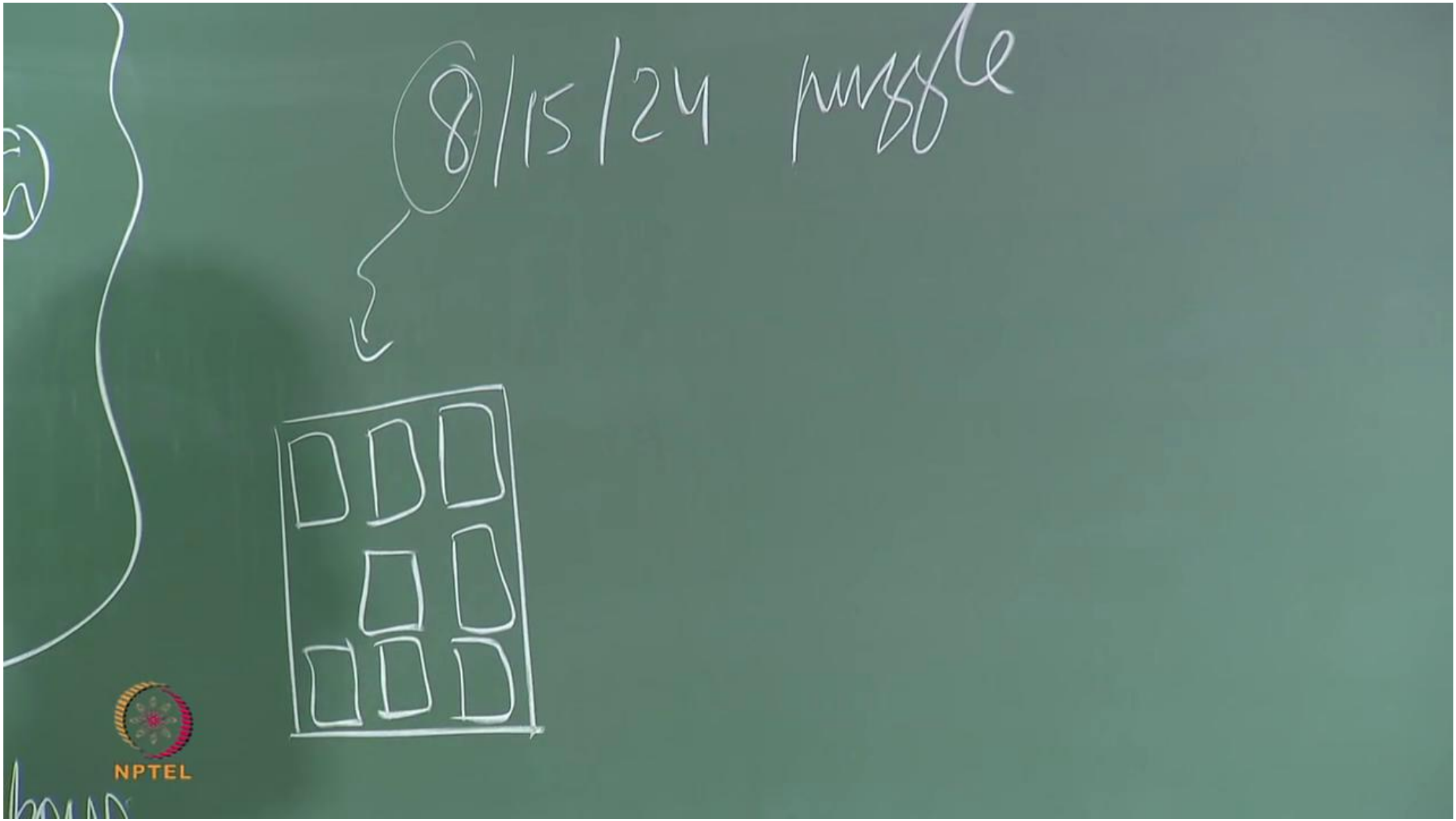

AI
Problem Solving
Given → Desired
decisions?
Knowledge Based
Search
Memory Based
Rule Based
NPTEL

