1. [Start of transcript. Skip to the end.](https://courses.edx.org/xblock/block-v1:ColumbiaX+CSMM.101x+3T2020+type@vertical+block@0d26fc3a3c224f50a615f1603bead9a4?show_title=0&show_bookmark_button=0#transcript-end-3814bffe67794ed590cb825ce56a7f13)
2. We'll illustrate the rest of this lecture
3. with this example drawn from the AI literature.
4. It's called the Wumpus World, invented
5. by Gregory Yob in 1975.
6. So the Wumpus World is actually a cave of four by four rooms.
7. So we have 16 rooms that are interconnected.
8. And we have an agent that evolves in this environment.
9. And the idea is that this room is actually-- this rooms
10. actually have some danger.
11. And this danger can be either a beast
12. called the Wumpus that would eat anybody who gets into the room.
13. It also has what we call a pit.
14. And this pit is actually bottomless.
15. And whoever falls in the pit would be stuck there forever.
16. These are all examples of pits and the Wumpus.
17. So we have an agent that starts the room 1,1.
18. And the mission of the agent is to navigate
19. in this environment or the cave without being eaten
20. or without falling into pits.
21. There is some reward.
22. It's possible for the agent to discover some gold
23. and get it and get out of the cave.
24. So there are some other components which is--
25. that help the agent navigate in the cave.
26. If the agent is in a room that actually
27. is close to a pit's room or Wumpus room,
28. this one will be smelly.
29. So it would have some stench.
30. If the agent moves to a room in which there is some breeze,
31. it means that there is some next room that has some pits.
32. So the pits emit some breeze.
33. So there are some percepts that can
34. help the agents navigate without being eaten
35. or fall into the pit.
36. So let's start formalizing the problem of the one Wumpus
37. World.
38. So we have a four by four grid of rooms in the cave.
39. Square are called adjacent if they
40. are on the same column or the same line.
41. So anything that's on the diagonal are not.
42. So for example, these two are adjacent
43. and these two are adjacent, all right?
44. But these two are not.
45. OK.
46. So squares that are adjacent to a Wumpus
47. have some stench smell.
48. So we have a stench here, here, and here
49. because the cells are close to a Wumpus.
50. Cells that are-- or rooms that are close to a pit,
51. such as these two--
52. these three rooms here have some breeze.
53. This is what the pit emits.
54. And also there is some glitter if there is--
55. if and only if there is gold in the room.
56. Also shooting the Wumpus with the only available arrow
57. will kill the Wumpus, in which case
58. it will lead to very big screen that can be heard anywhere
59. in the cave.
60. Also grabbing picks the gold in the same room,
61. and releasing droops the gold in the same room.
62. All right.
63. So this is the Wumpus World.
64. So let's now define the Wumpus World in terms of the PEAS
65. environment criteria.
66. So remember, PEAS stands for performance, environment,
67. actions, and sensors.
68. For the performance measure, we are
69. going to add 1,000 points if the agent gets the gold.
70. We're going to substract 1,000 points if it is eaten
71. or fail in a pit.
72. We are going to subtract 1 point whenever the agent makes
73. an action, and minus 10 if the agents chooses the arrow.
74. The game ends either when the agent dies or comes out
75. with the gold.
76. The environment is a four by four grid of rooms.
77. The agent starts in the bottom left room--
78. that's the room 1, 1 facing to the right.
79. Locations of the gold and the Wumpus
80. are chosen randomly with a uniform distribution
81. from all squares except the first start, square 1, 1.
82. Each square other than the start can
83. be a pit with some probability, which is actually
84. a probability of 0.2.
85. So the actuators are left turn, right turn, forward,
86. grab, release and shoot.
87. And the sensor would be stench if there
88. is a Wumpus in one of the adjacent rooms, a breeze
89. if there is a pit, a glitter if there is gold
90. in the room, a bump if the agent is facing a wall
91. and trying to go forward, and a scream
92. is if the Wumpus is killed.
93. This can be represented as a five element
94. list, in which we have an indicator for each
95. of these sensors.
96. So for example, stench, breeze, none, none, none,
97. expresses the fact that there is in the adjacent room
98. a Wumpus and a pit.
99. So we have to figure out which rooms have actually these two
100. elements.
101. The Wumpus World properties are as follows.
102. It's partially observable because the agent can only
103. perceive it as close environment,
104. like the adjacent rooms.
105. It's static because the Wumpus and the pits are not moving.
106. It's discrete.
107. We know exactly the actions and the outcomes.
108. It's single agent.
109. It's deterministic.
110. Finally, it's sequential.
111. Now we'll introduce some informal language using symbols
112. in the grid, and do some logical reasoning
113. about how the agent should evolve in the cave.
114. So initially, the agent is in-- these are the first steps--
115. the agent is in the first room.
116. And we know that by default this room is safe for the agent.
117. So the room we're going to add the symbol OK to say
118. that the room is OK to be in.
119. So this room is safe.
120. We're going to use the symbols A, for agents, B for breeze,
121. G for glitter of gold, OK if the square or the room is safe,
122. P for pit, S for stench, V for the room has been visited,
123. and W for Wumpus.
124. All right.
125. So initially this room is safe means that there is no--
126. there's nothing in there.
127. But also, by looking into this room,
128. it says that there is no breeze or no Wumpus around.
129. So he could either move to the room 1, 2 or to the room 2, 1.
130. So suppose we pick up to go to the room to one.
131. Then the agent will move in this room here.
132. This room is visited, right?
133. But this room has actually a breeze,
134. which means that there is potentially a pit here or here.
135. So I'm going to add the question mark to the symbol pit
136. to say that, is this a pit?
137. OK.
138. So here the agent will think and not make any hazardous actions.
139. So he needs to really be careful.
140. So what would happen is that the agent
141. would need to come back to go back to where it came from,
142. and explore maybe the room 1, 2 before
143. moving forward through any of these rooms,
144. given that there is a risk it falls in a pit.
145. So what I just did is an inference
146. or a complex process, in which I figured it out,
147. thinks which room to go to, where
148. is the gold, where is the Wumpus, where is the pit,
149. based on different time points, different locations,
150. and all the percepts that the agent has perceived.
151. So this is-- this is kind of complexity
152. that we want to be able to embed in the logical agents using
153. this kind or— some sort of a presentation to navigate
154. into its environment.
155. So in the rest of this lecture, we'll
156. study how to build logical agents such as in the Wumpus
157. that can represent information, and draw conclusions
158. **to make the agent progress in its environment.**