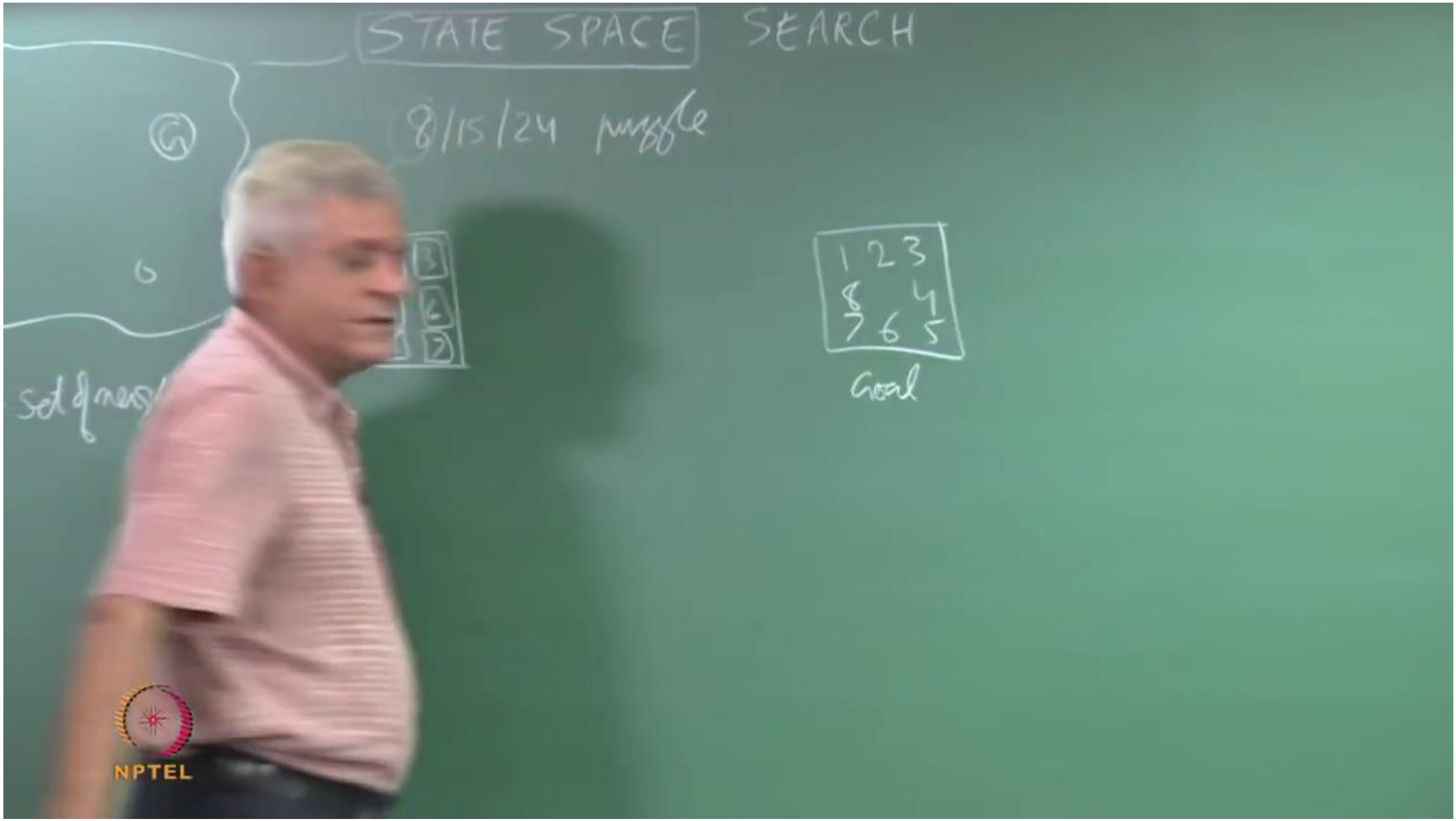

STATE SPACE SEARCH
NPTEL

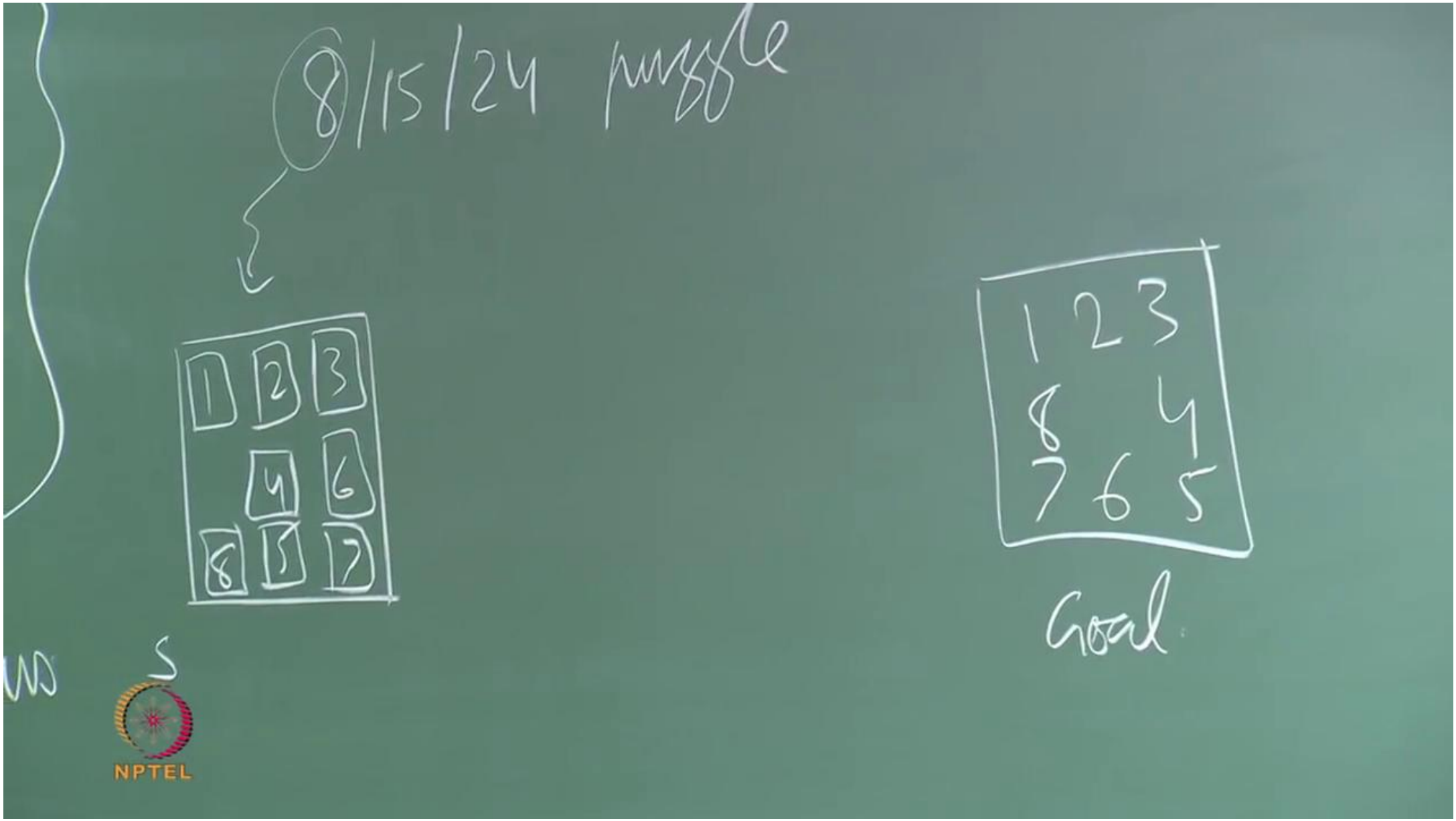

STATE SPACE
SEARC
S
G
NPTEL

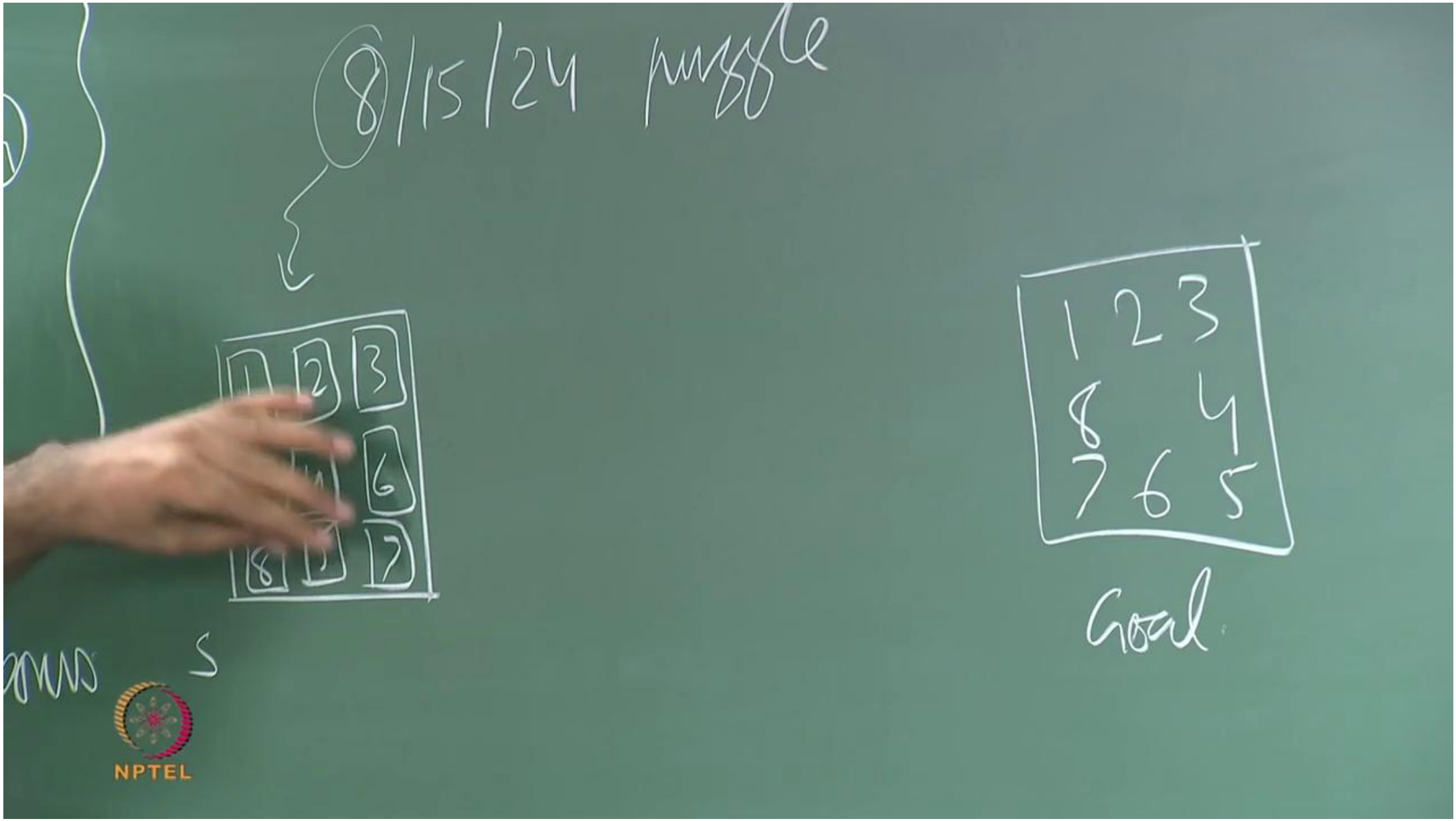

STATE SPACE SEARCH
S
MoveGen(S)
NPTEL

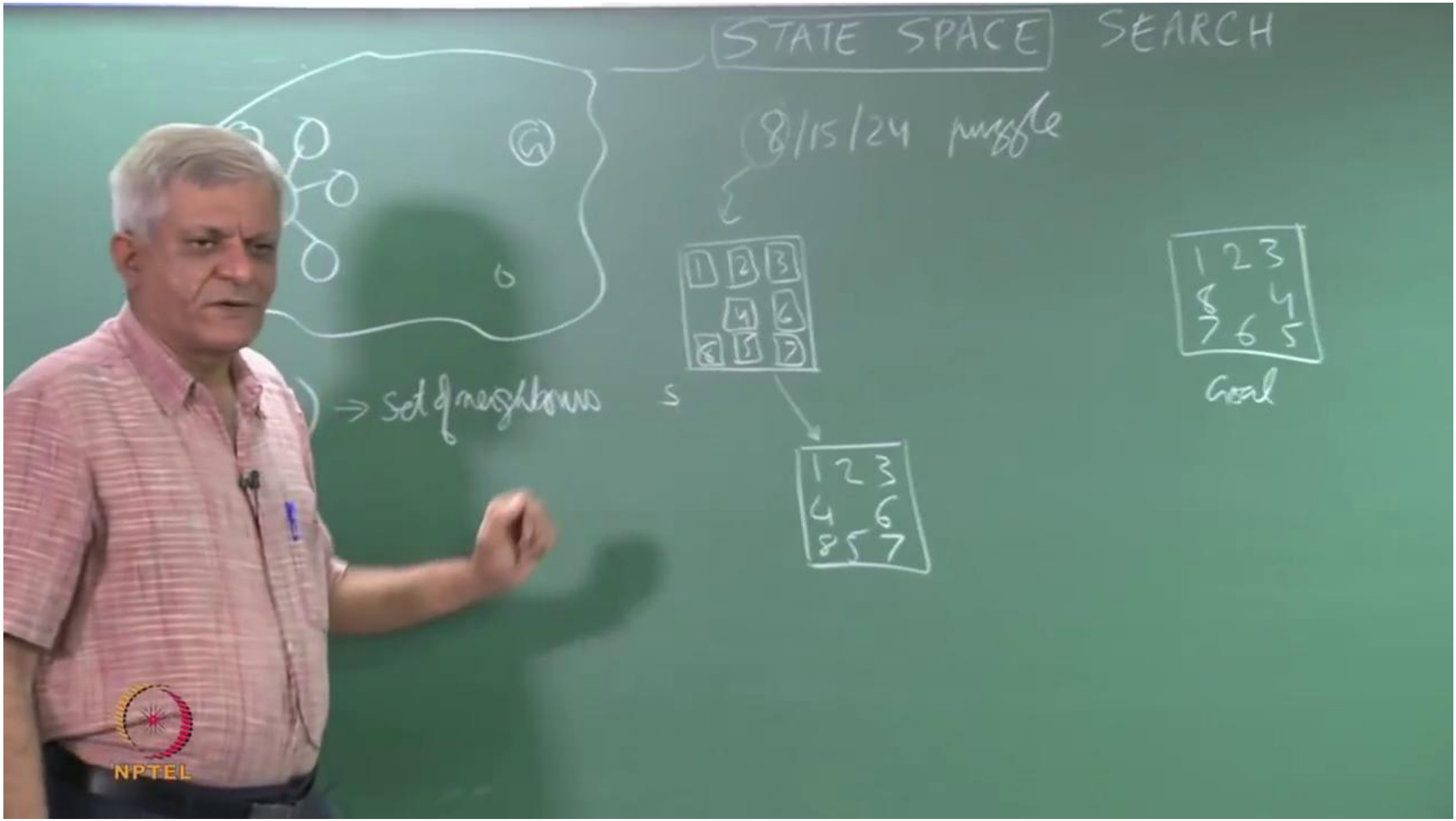

STATE SPACE SEARCH
8/15/24 puzzle
S
G
nbrs(S) → set of neighbours
NPTEL

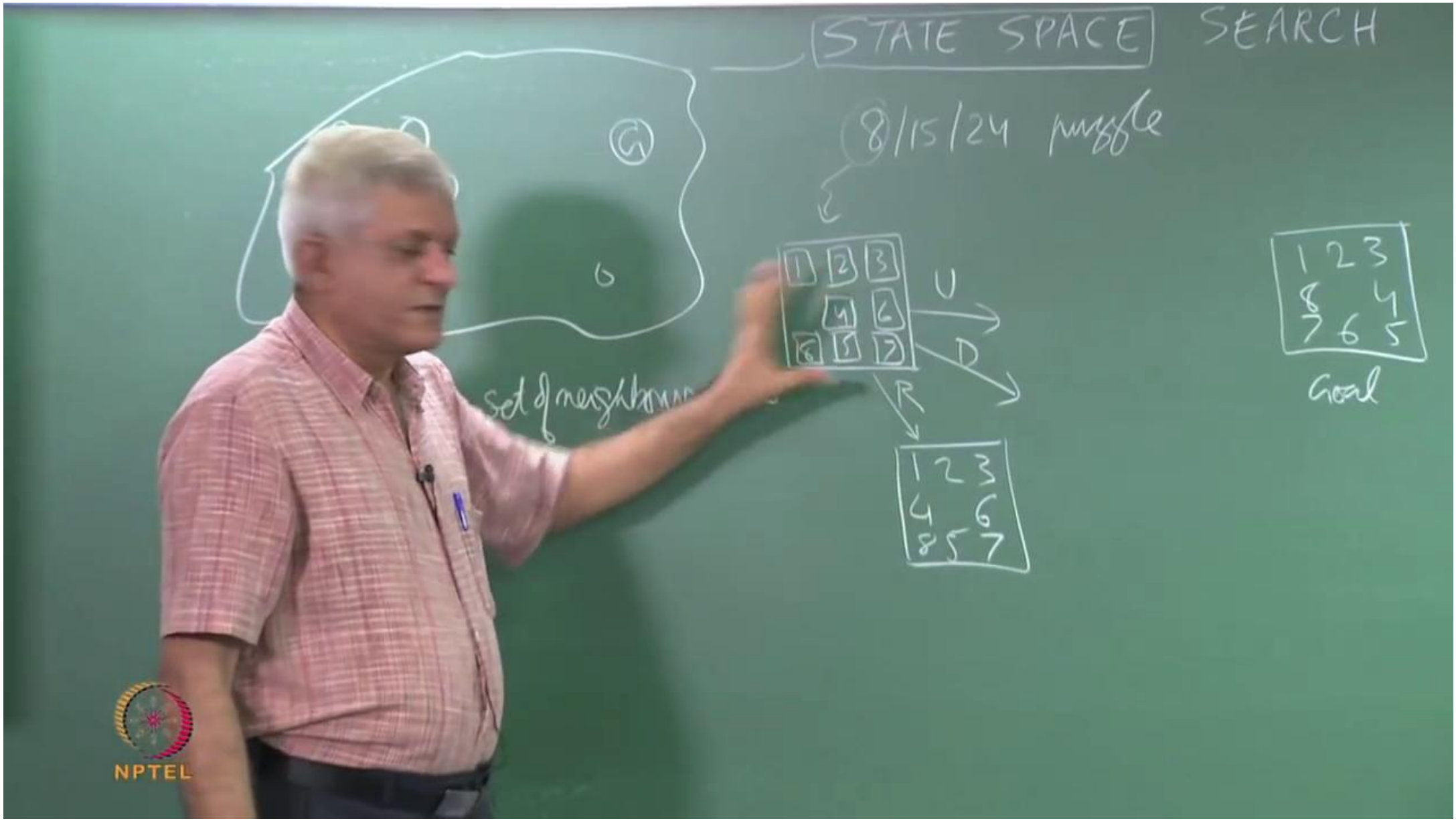

8/15/24
NPTEL

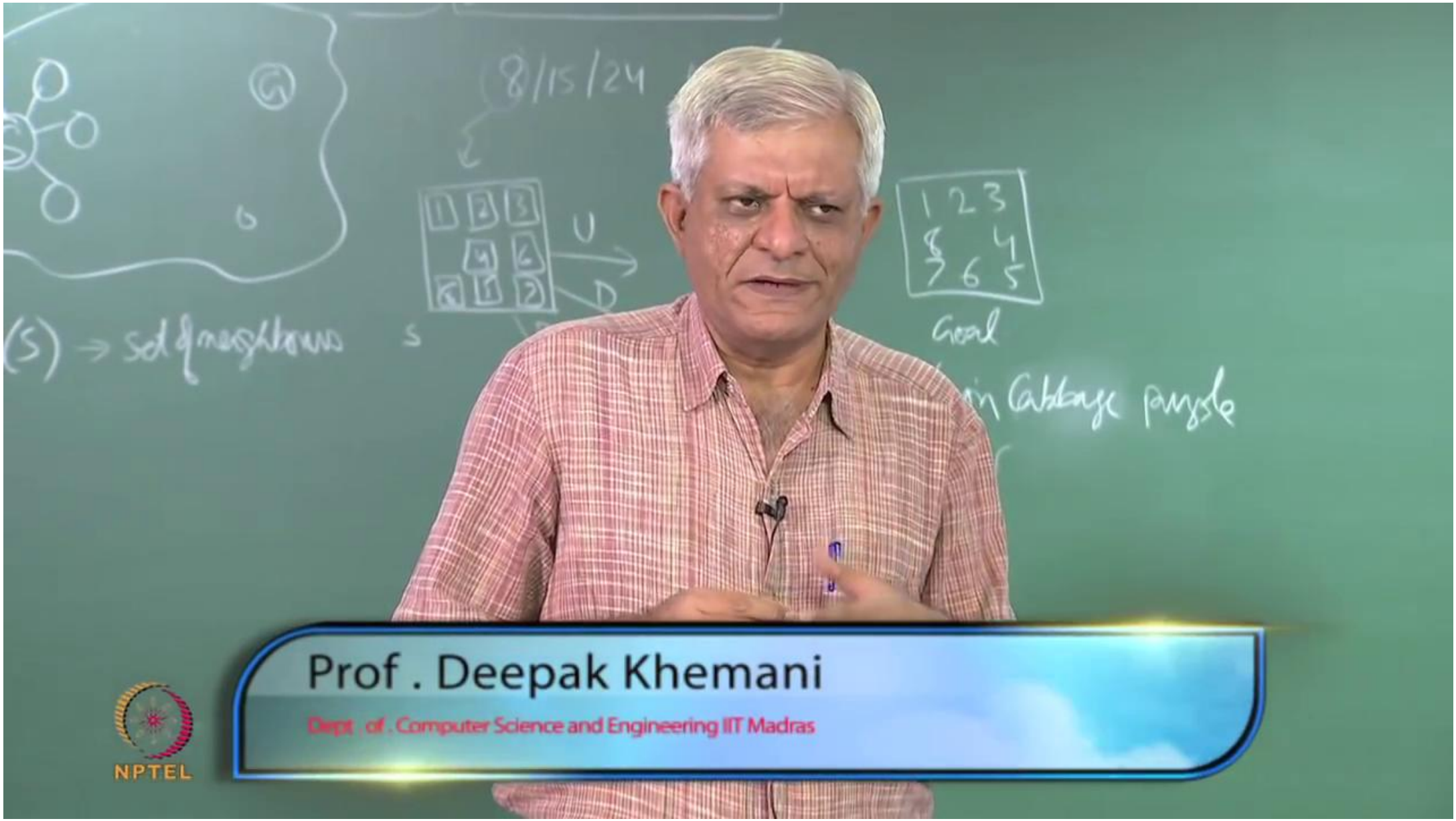

STATE SPACE SEARCH
8/15/24 puzzle
1 2 3
8 4
7 6 5
Goal
NPTEL


8/15/24 puzzle
1 2 3
4 6
8 5 7
1 2 3
8 4
7 6 5
Goal
NPTEL


8/15/24 puzzle
1 2 3
8 4
7 6 5
Goal
NPTEL


STATE SPACE SEARCH
8/15/24 puzzle
Goal
NPTEL


STATE SPACE
SEARCH
8/15/24 puzzle
Goal
U
D


8/15/24
Goal
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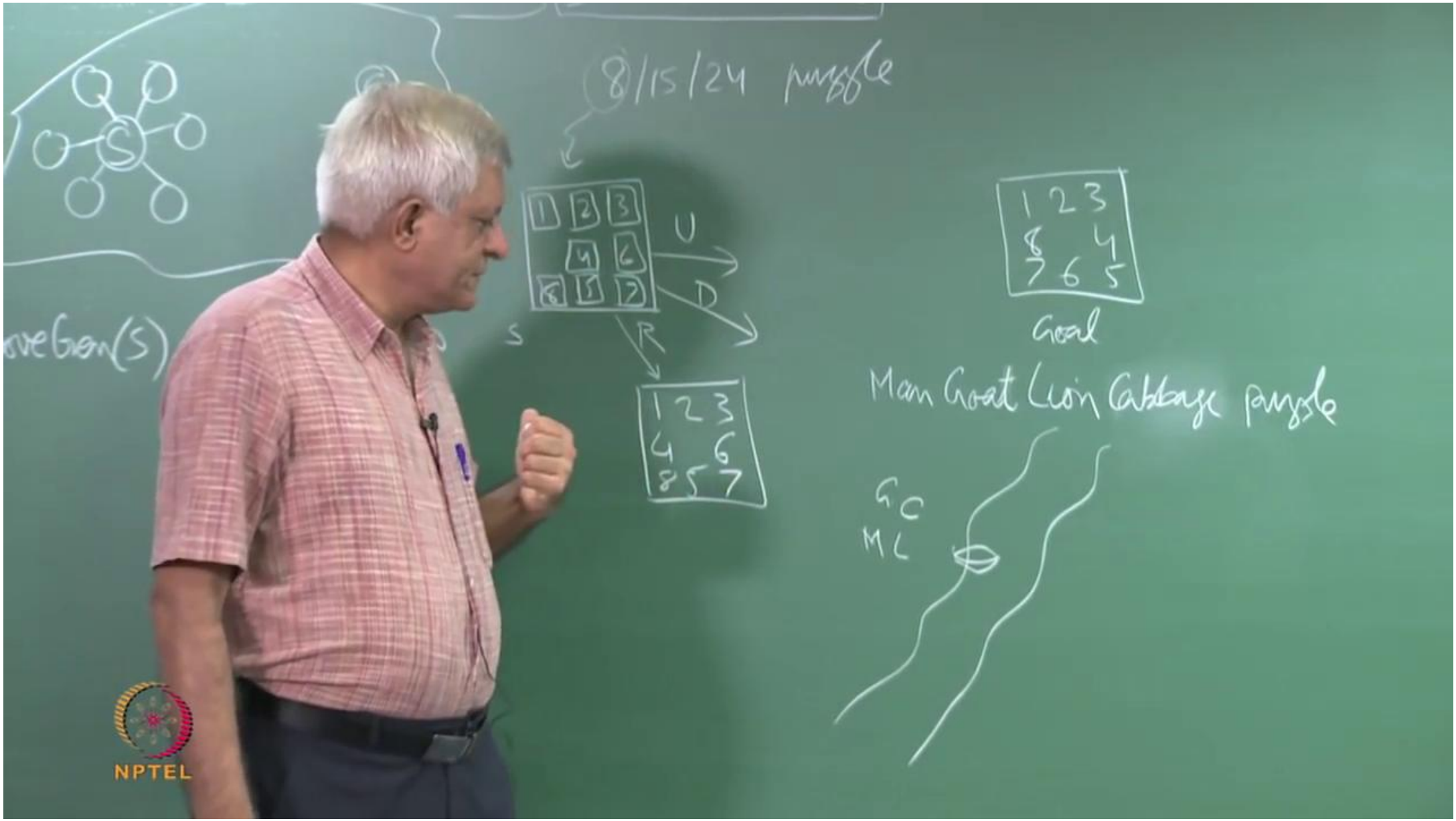
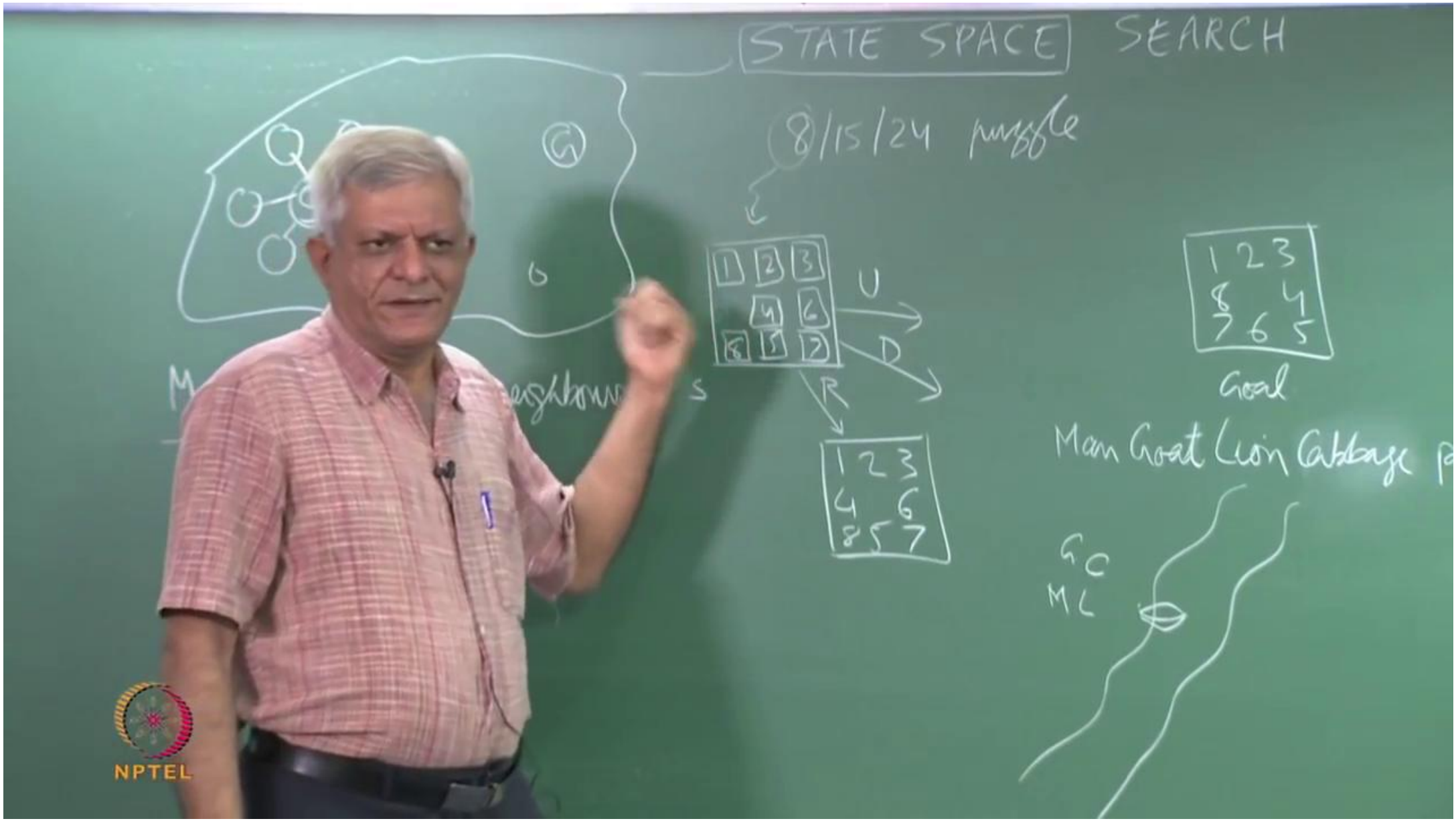
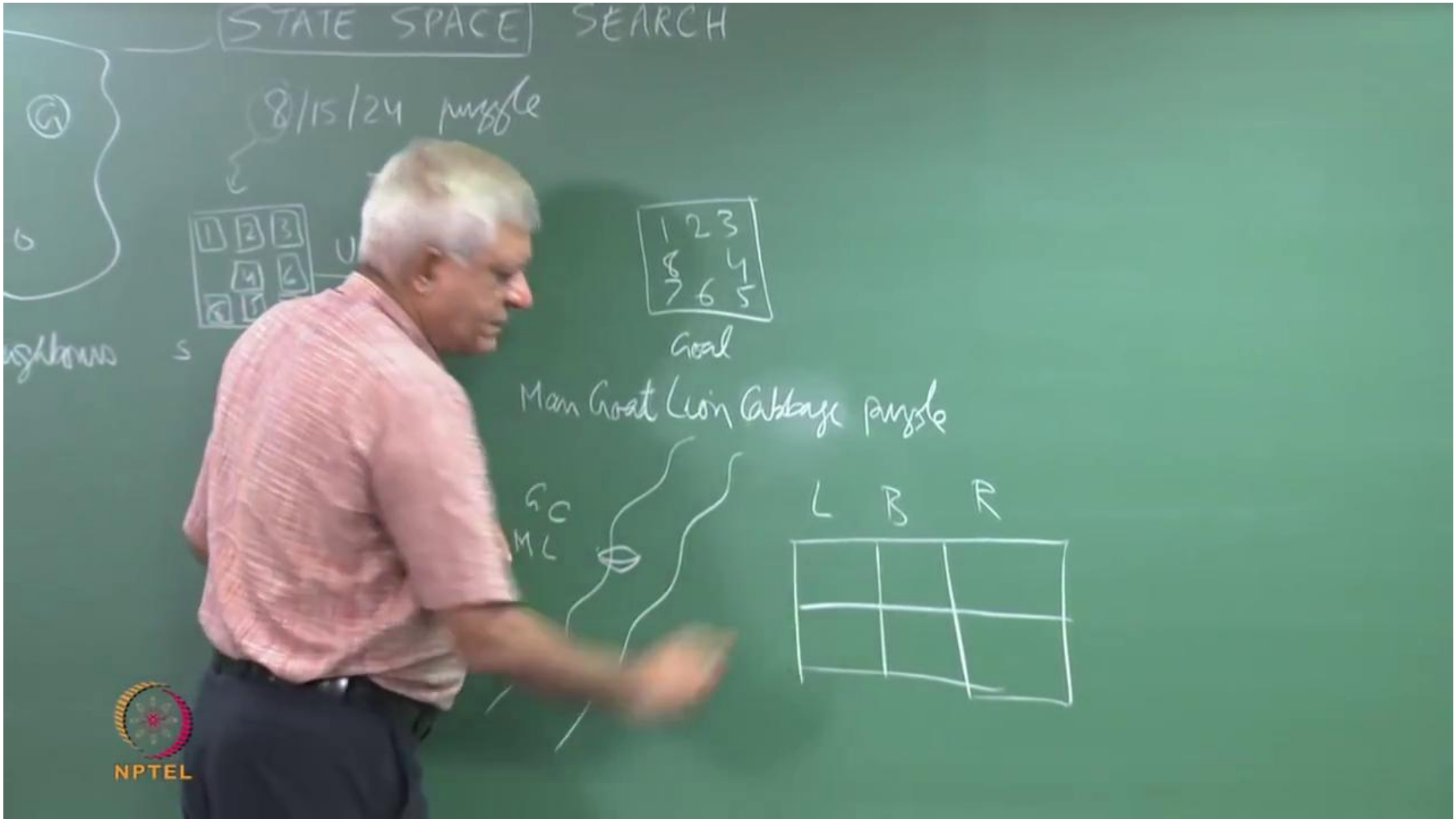
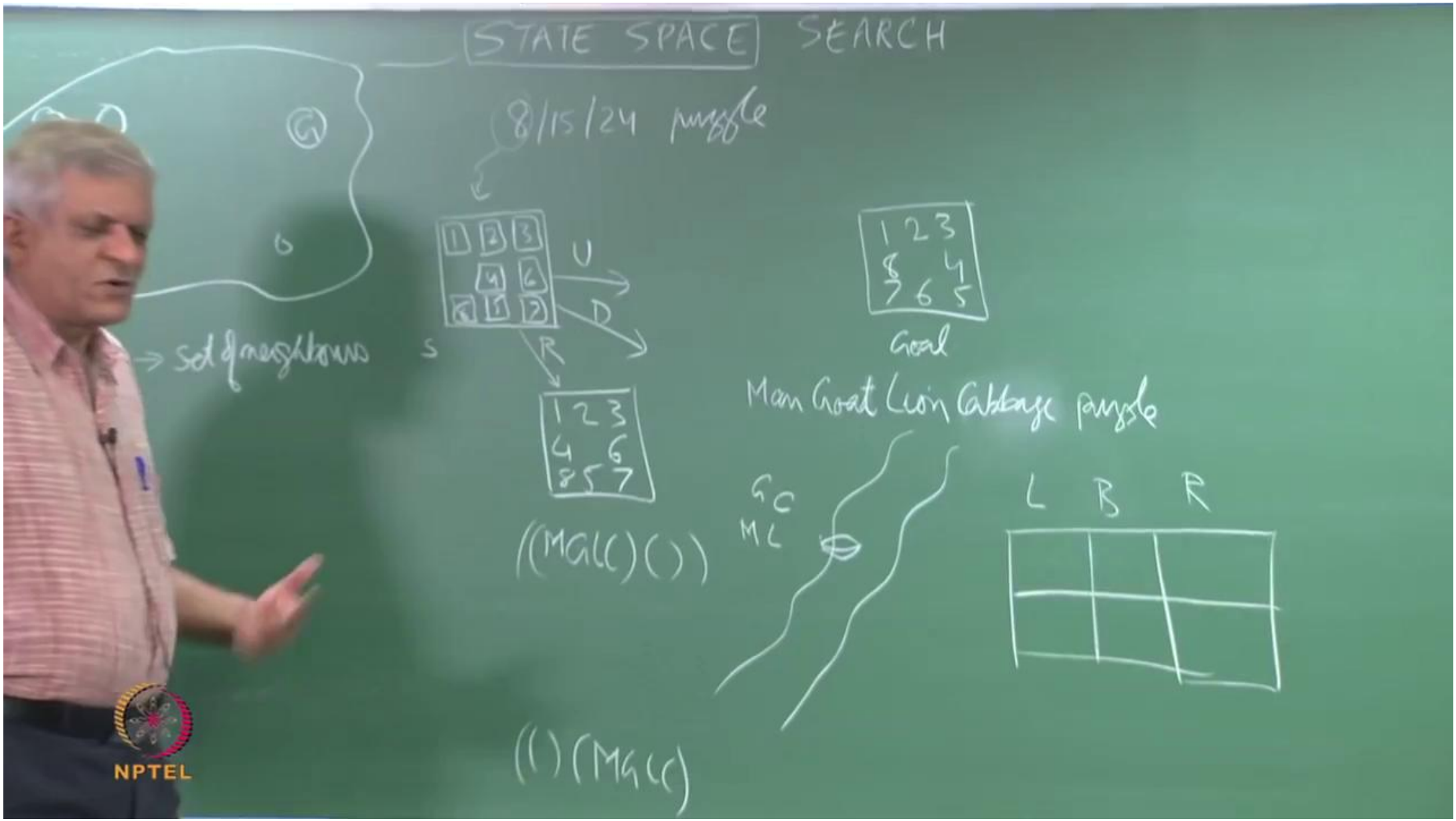
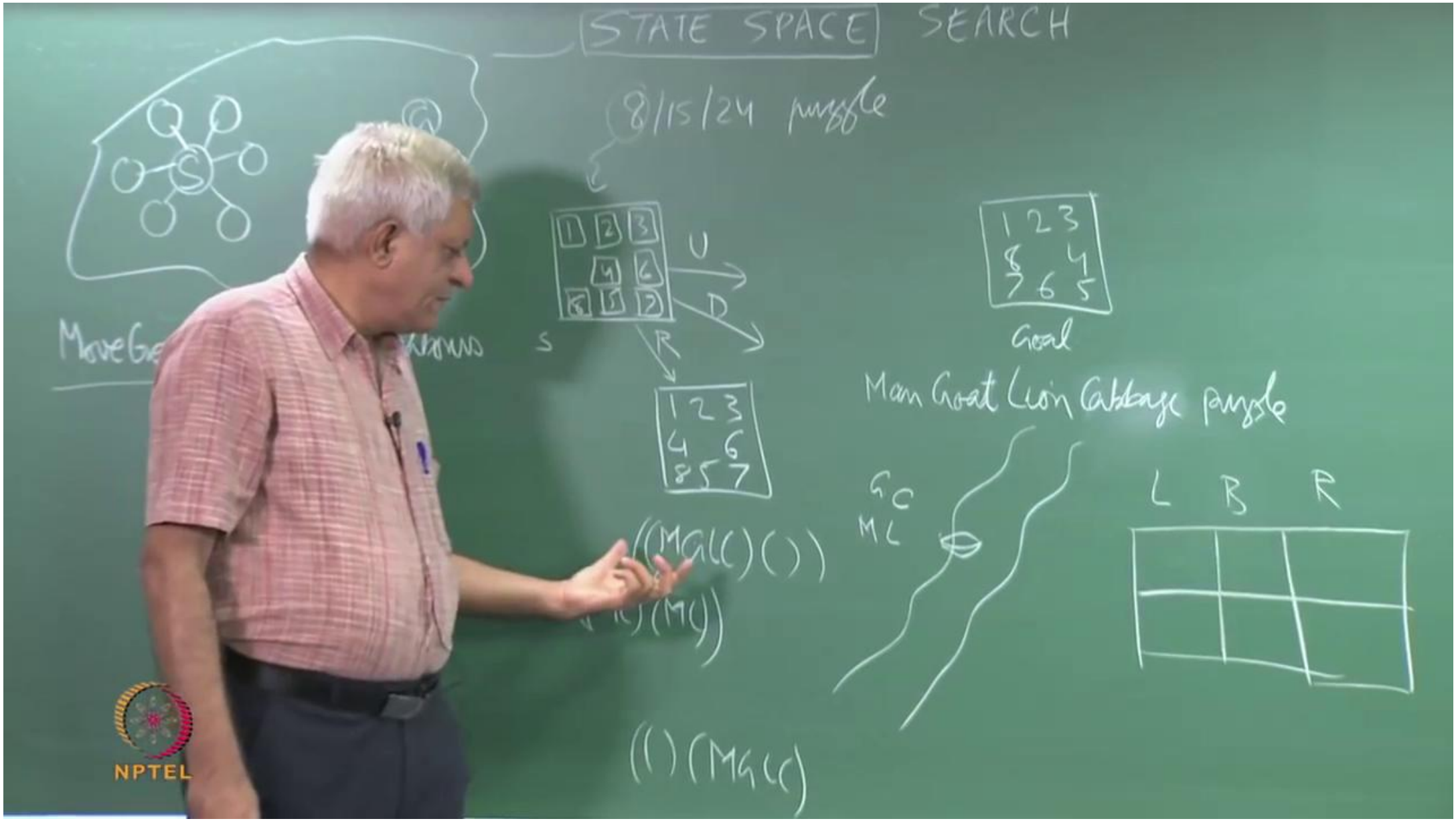
NPTEL

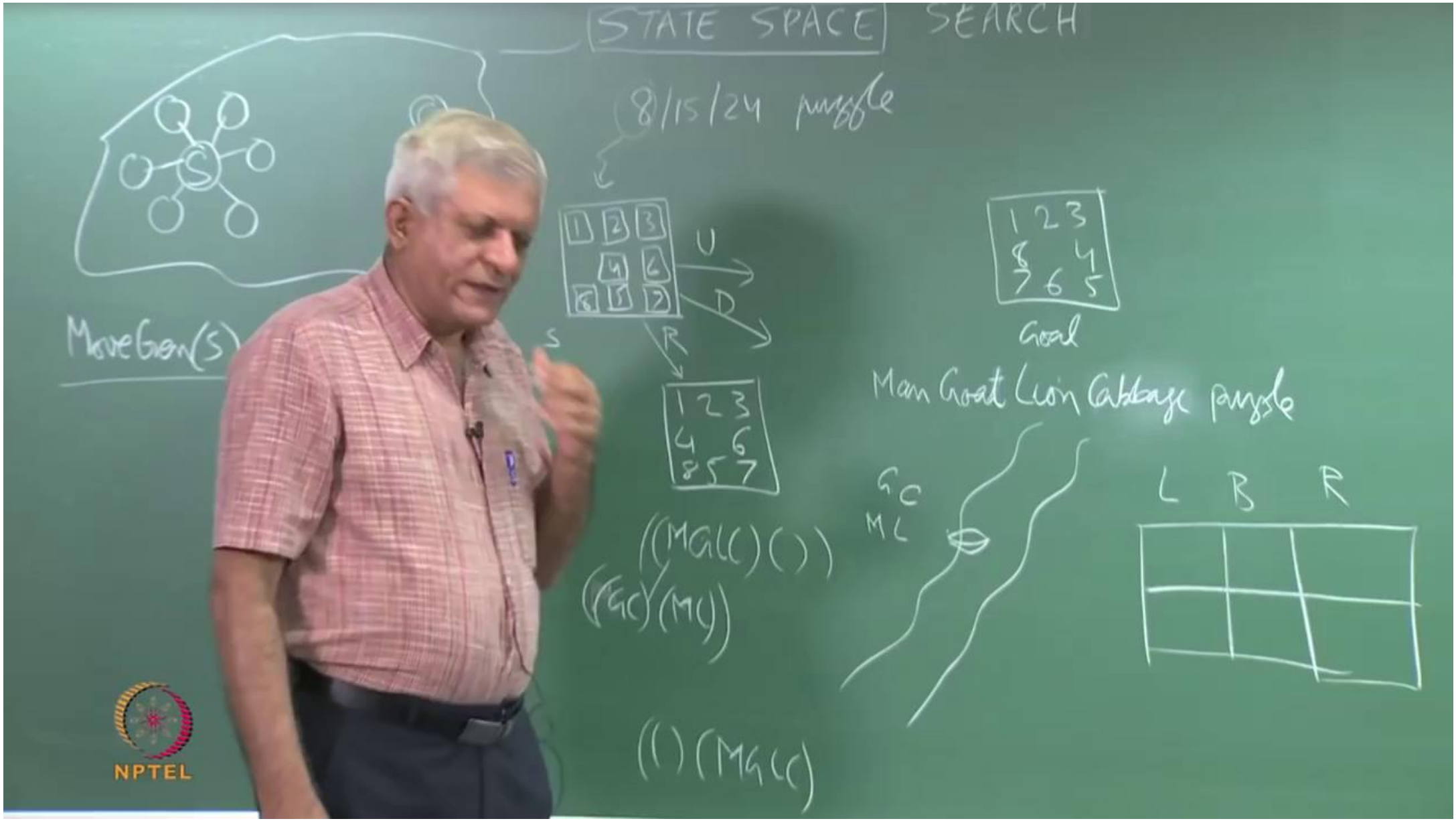

8/15/24 puzzle
U
D
R
L
Goal
Man Goat Lion Cabbage puzzle
GC
ML
NPTEL

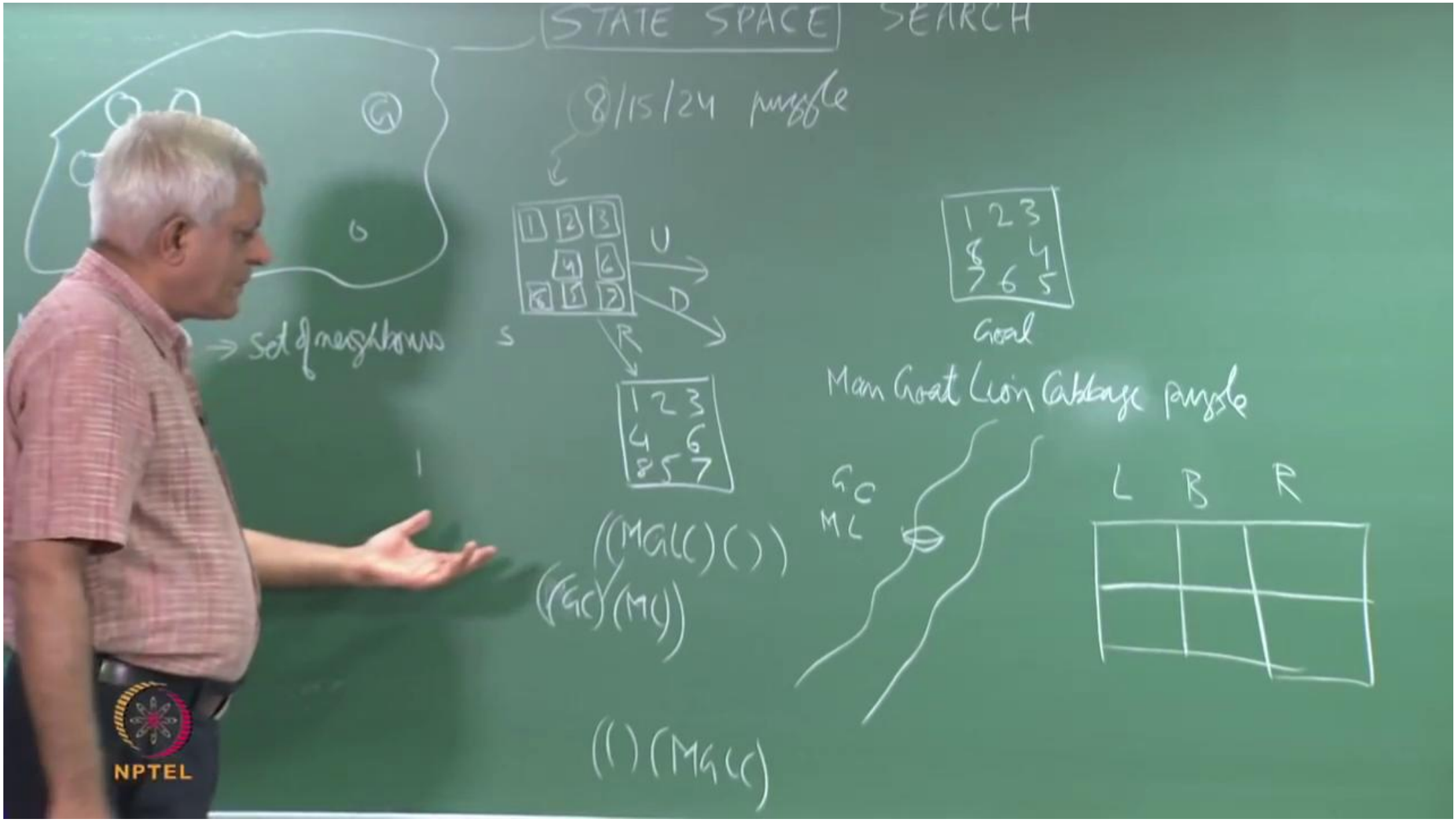

STATE SPACE SEARCH
8/15/24 puzzle
U
D
R
Goal
Man Goat Lion Cabbage
GC
ML
NPTEL

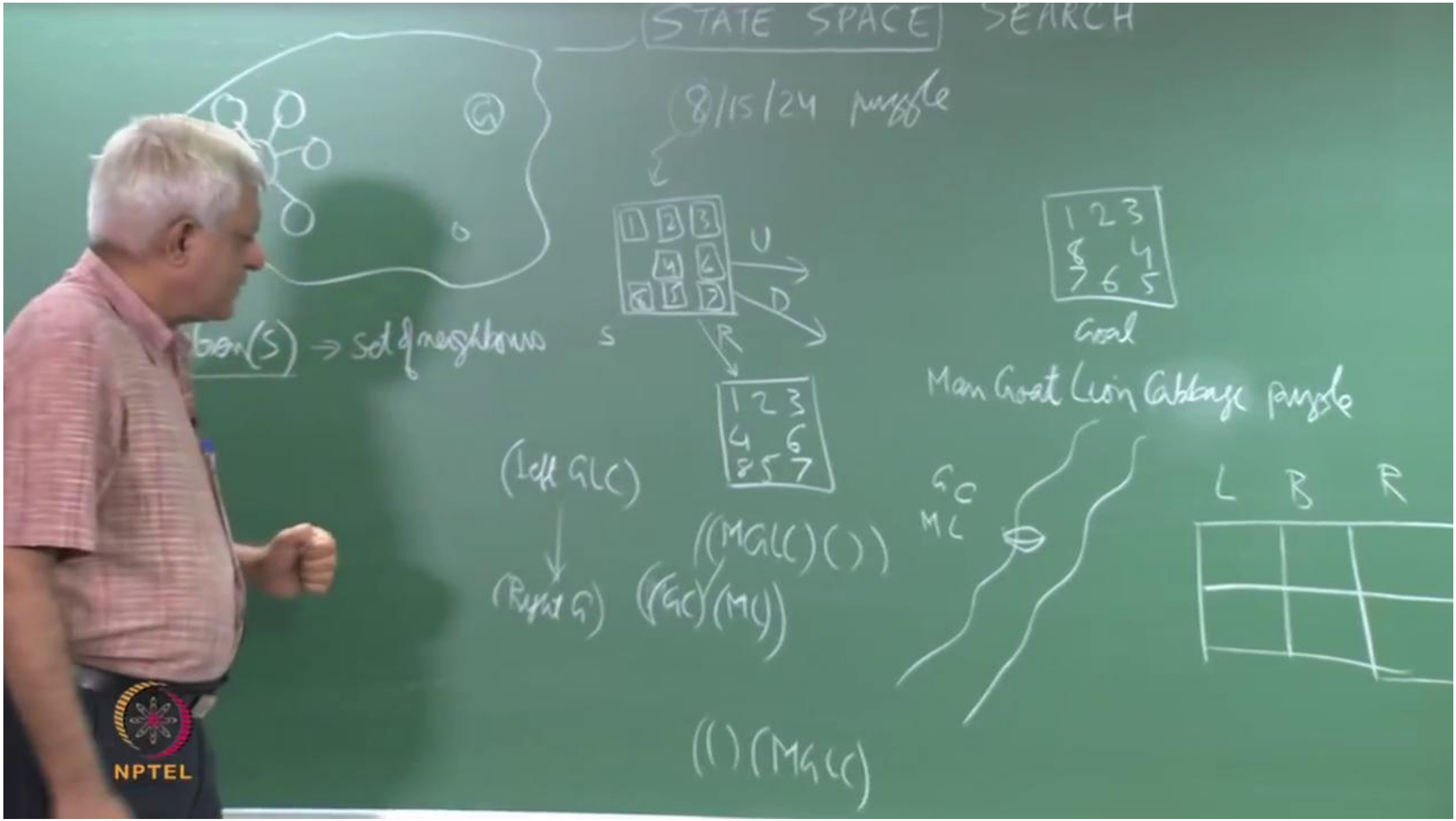

STATE SPACE SEARCH
8/15/24 puzzle
1 2 3
Goal
Man Goat Lion Cabbage puzzle
L B R
GC
ML
NPTEL

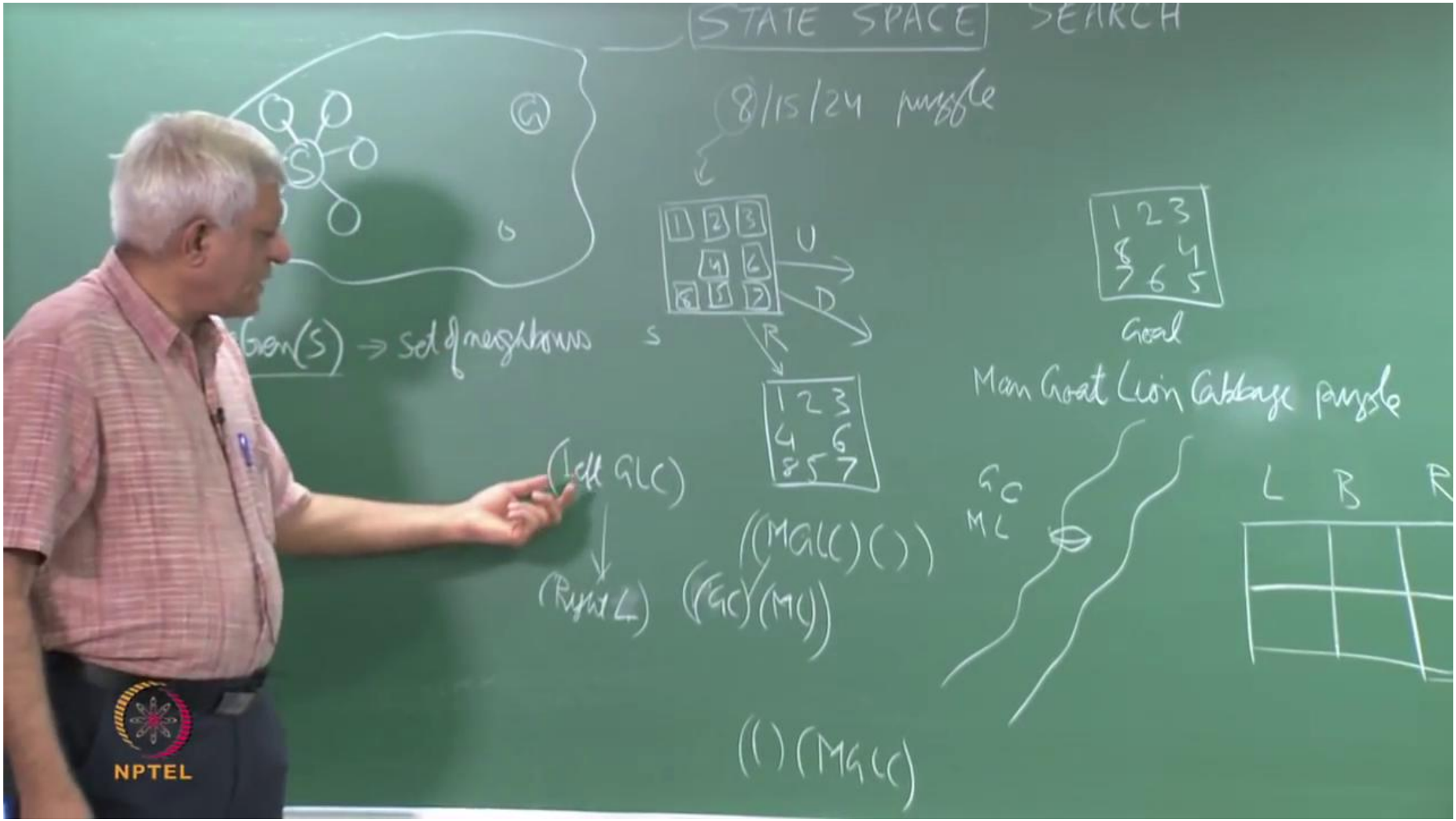

STATE SPACE SEARCH
8/15/24 puzzle
U
D
R
Goal
Man Goat Lion Cabbage puzzle
GC
ML
L B R
((MGLC)())
(()(MGLC)

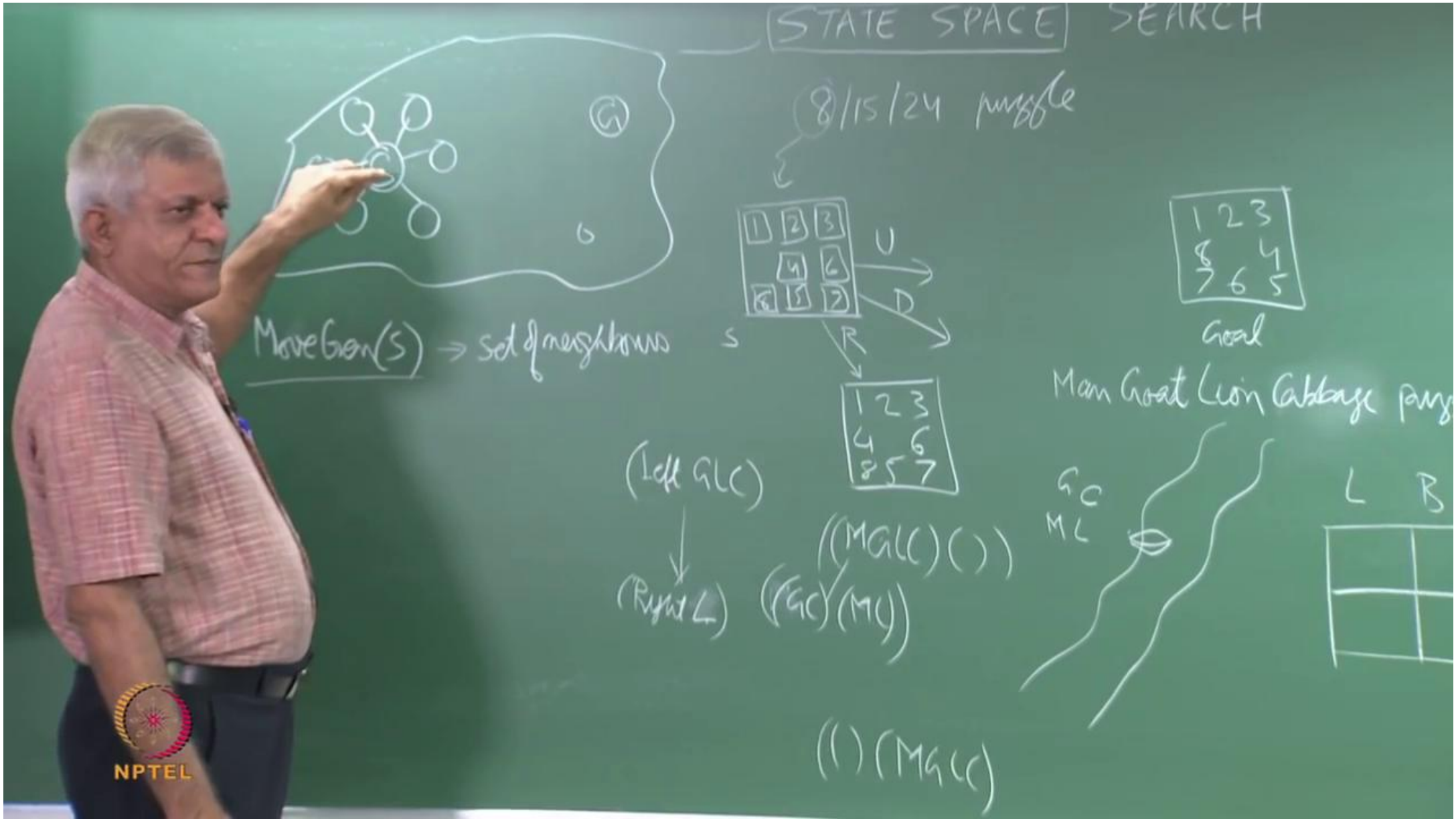

STATE SPACE SEARCH
8/15/24 puzzle
S
U
D
R
Goal
Man Goat Lion Cabbage puzzle
GC
ML
L B R
((MGLC)())
(())(MGLC)

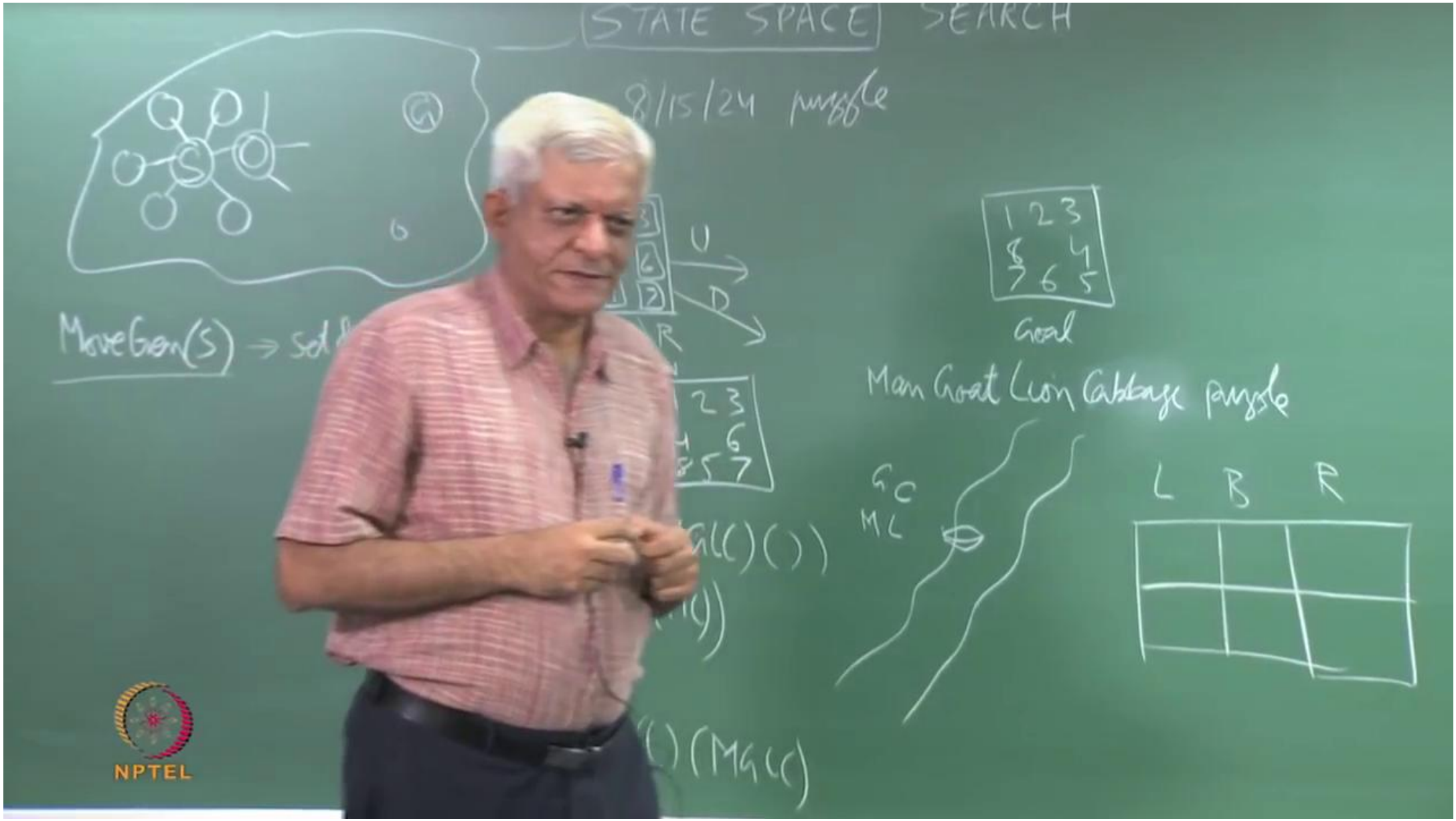

STATE SPACE SEARCH
8/15/24 puzzle
MoveGen(S)
S
U
D
R
1 2 3
4 6
5 7 8
1 2 3
4 5
6 7 8
Goal
Man Goat Lion Cabbage puzzle
GC
ML
L B R
((MGLC)())
(GC)(MC)
(())(MGLC)
NPTEL

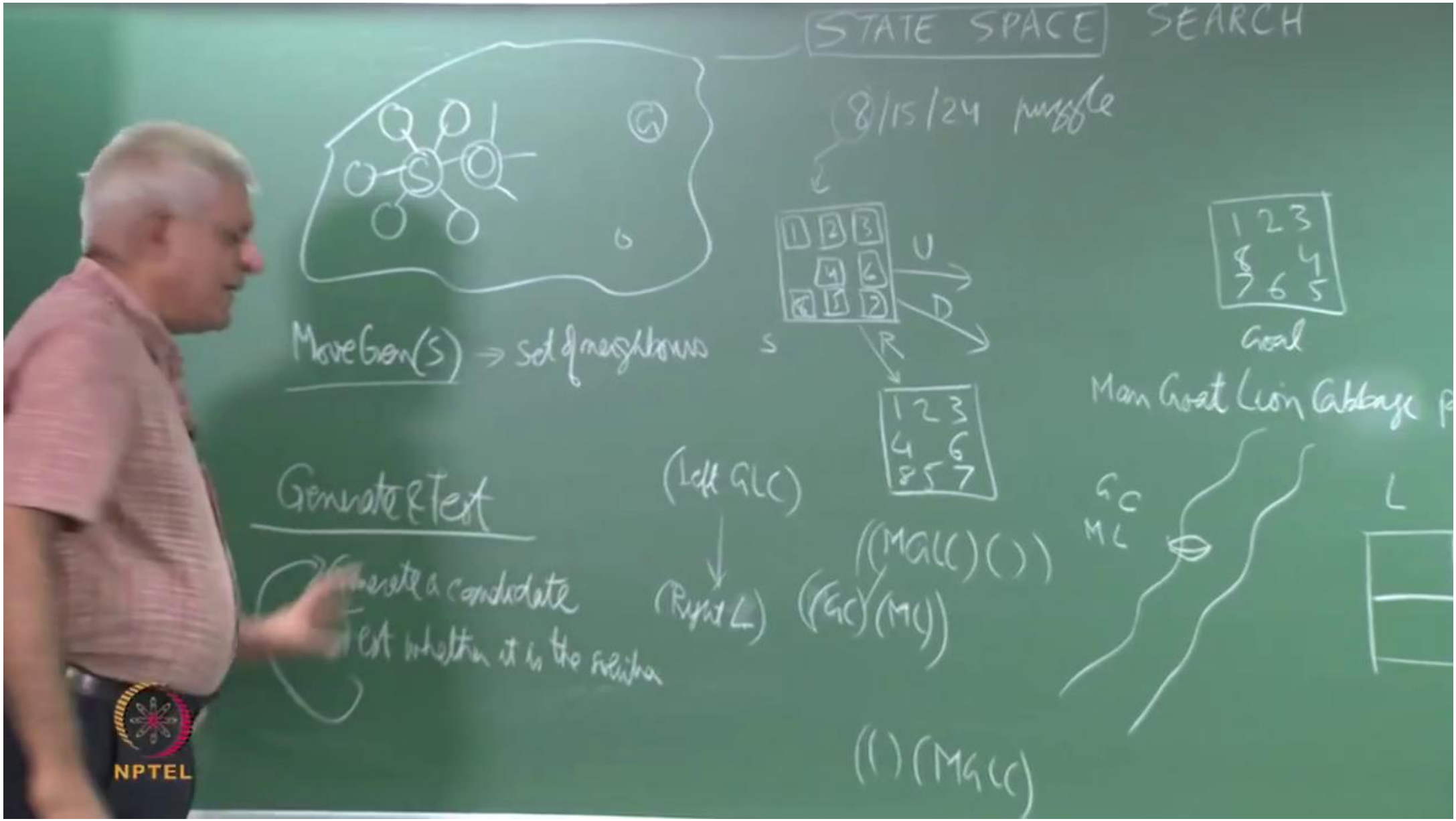

STATE SPACE SEARCH
8/15/24 puzzle
G
S
→ set of neighbours
U
D
R
1 2 3
4 6
7 5 8
1 2 3
8 4
7 6 5
Goal
Man Goat Lion Cabbage puzzle
((MGLC)())
(GC)(ML)
GC
ML
L B R
(())(MGLC)

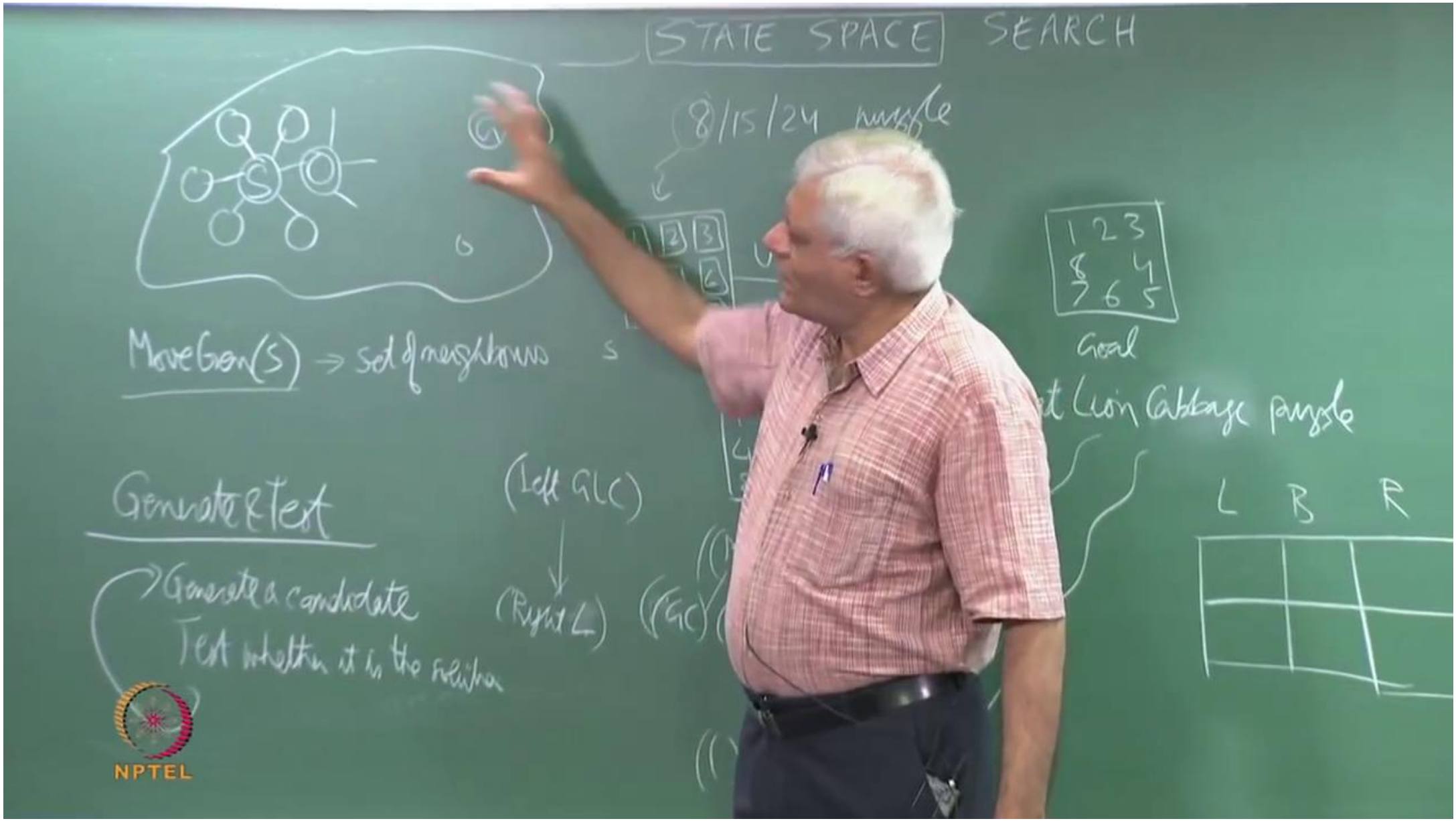

STATE SPACE SEARCH
8/15/24 puzzle
G
D
neighbors(S) → set of neighbours
S
U
D
R
1 2 3
4 6
7 5 8
1 2 3
8 4
7 6 5
Goal
Man Goat Lion Cabbage puzzle
(left GLC)
(Right G)
((MGLC)())
((GC)(ML))
GC
ML
L B R
((())(MGLC))
NPTEL

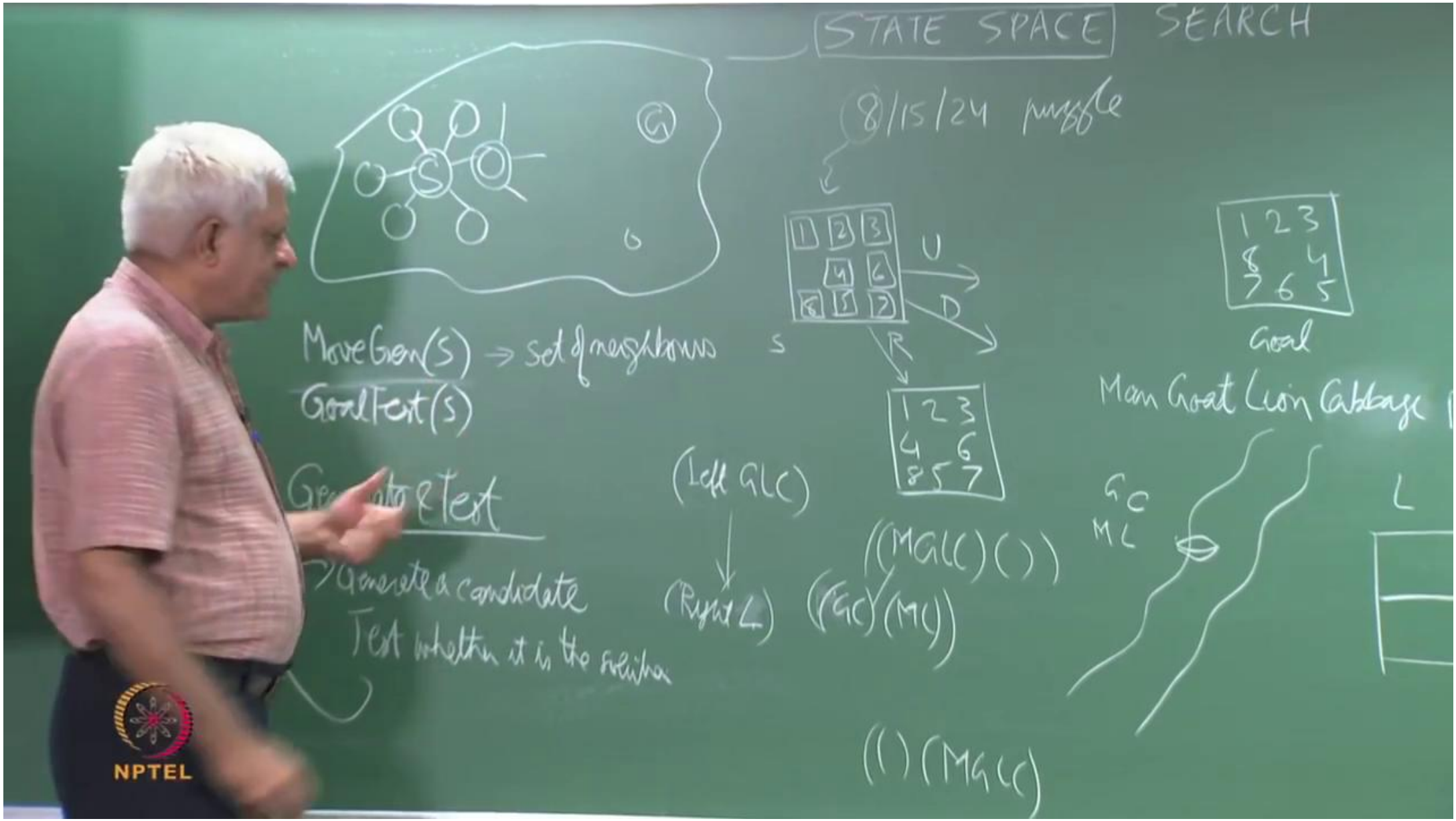

STATE SPACE SEARCH
8/15/24 puzzle
Goal
Man Goat Lion Cabbage puzzle
L B R
NPTEL

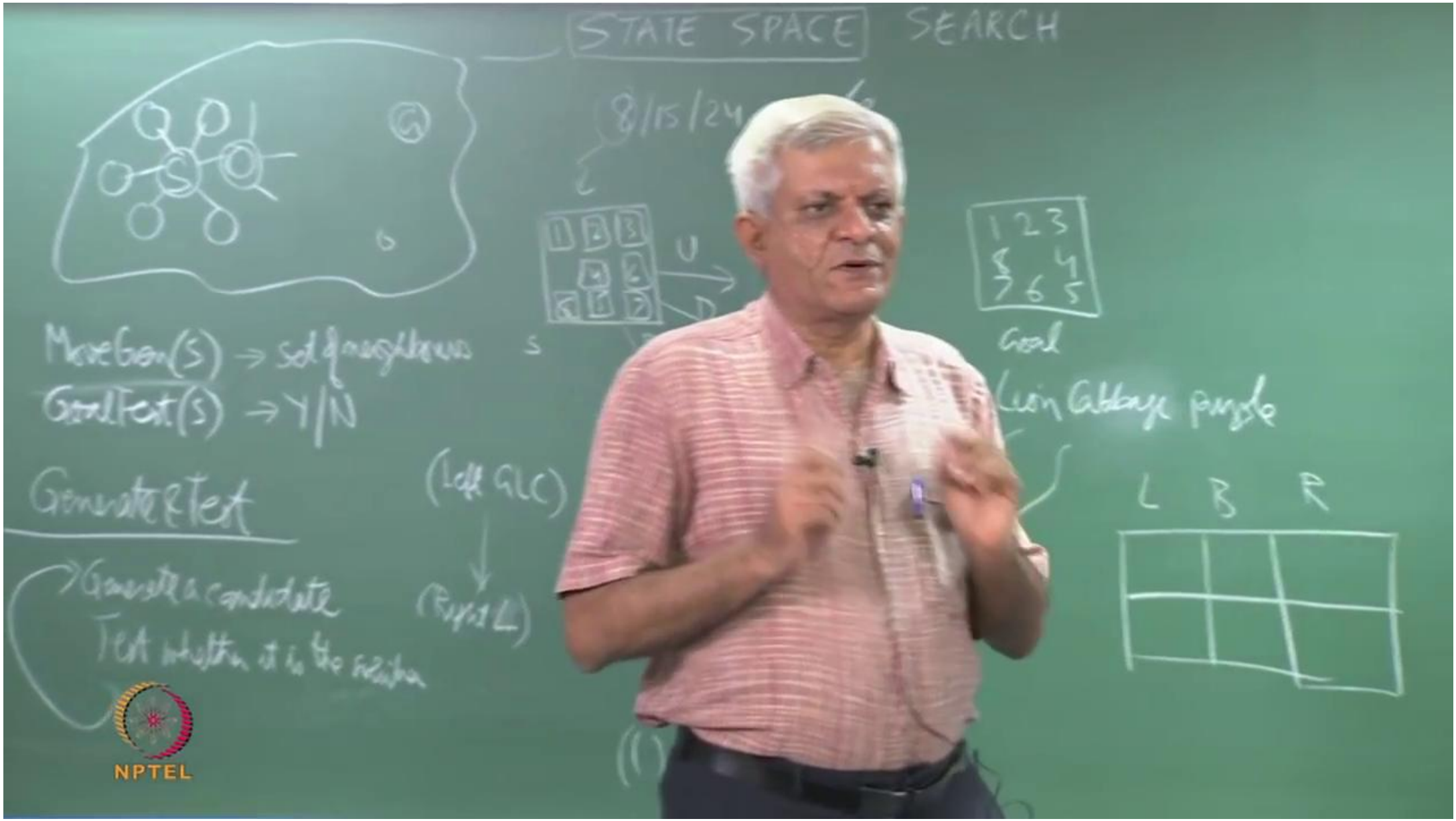

STATE SPACE SEARCH
8/15/24 puzzle
MoveGen(S) → set of neighbours
S
U
D
R
Goal
Man Goat Lion Cabbage
(Left GL())
(Right L)
((MGL())())
((GC)(ML))
((())(MGL())
L B
NPTEL

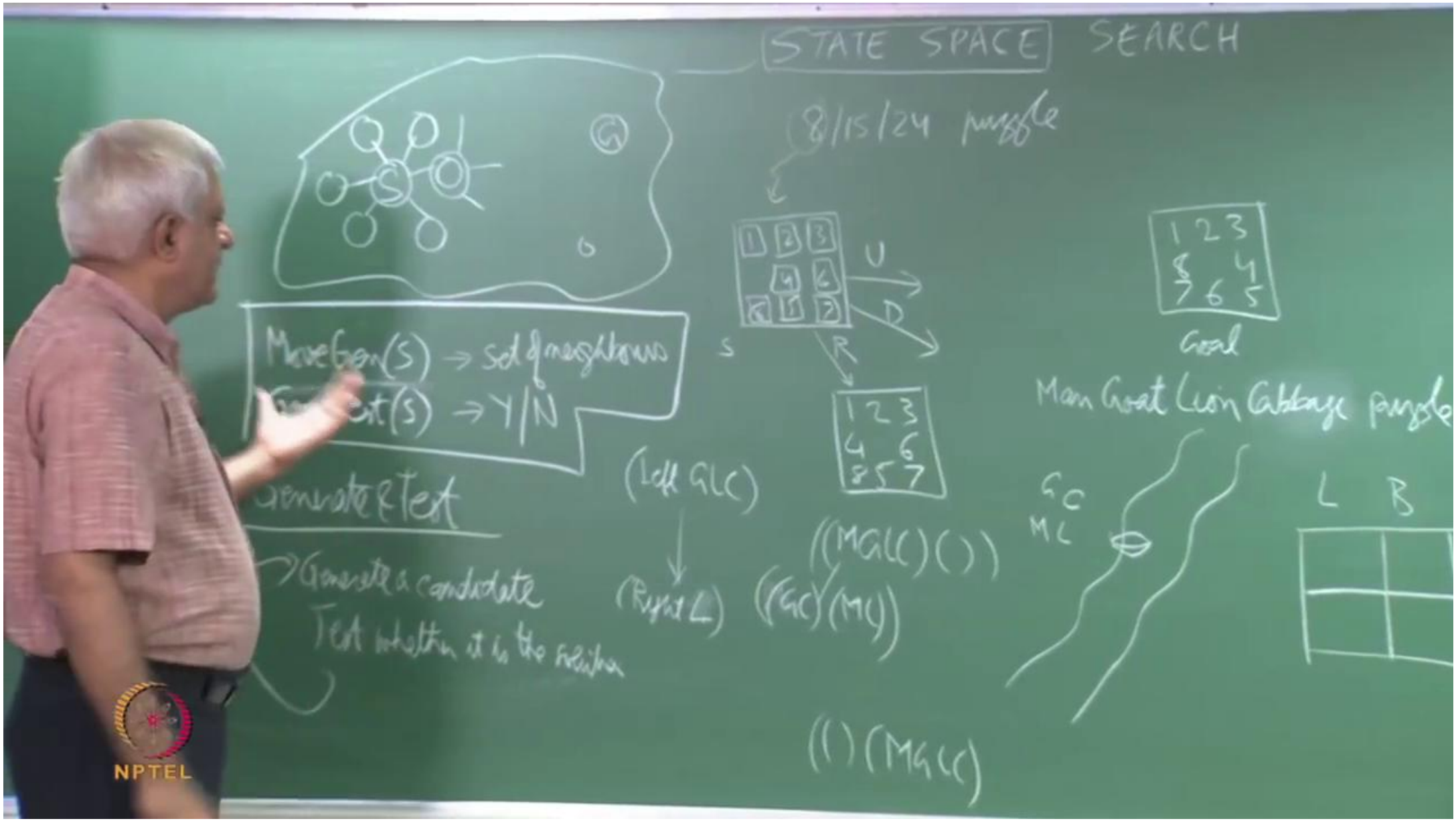

STATE SPACE SEARCH
8/15/24 puzzle
MoveGen(S) ⇒
U
D
R
1 2 3
8 4
7 6 5
Goal
Man Goat Lion Cabbage puzzle
GC
ML
L B R
NPTEL

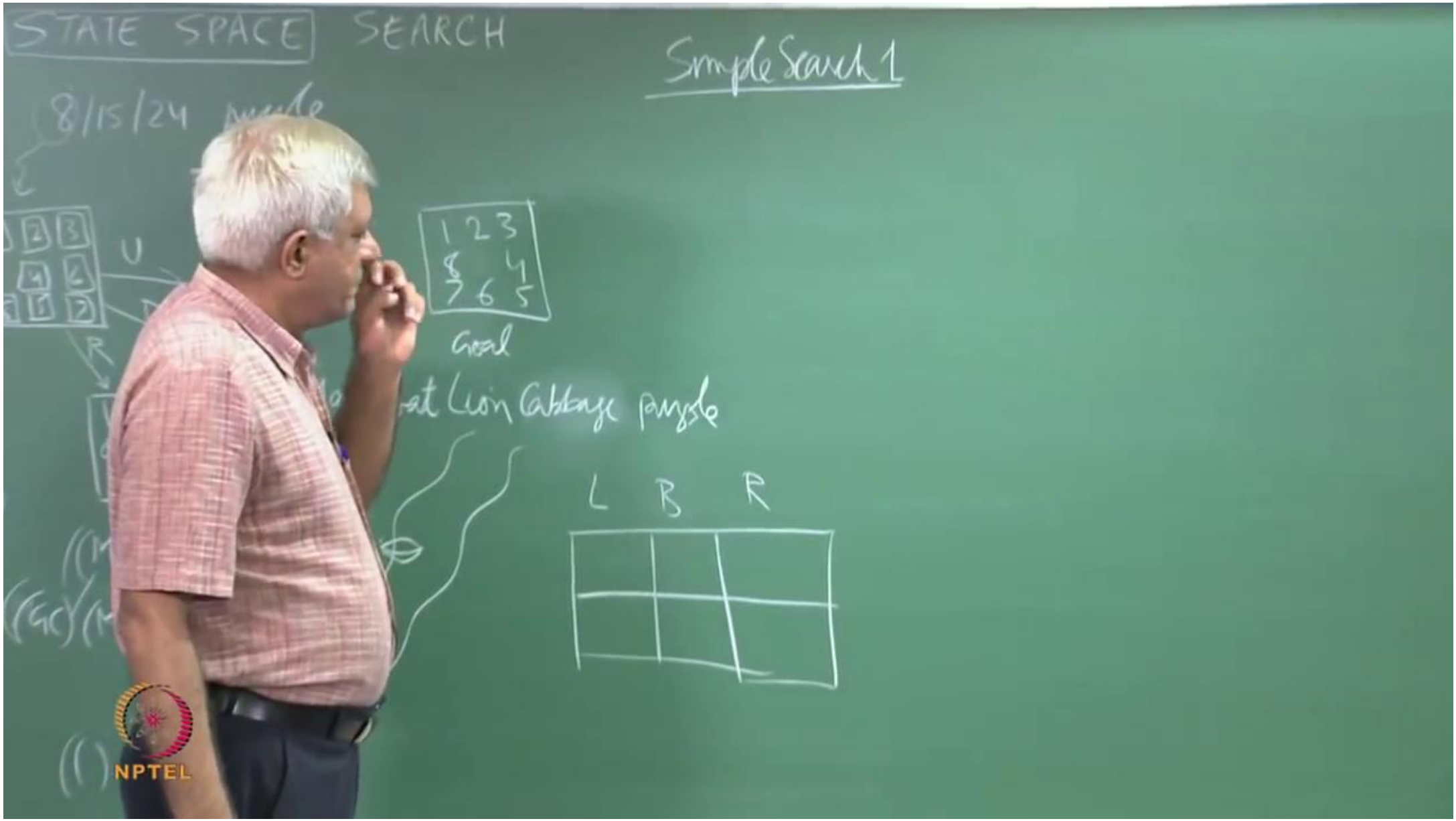

STATE SPACE SEARCH
8/15/24 puzzle
MoveGen(S) → set of neighbours
S
U
D
R
Goal
Man Goat Lion Cabbage
Generate & Test
(Left GL())
(Right L)
((MGL())())
((GC)(M()))
GC
ML
L
((())(MGL())


STATE SPACE SEARCH
8/15/24 puzzle
MoveGen(S) ⇒ set of neighbours
Goal
Lion Cabbage puzzle
L B R
Generate & Test
Generate a candidate
Test whether it is the solution
(Left GLC)
(Right L)
NPTEL


STATE SPACE SEARCH
8/15/24 puzzle
MoveGen(s) → set of neighbours
GoalTest(s)
Generate & Test
Generate a candidate
Test whether it is the solution
s
U
D
Goal
Man Goat Lion Cabbage
(left GLC)
(Right L)
((MGLC)())
((GC)(ML))
((())(MGLC))
GC
ML
L
NPTEL

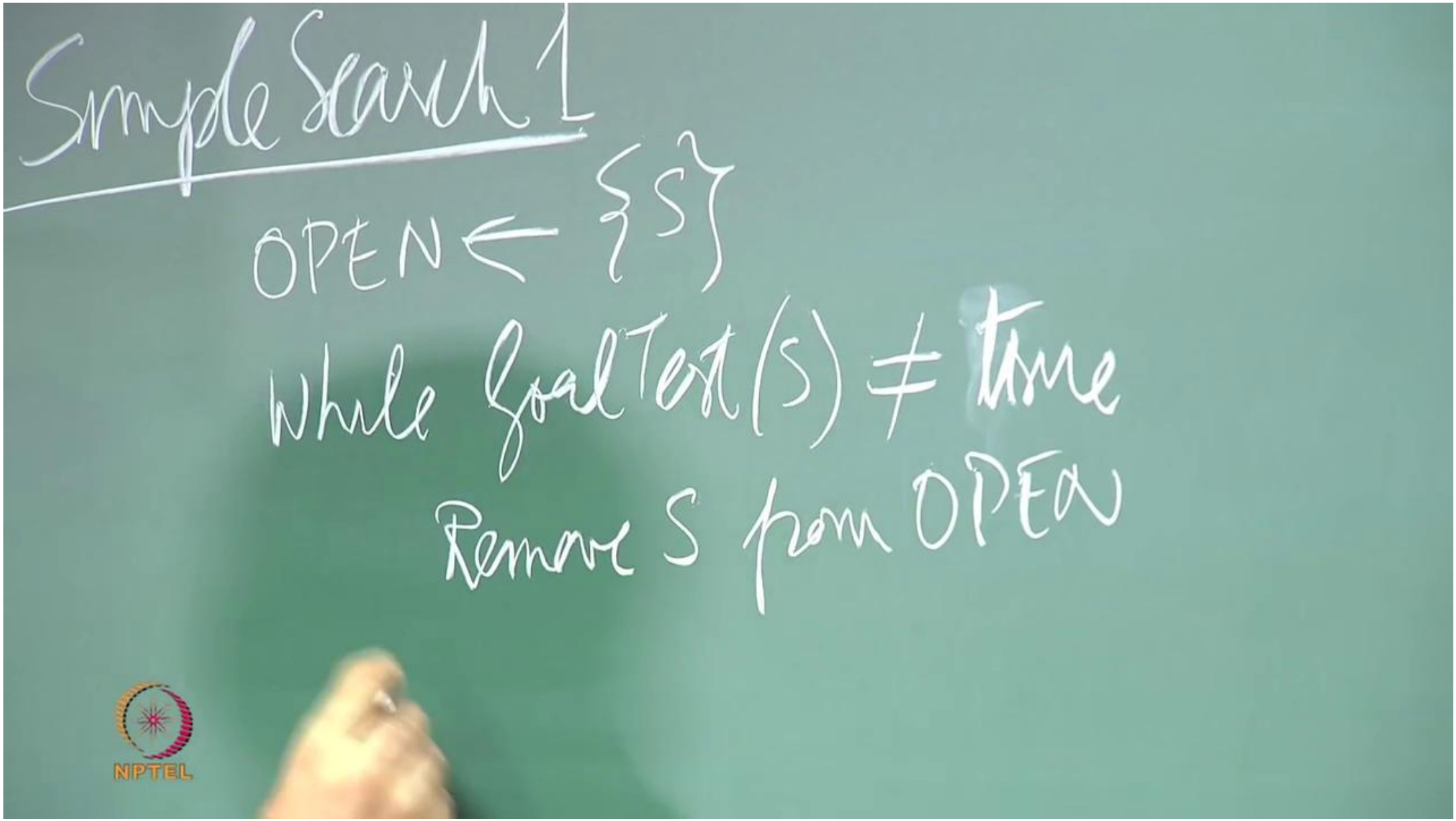

STATE SPACE SEARCH
8/15/24
Goal
L B R
Generate & Test
NPTEL

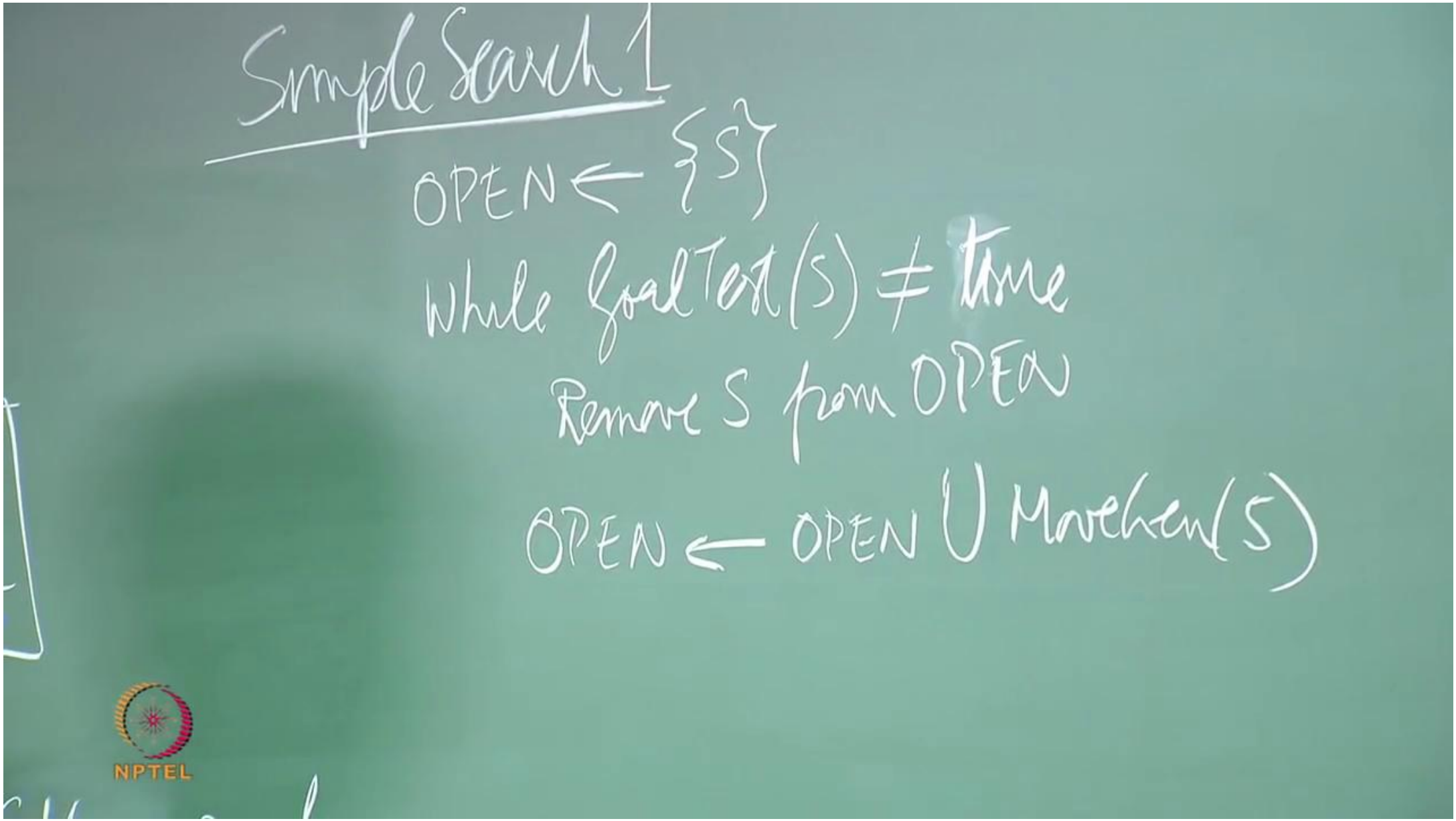

STATE SPACE SEARCH
8/15/24 puzzle
Move Gen(S) → set of neighbours
Goal test(S) → Y/N
Generate & Test
Generate a candidate
Test whether it is the solution
U
D
R
S
Goal
Man Goat Lion Cabbage puzzle
(left GLC)
(Right L)
((MGLC)())
((GC)(ML))
(()(MGLC)
GC
ML
L
B

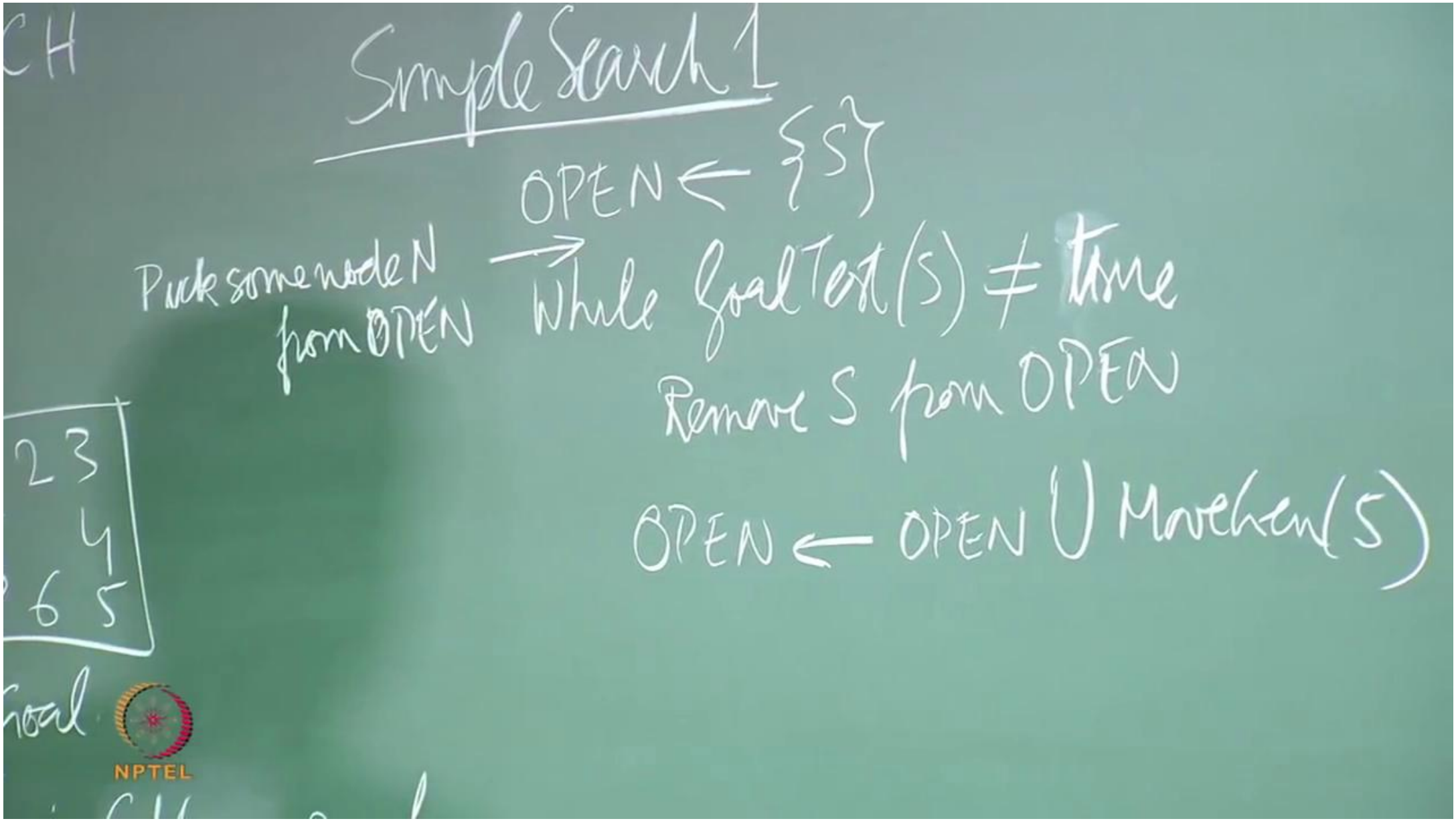

STATE SPACE SEARCH
Simple Search 1
8/15/24
U
R
1 2 3
8 4
7 6 5
Goal
L B R
NPTEL

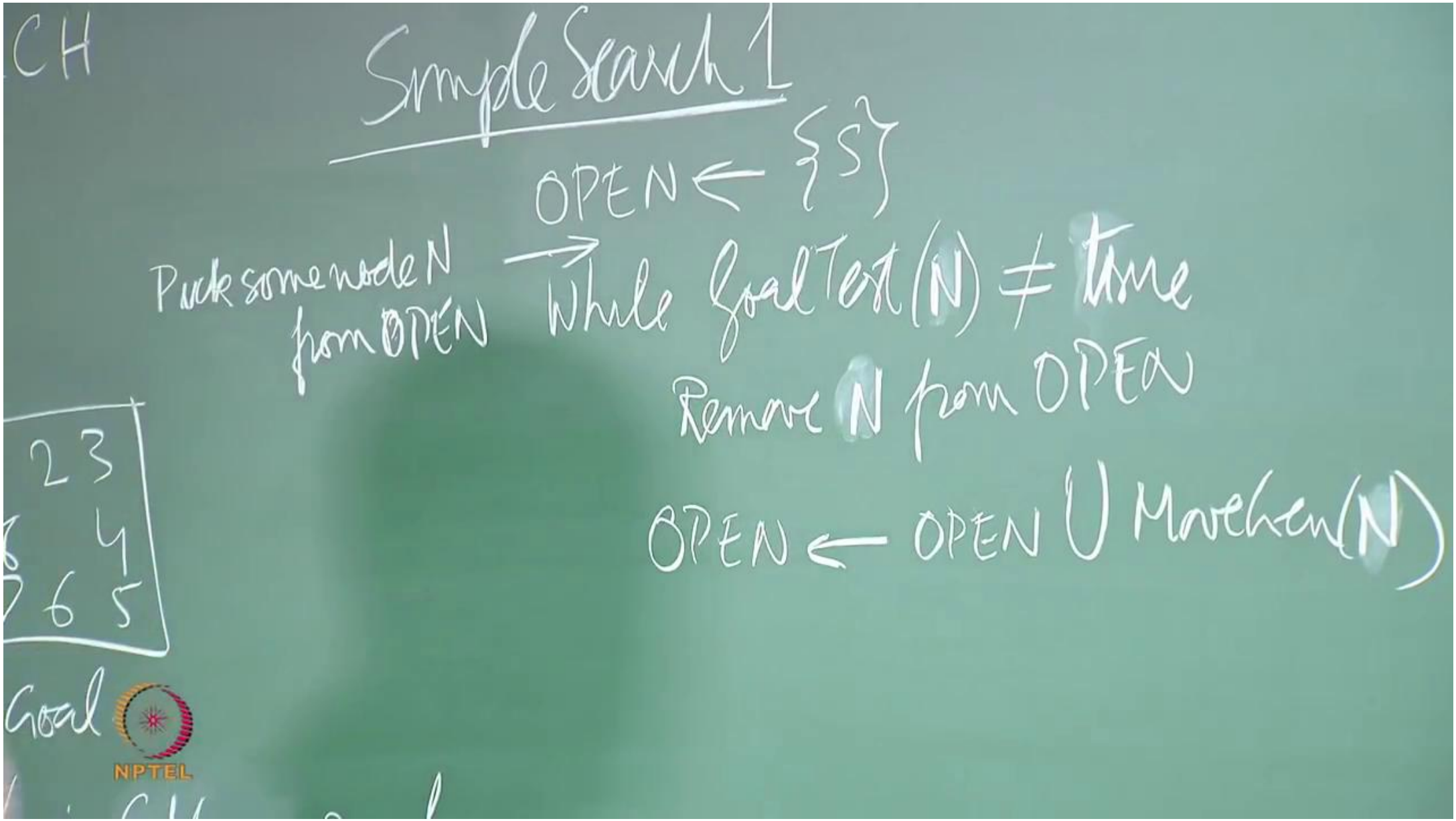
Simple Search 1

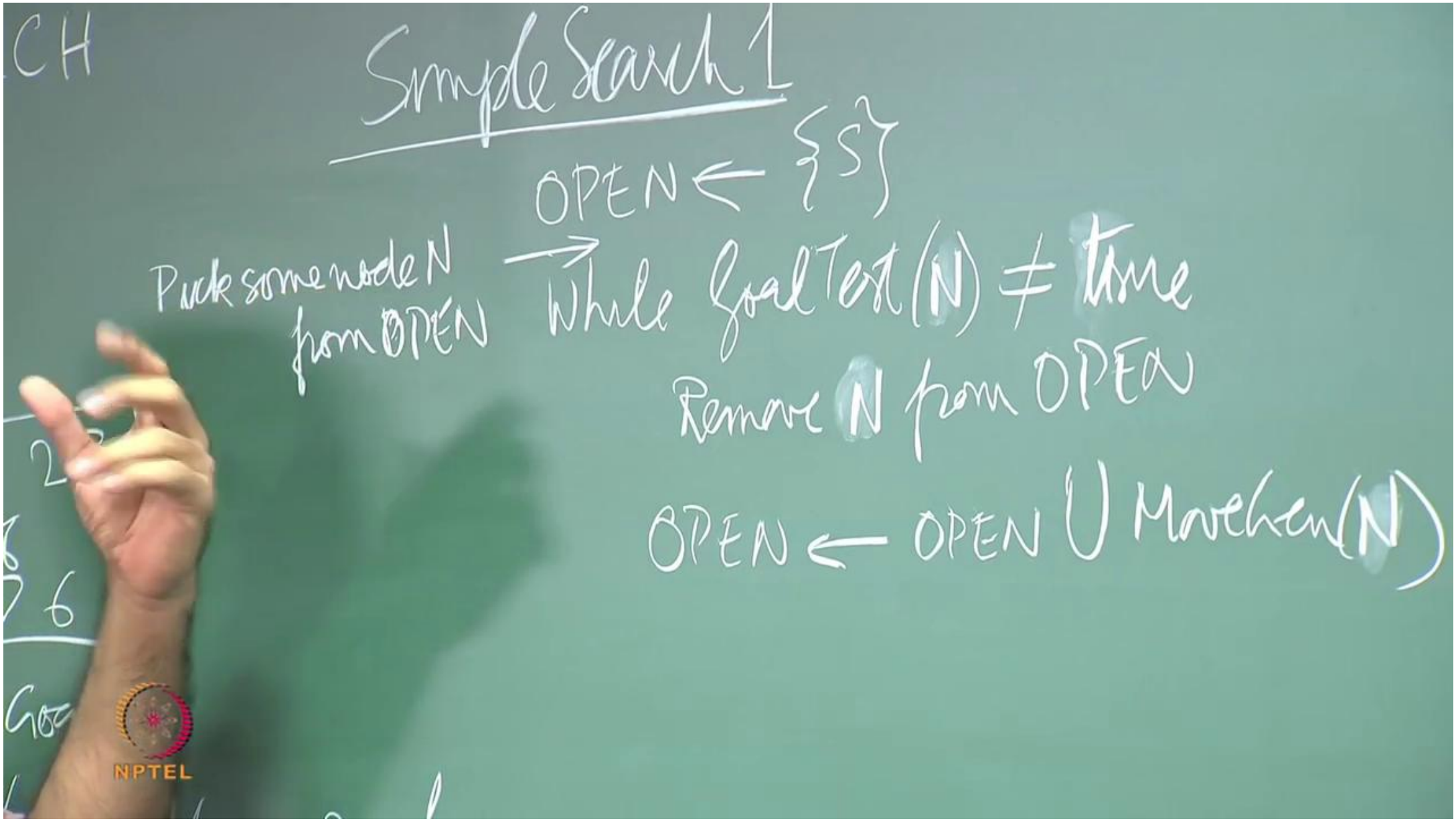
OPEN ← {s}

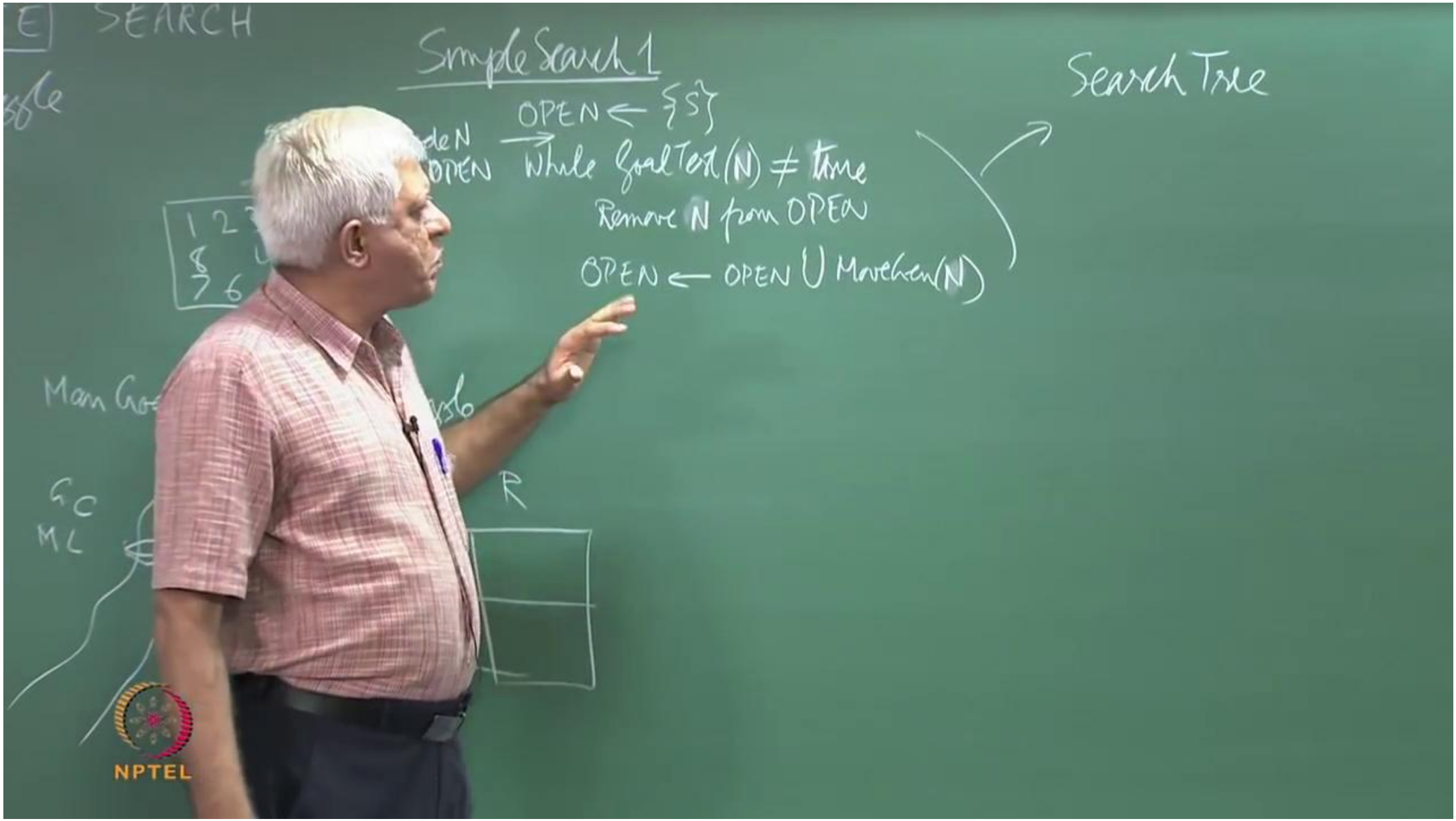

Simple Search 1
OPEN ← {S}
While GoalTest(S) ≠ true
Remove S from OPEN
NPTEL

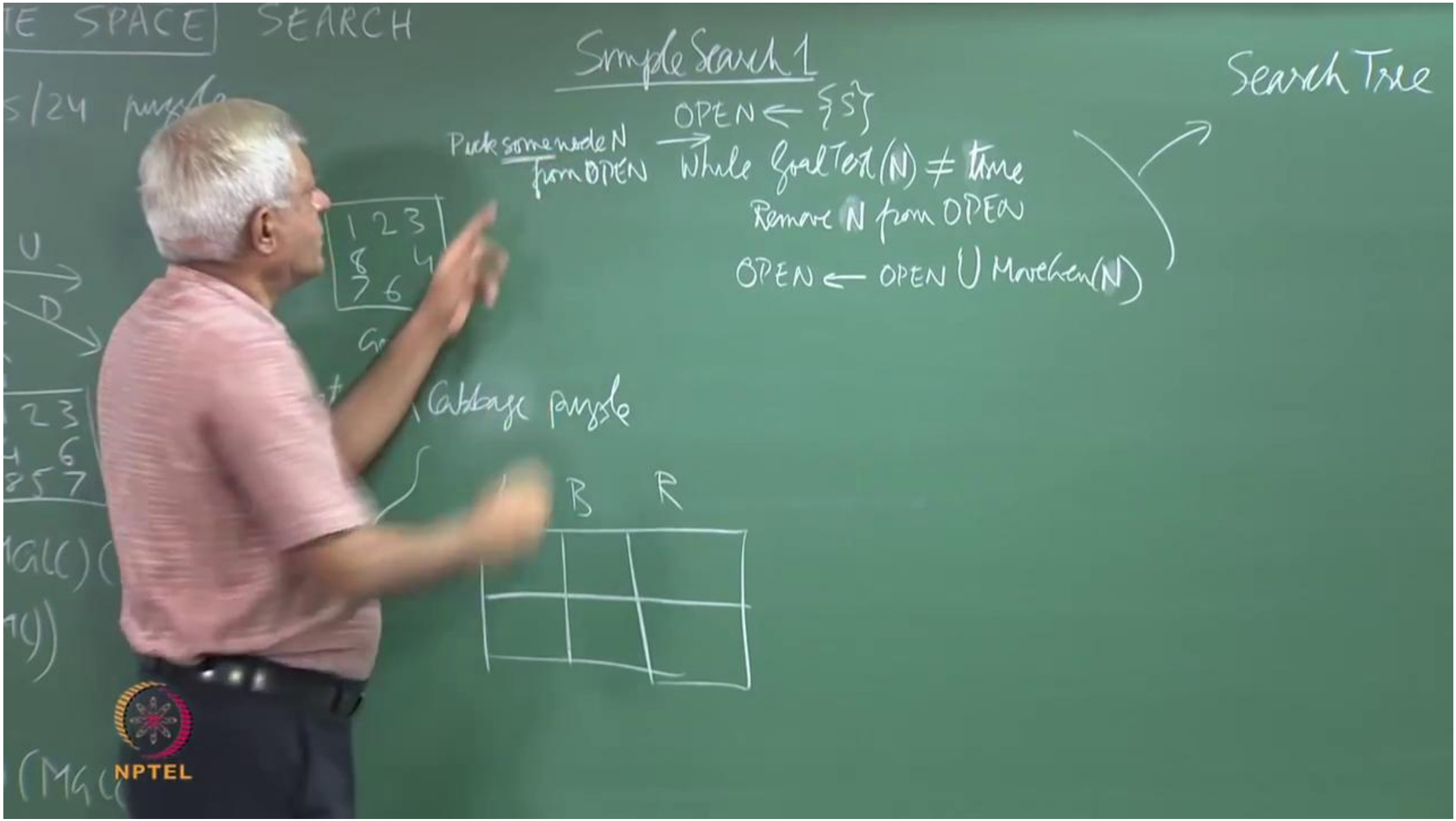

Simple Search 1
OPEN ← {S}
While GoalTest(S) ≠ true
Remove S from OPEN
OPEN ← OPEN ∪ Moveken(S)
NPTEL

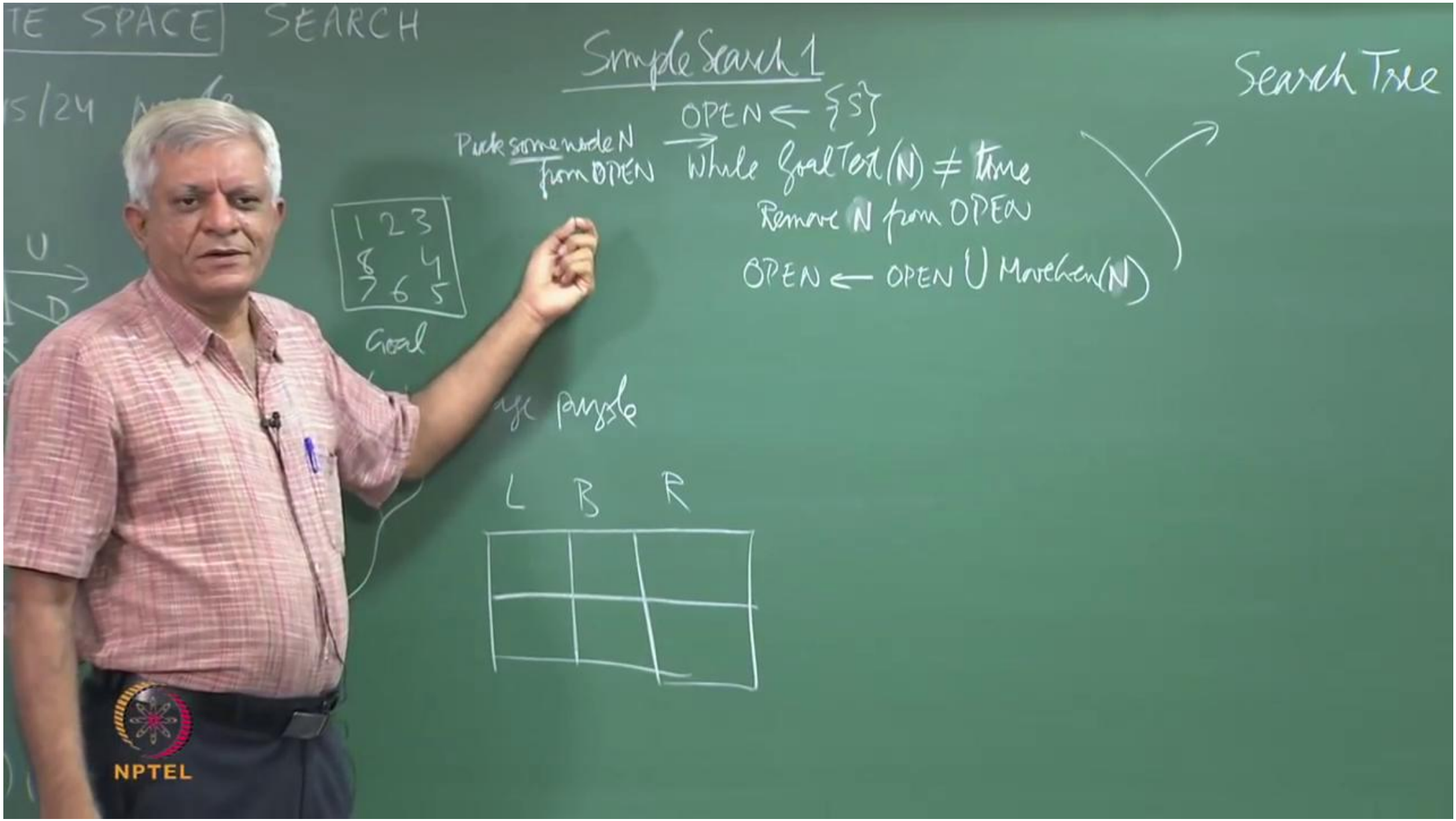

CH
Simple Search 1
OPEN ← {S}
Pick some node N from OPEN
While GoalTest(S) ≠ true
Remove S from OPEN
OPEN ← OPEN ∪ MoveGen(S)
2 3
4
1
6 5
Goal
NPTEL

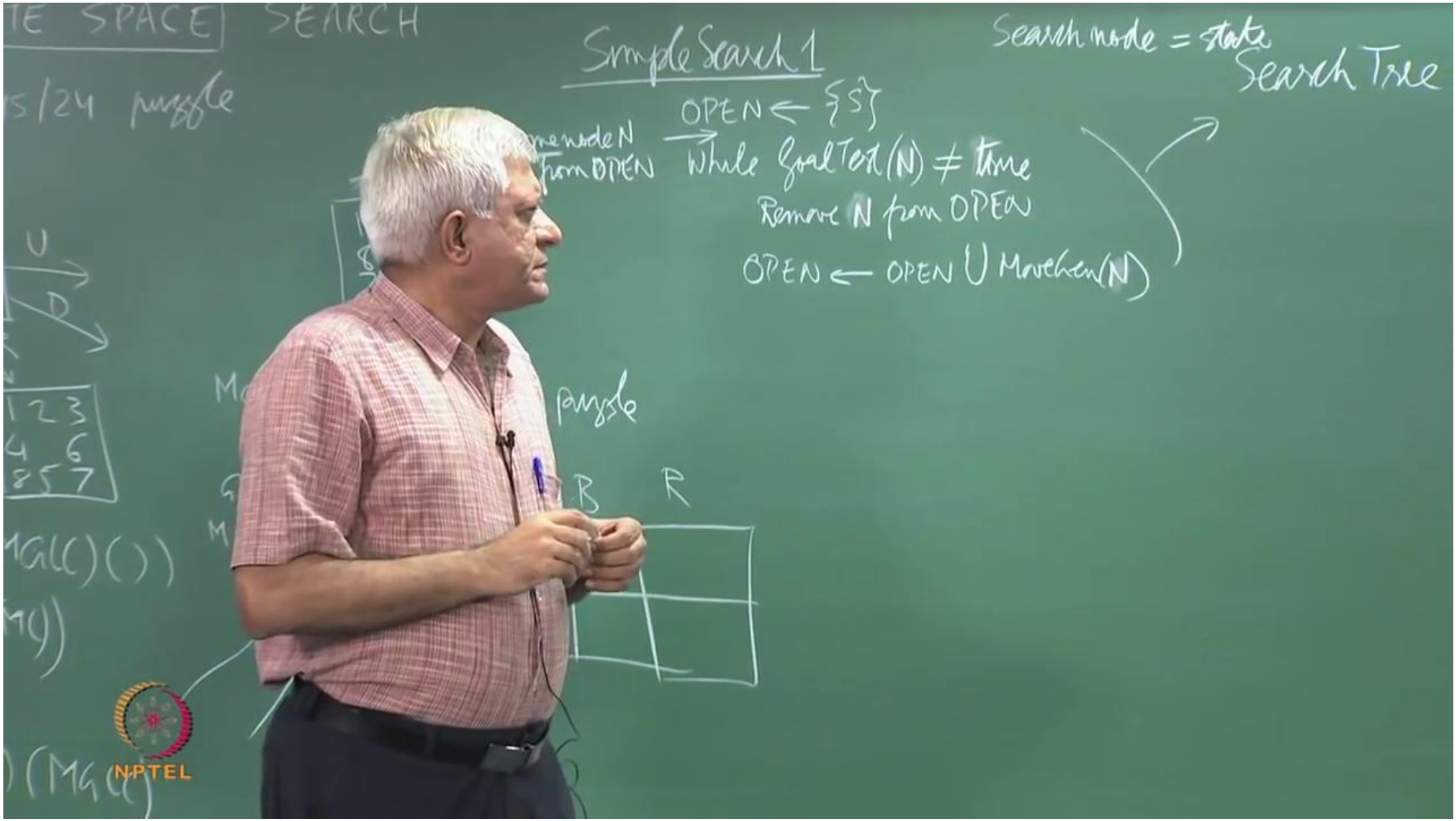

CH
Simple Search 1
OPEN ← {S}
Pick some node N from OPEN
While GoalTest(N) ≠ true
Remove N from OPEN
OPEN ← OPEN ∪ Moveto(N)
2 3
4
1
6 5
Goal

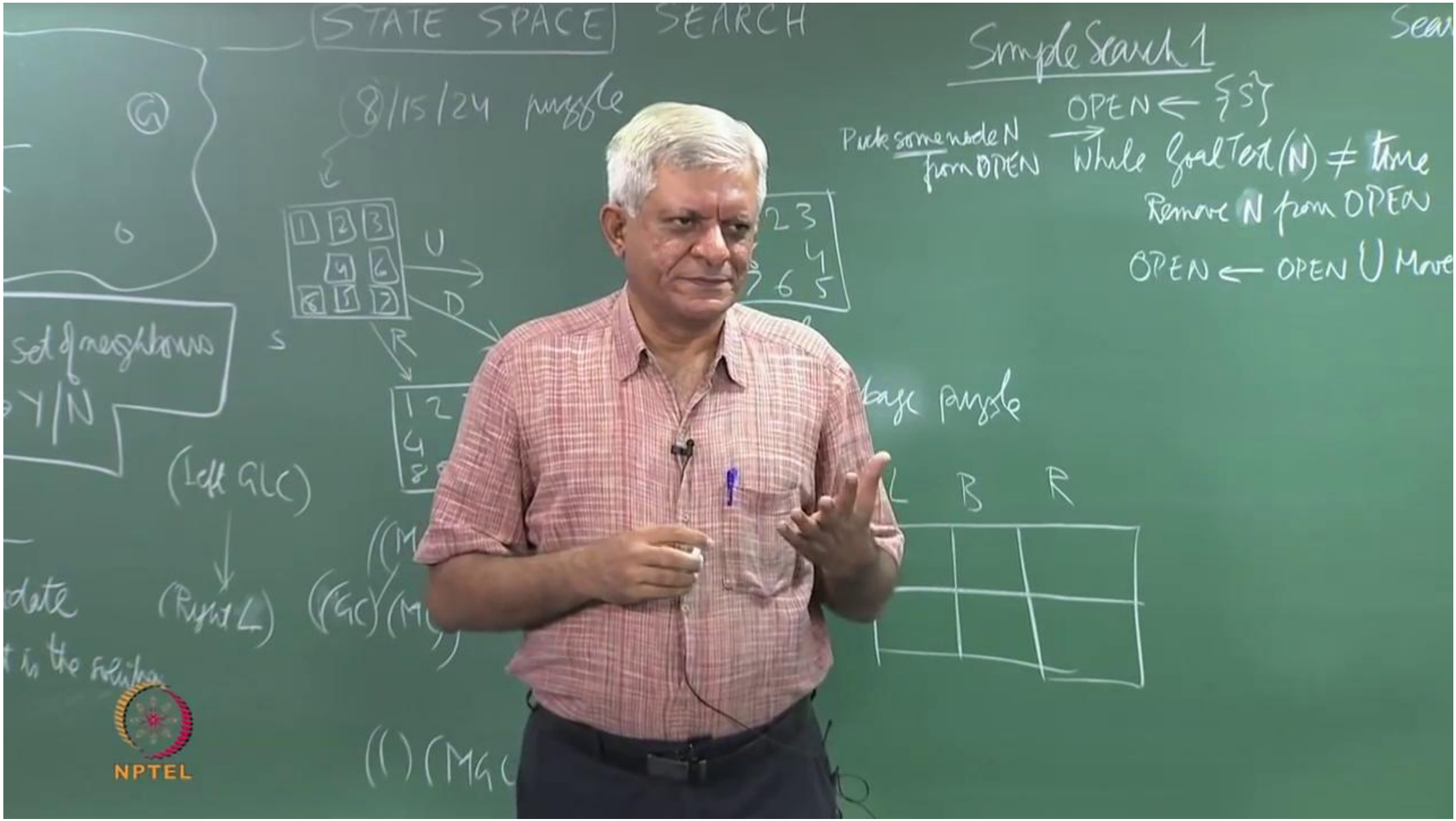

CH
Simple Search 1
OPEN ← {S}
Pick some node N from OPEN
While GoalTest(N) ≠ true
Remove N from OPEN
OPEN ← OPEN ∪ MoveGen(N)
NPTEL

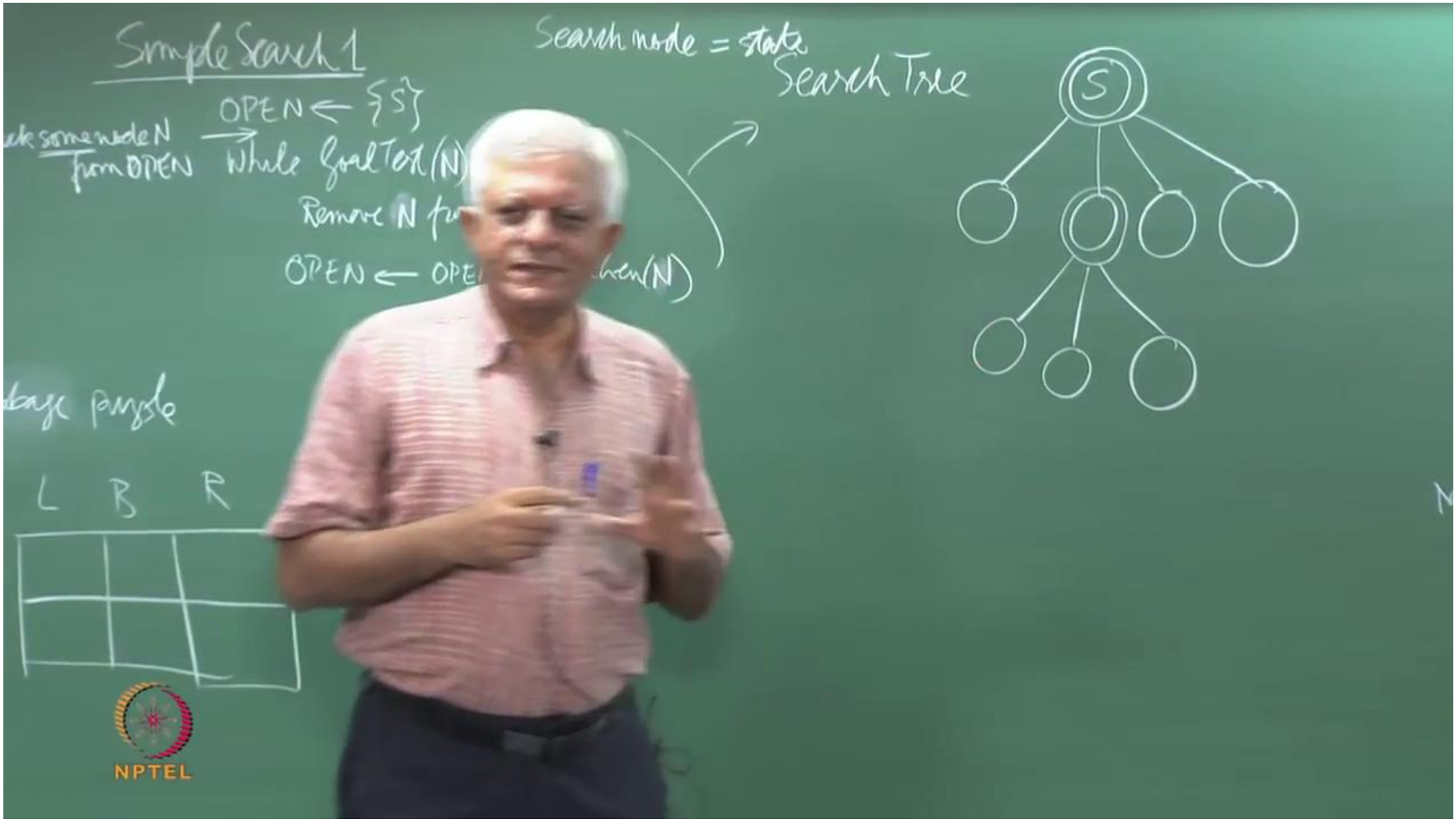

SEARCH
Simple Search 1
OPEN ← {S}
While GoalTest(N) ≠ true
Remove N from OPEN
OPEN ← OPEN ∪ MoveGen(N)
Search Tree
NPTEL

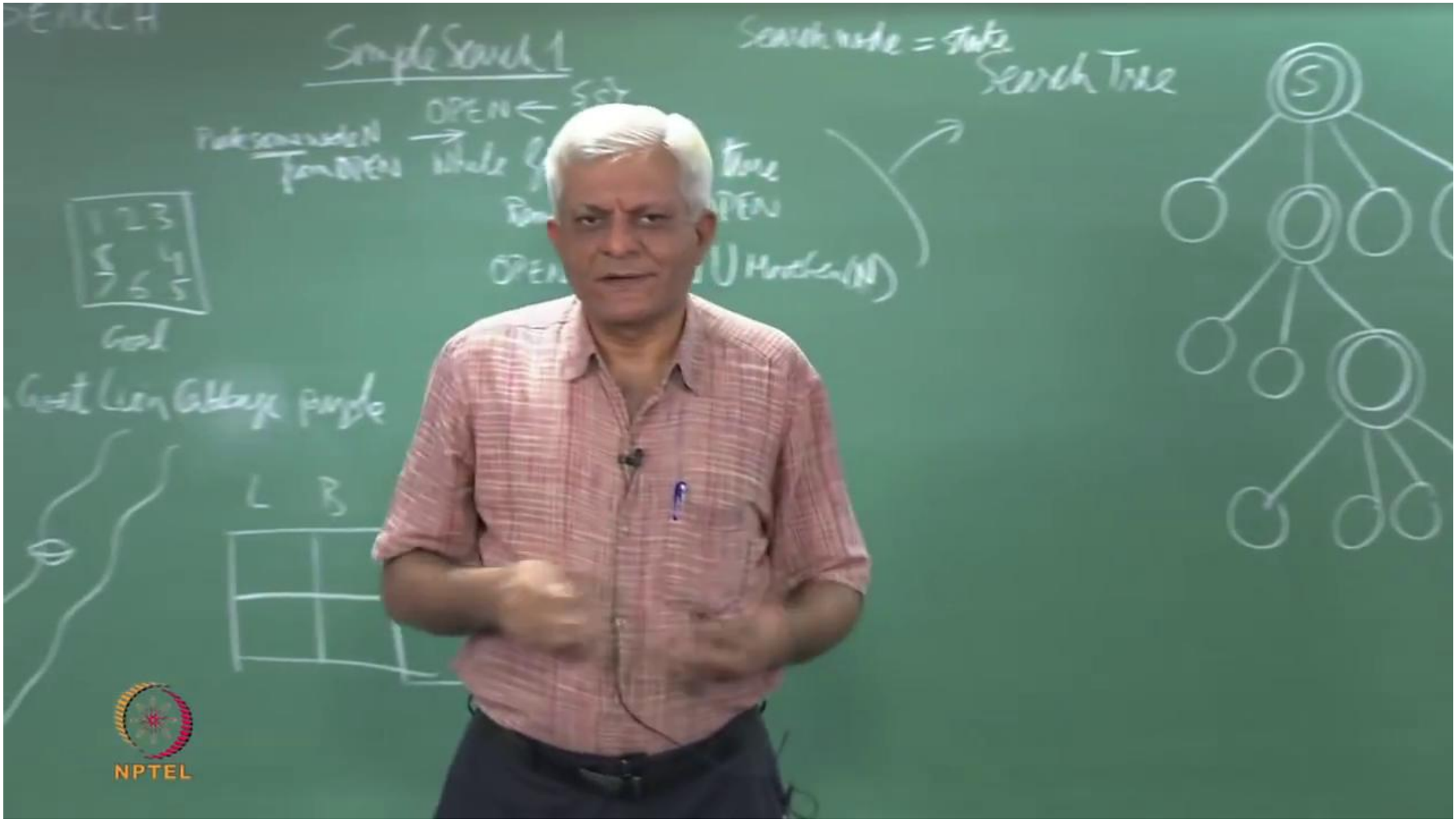

E SPACE SEARCH
Simple Search 1
Search Tree
OPEN ← {S}
Pick some node N from OPEN
While GoalTest(N) ≠ true
Remove N from OPEN
OPEN ← OPEN ∪ MoveGen(N)
Cabbage puzzle
B R
NPTEL

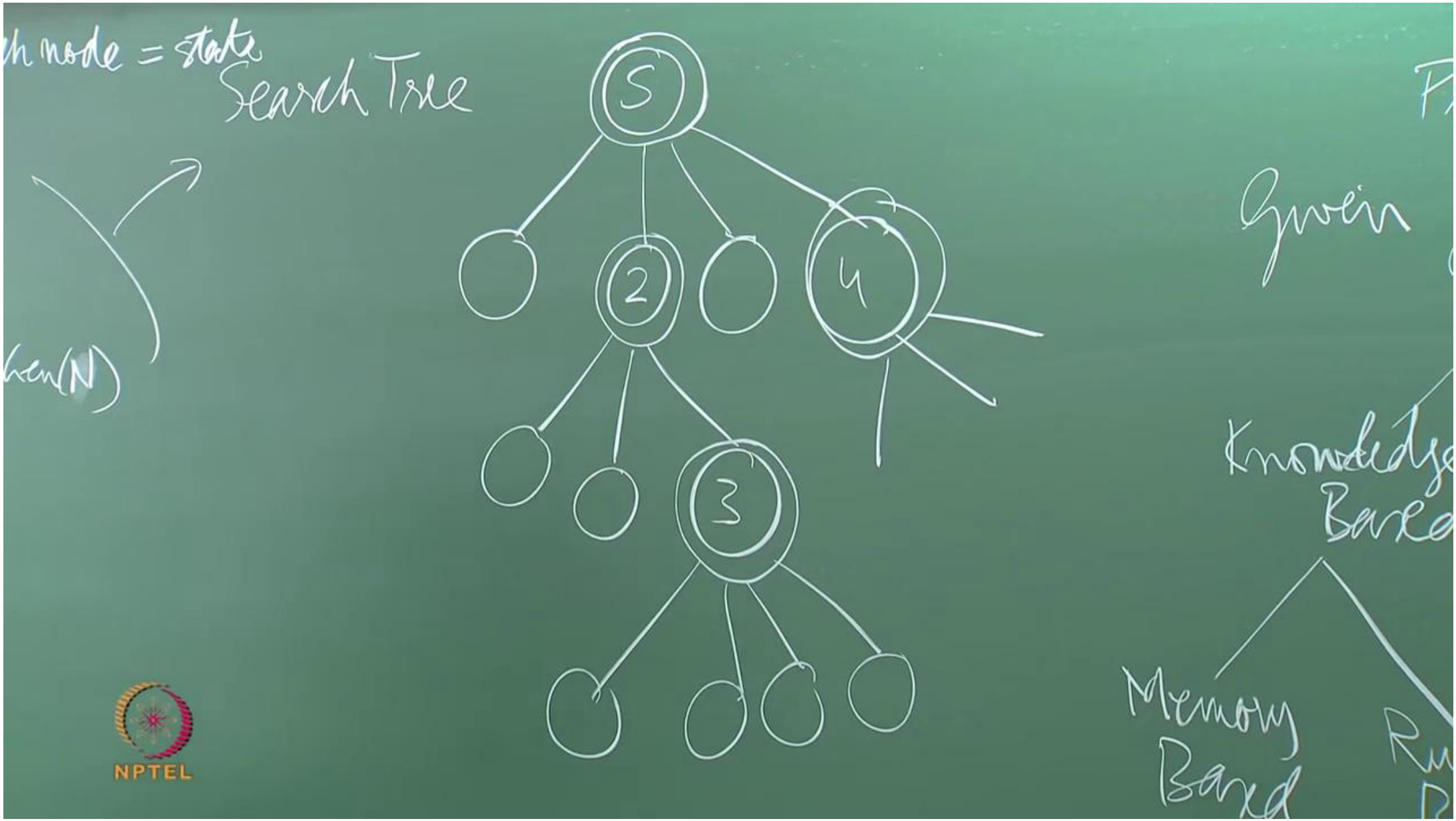

TE SPACE SEARCH
Simple Search 1
Search Tree
OPEN ← {S}
Pick some node N from OPEN
While GoalTest(N) ≠ true
Remove N from OPEN
OPEN ← OPEN ∪ MoveGen(N)
1 2 3
8 4
7 6 5
Goal
L B R
NPTEL

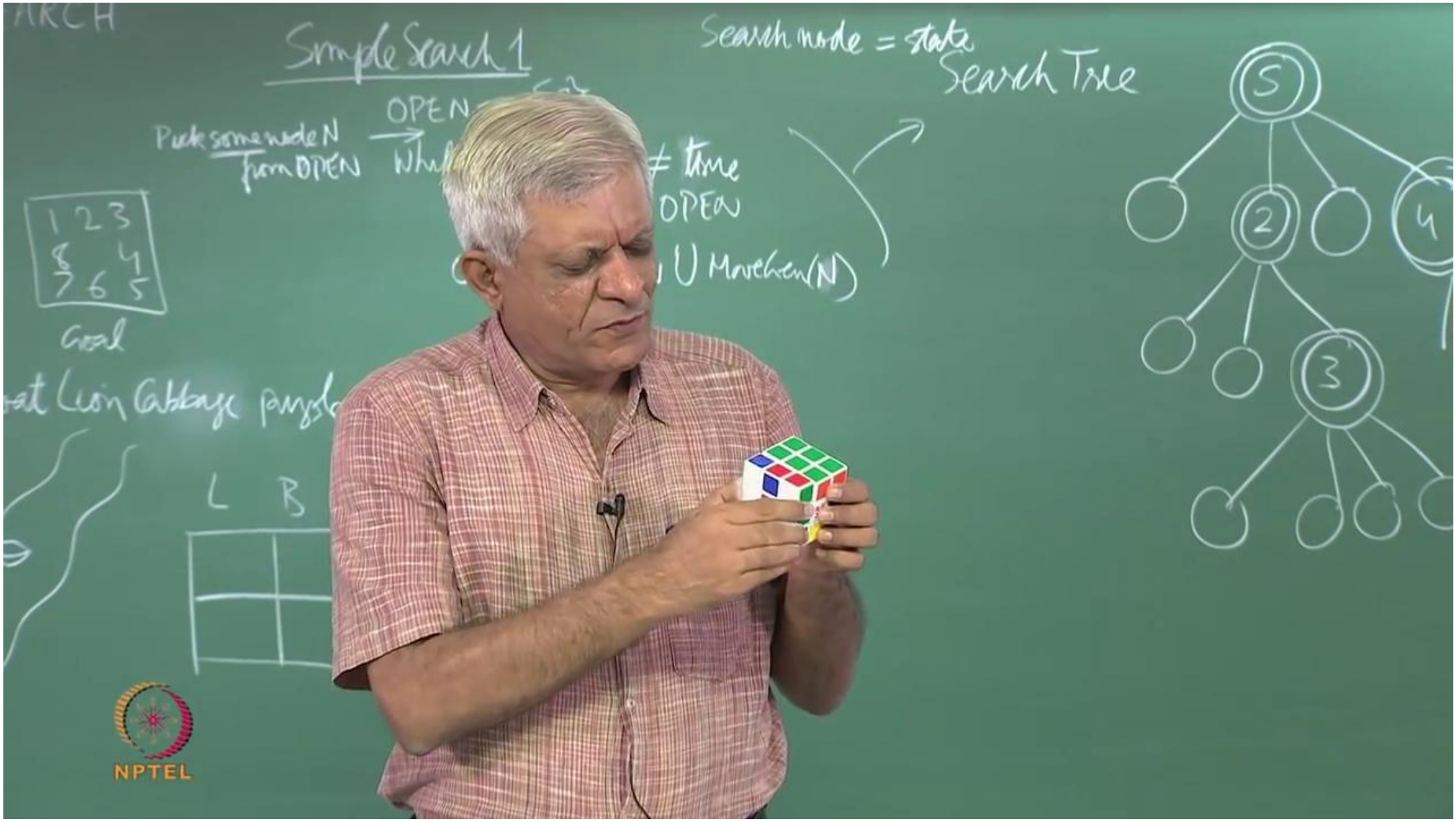

SEARCH
Simple Search 1
Search node = state
Search Tree
OPEN ← {S}
while GoalTest(N) ≠ true
Remove N from OPEN
OPEN ← OPEN ∪ Moves(N)
B
R
NPTEL

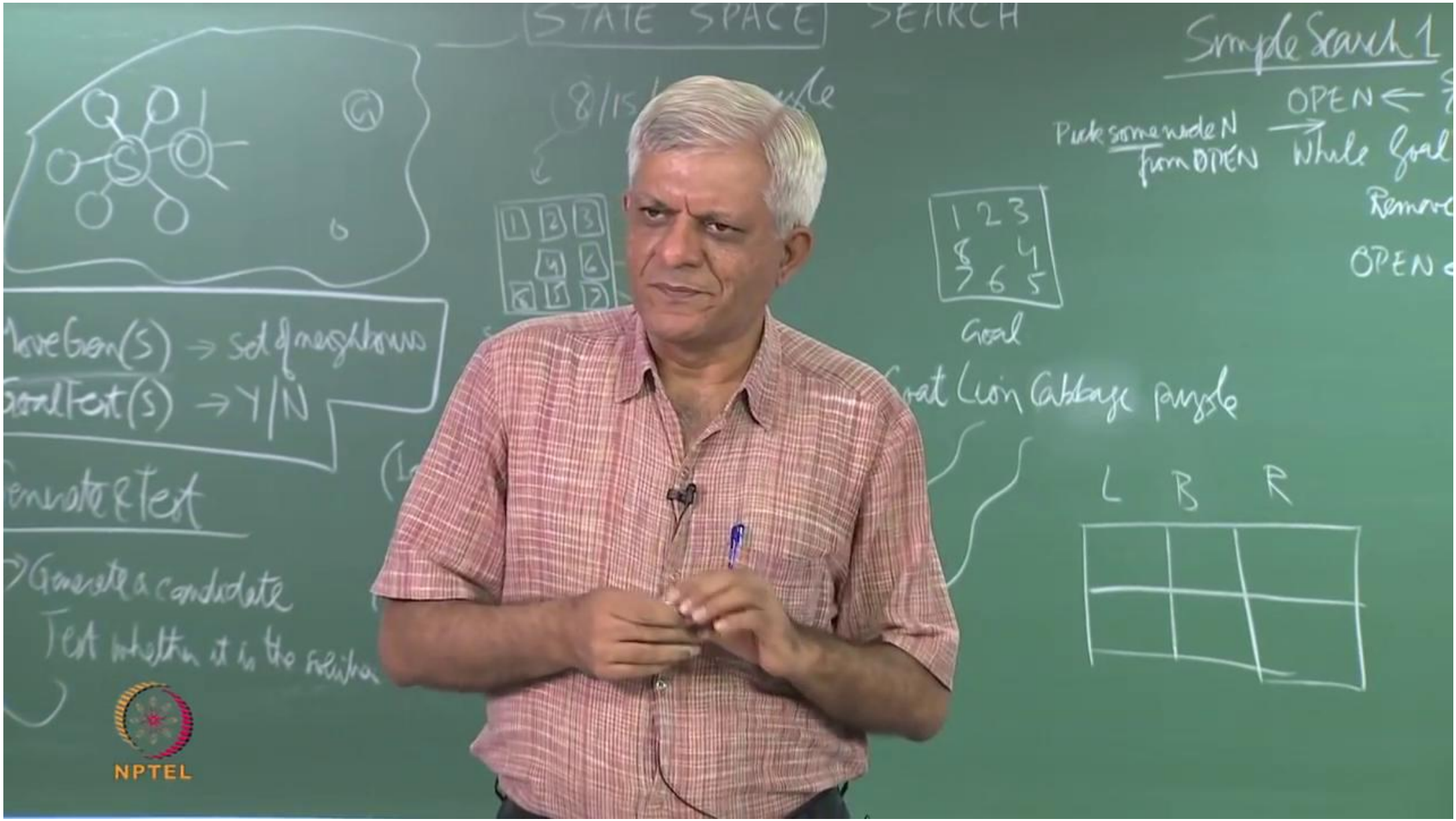

STATE SPACE SEARCH
Simple Search 1
OPEN ← {S}
Pick some node N from OPEN
While GoalTest(N) ≠ true
Remove N from OPEN
OPEN ← OPEN ∪ Move
8/15/24 puzzle
set of neighbours
Y/N
(left GLC)
(Right GLC)
L B R
NPTEL

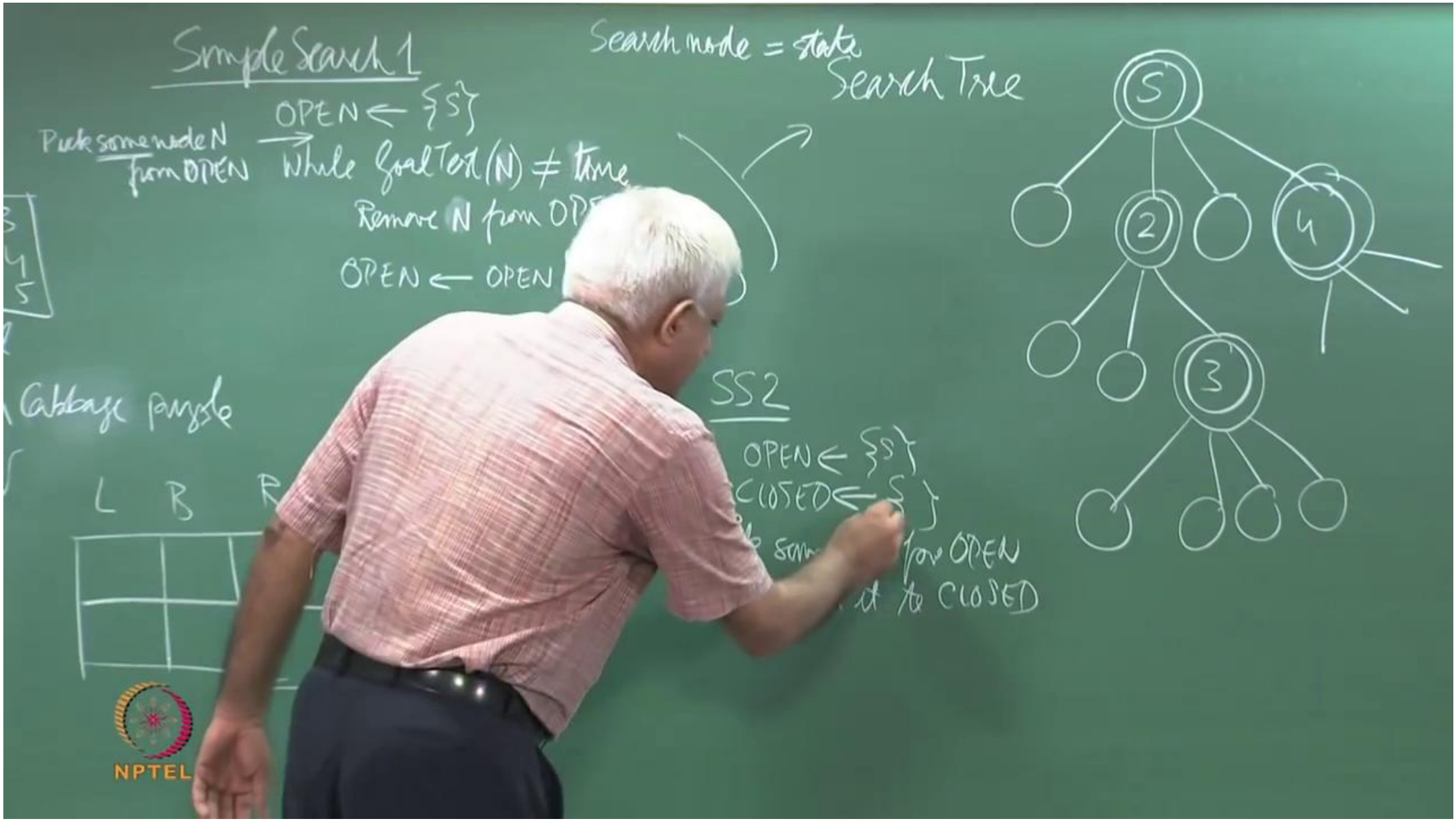

Simple Search 1
Search node = state
Search Tree
OPEN ← {S}
From OPEN
While GoalTest(N)
Remove N
OPEN ←
S
L B R
NPTEL

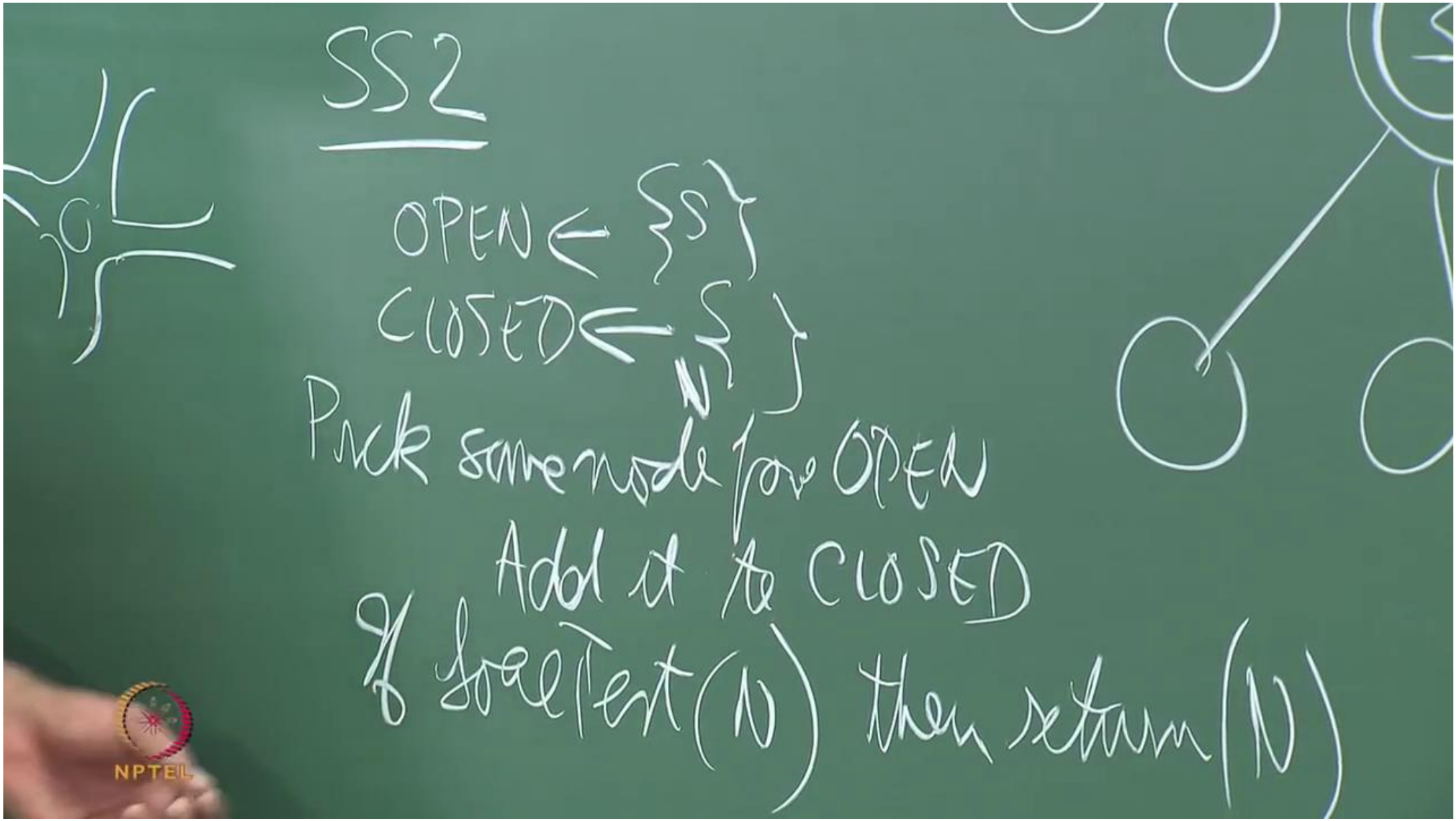

Simple Search 1
Search Tree
S
Goal
L B
NPTEL

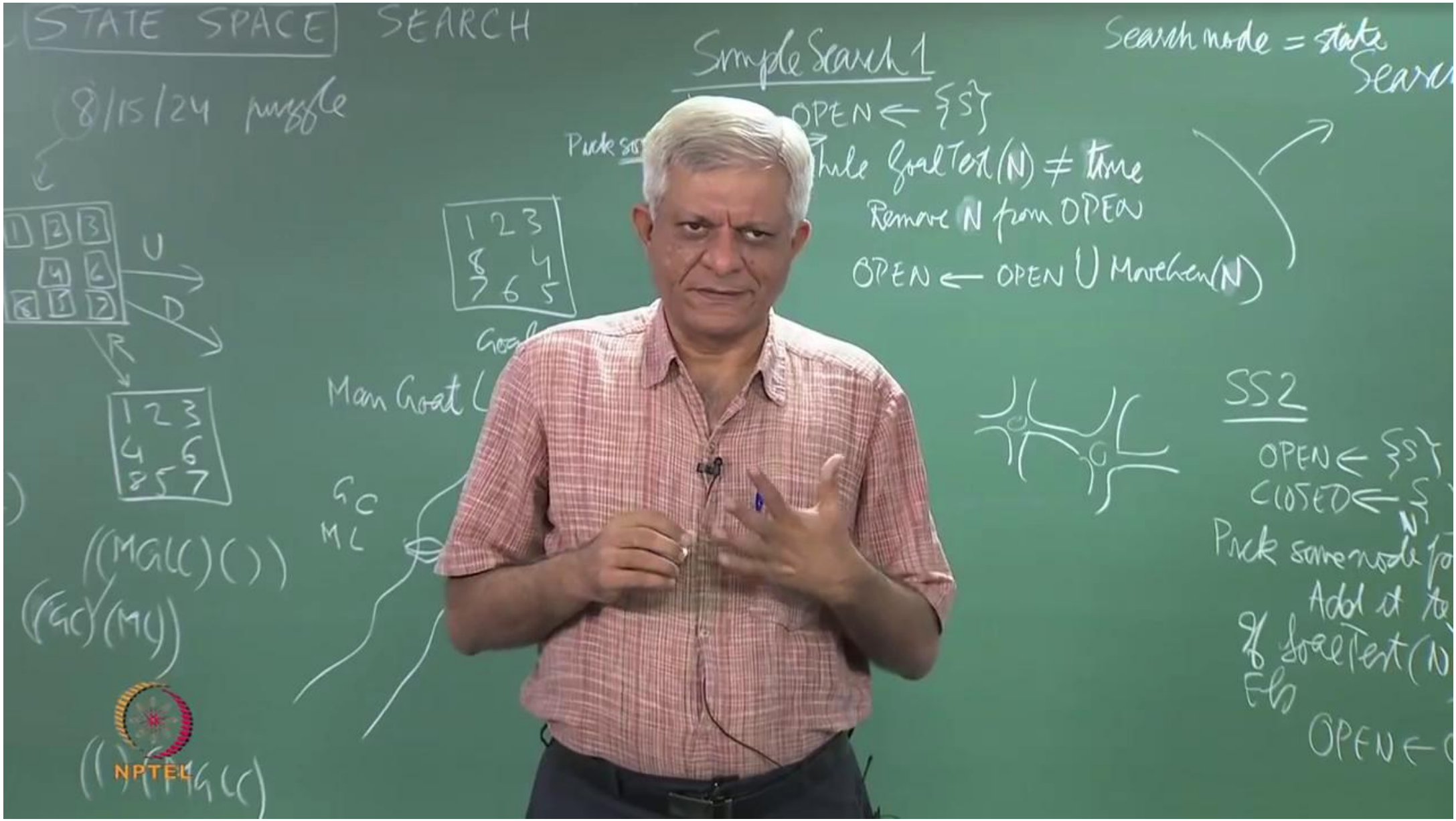

node = state
Search Tree
S
2
4
3
Given
Memory
Bound
NPTEL

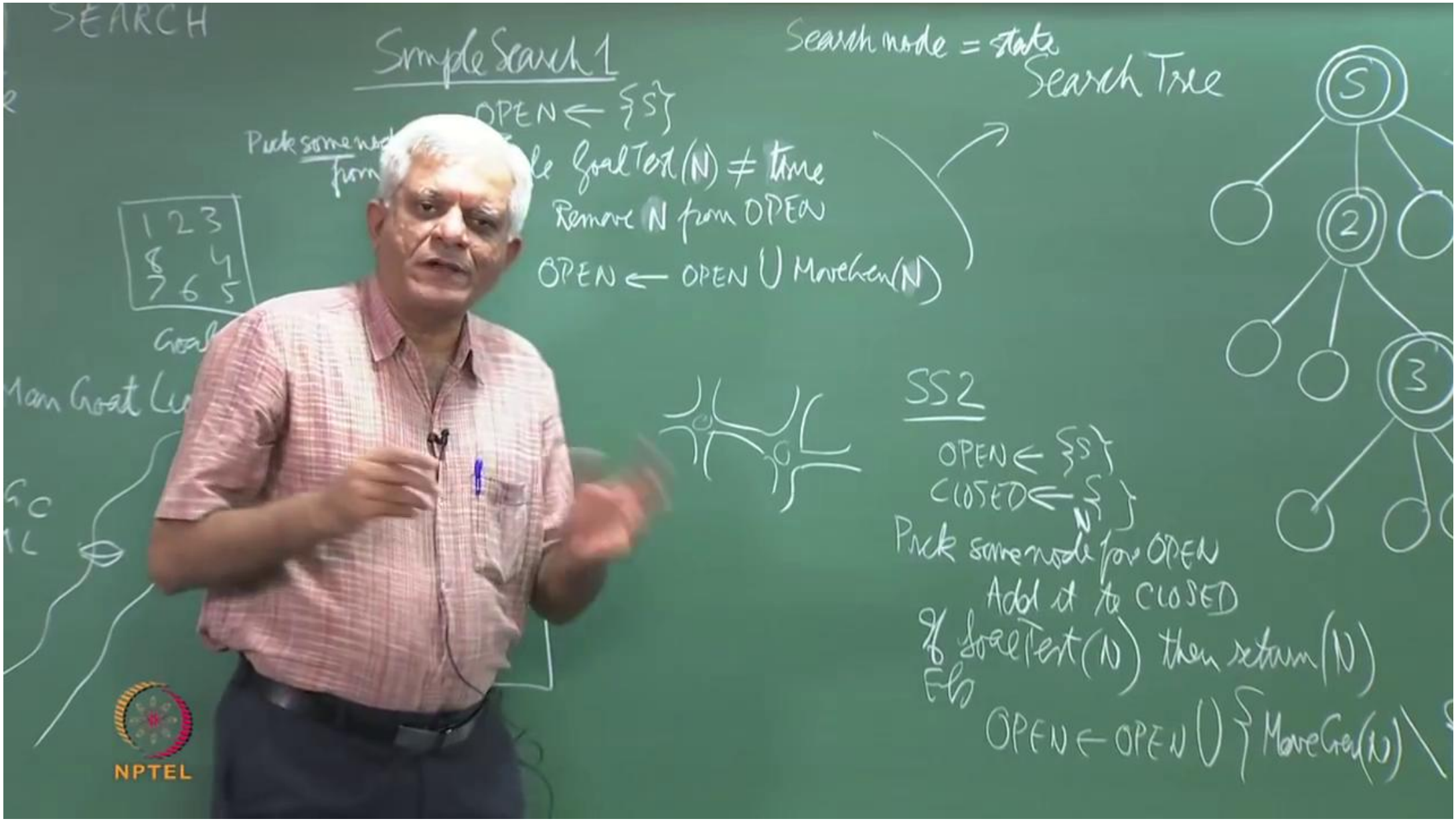

ARCH
Simple Search 1
Search node = state
Search Tree
OPEN
Pick some node N from OPEN
≠ time
OPEN
U MoveGen(N)
1 2 3
8 4
7 6 5
Goal
L B
S
2
4
3
NPTEL

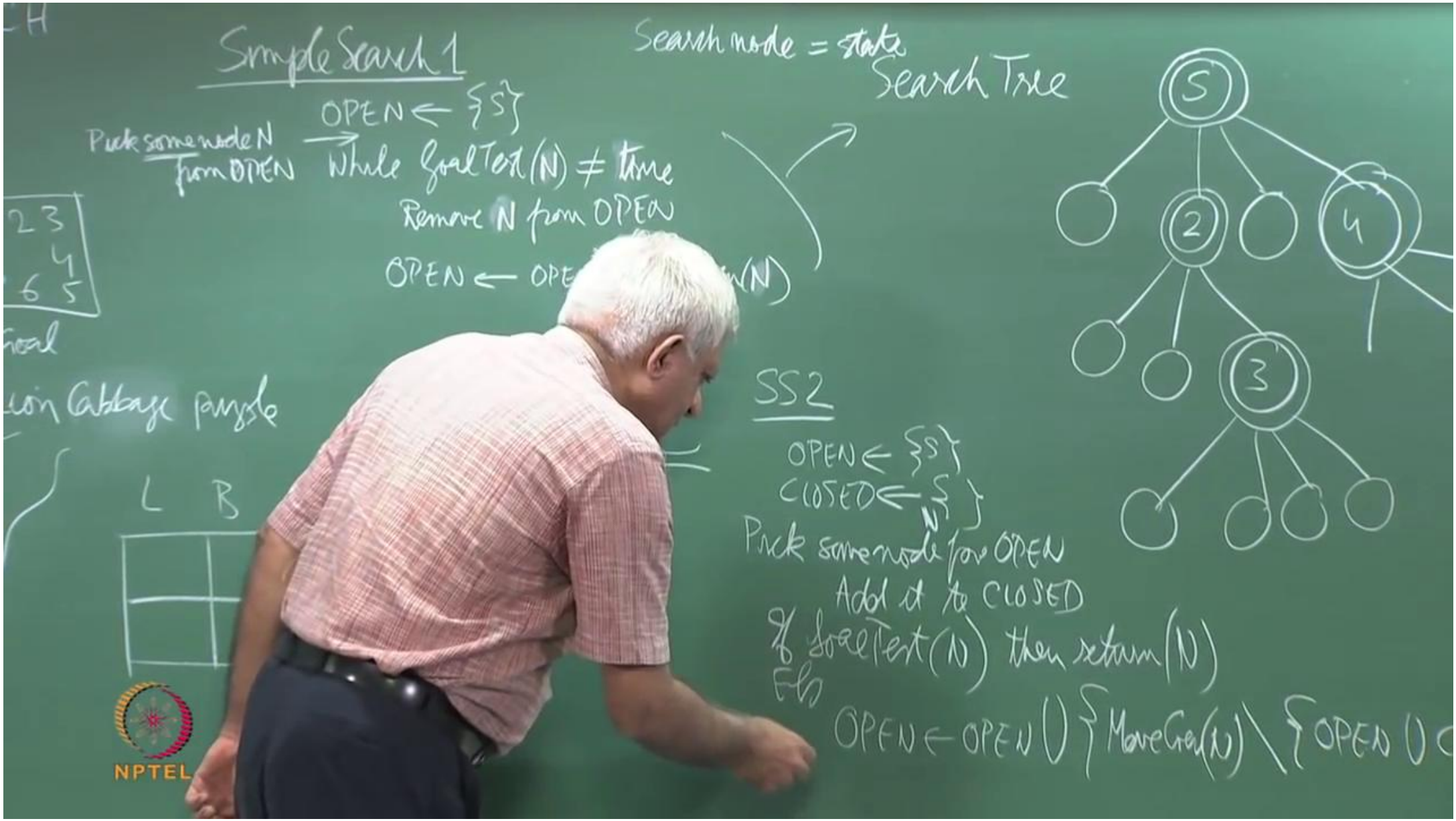

STATE SPACE SEARCH
Simple Search 1
OPEN
Pick some node N from OPEN
While Goal
Goal
MoveGen(S) → set of neighbours
GoalTest(S) → Y/N
Generate & Test
Generate a candidate
L B R
NPTEL

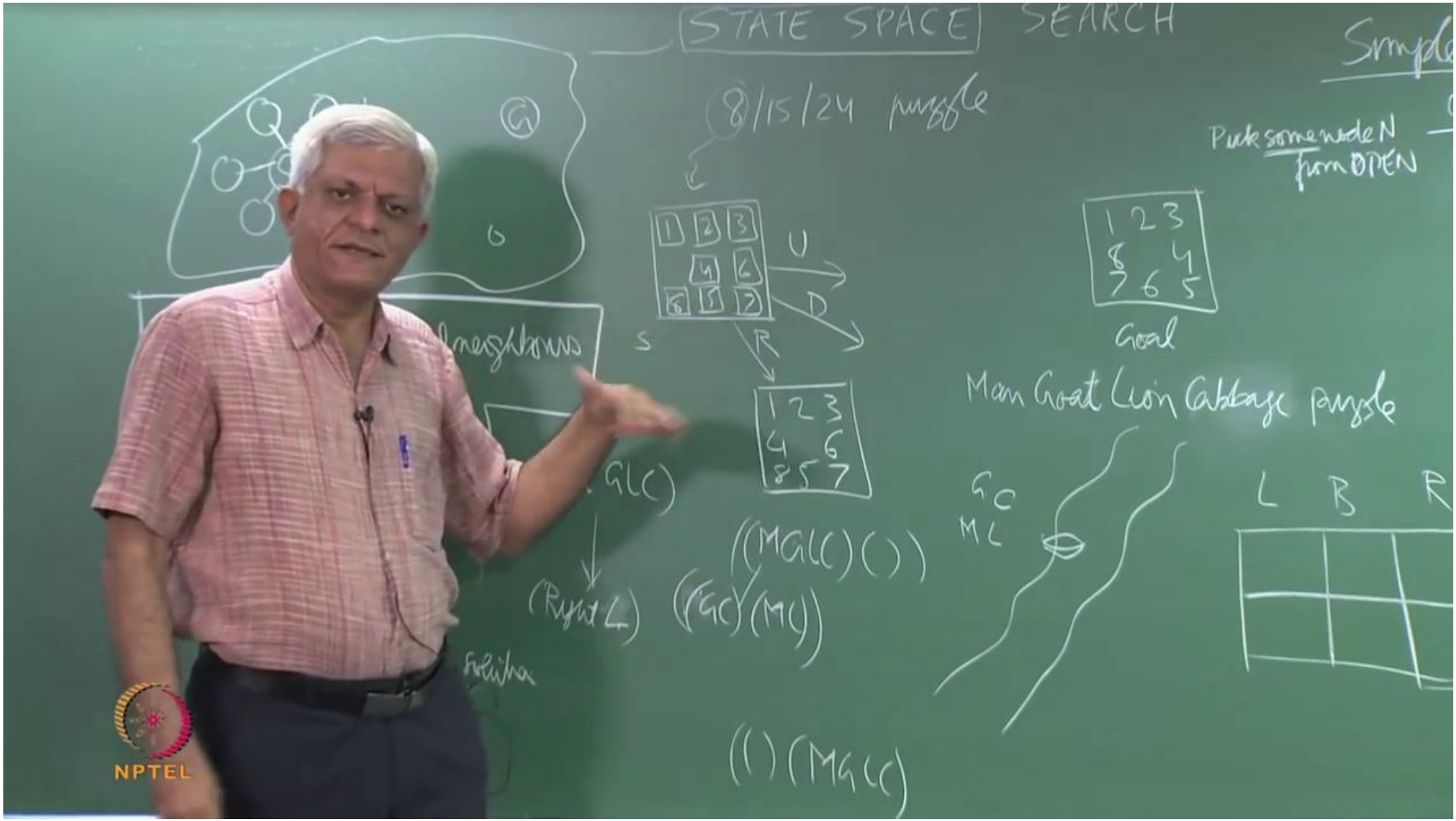

Simple Search 1
Search node = state
Search Tree
OPEN ← {S}
Pick some node N from OPEN
While GoalTest(N) ≠ true
Remove N from OPEN
OPEN ← OPEN
SS2
OPEN ← {S}
CLOSED ← {}
Cabbage puzzle
L B R
S
2
4
3
NPTEL

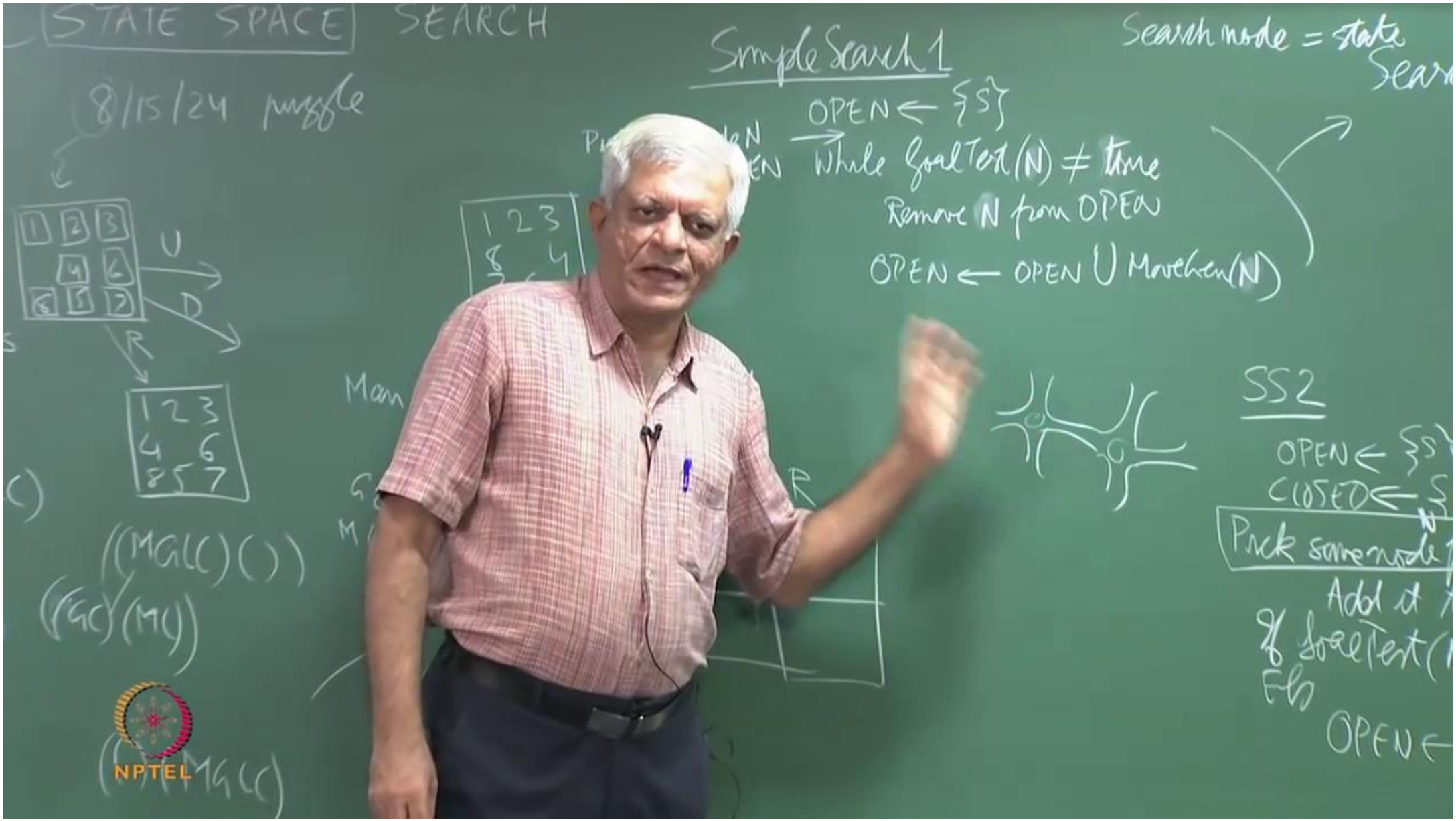

SS2
OPEN ← {s}
CLOSED ← {}
Pick some node N for OPEN
Add it to CLOSED
If goalTest(N) then return(N)


STATE SPACE SEARCH
8/15/24 puzzle
Simple Search 1
OPEN ← {S}
Search node = state
Remove N from OPEN
OPEN ← OPEN ∪ Moves(N)
SS2
OPEN ← {S}
CLOSED ←
Add it to
NPTEL


SEARCH
Simple Search 1
OPEN ← {S}
Search node = state
Search Tree
S
2
3
1 2 3
8 4
7 6 5
SS2
OPEN ← {S}
CLOSED ← {}
Pick some node from OPEN
Add it to CLOSED
NPTEL


Simple Search 1
OPEN ← {S}
Pick some node N from OPEN
While GoalTest(N) ≠ true
Remove N from OPEN
Search node = state
Search Tree
S
2
4
3
SS2
OPEN ← {S}
CLOSED ← { }
Pick some node from OPEN
Add it to CLOSED
GoalTest(N) then return(N)
OPEN ← OPEN ∪ {MoveGen(N) \ {OPEN ∪
L B
NPTEL


STATE SPACE SEARCH
8/15/24 puzzle
Pick some node N from OPEN
Goal
Man Goat Lion Cabbage puzzle
L B R
NPTEL


STATE SPACE SEARCH
8/15/24 puzzle
Simple Search 1
OPEN ← {S}
While GoalTest(N) ≠ true
Remove N from OPEN
OPEN ← OPEN ∪ MoveGen(N)
Search node = state
SS2
OPEN ←
CLOSED ←
Pick same node
Add it
OPEN ←
U
D
R
NPTEL