Do Robots need Probabilities?

Guest Lecture in Mrs. Green's Class on 9/13/2007

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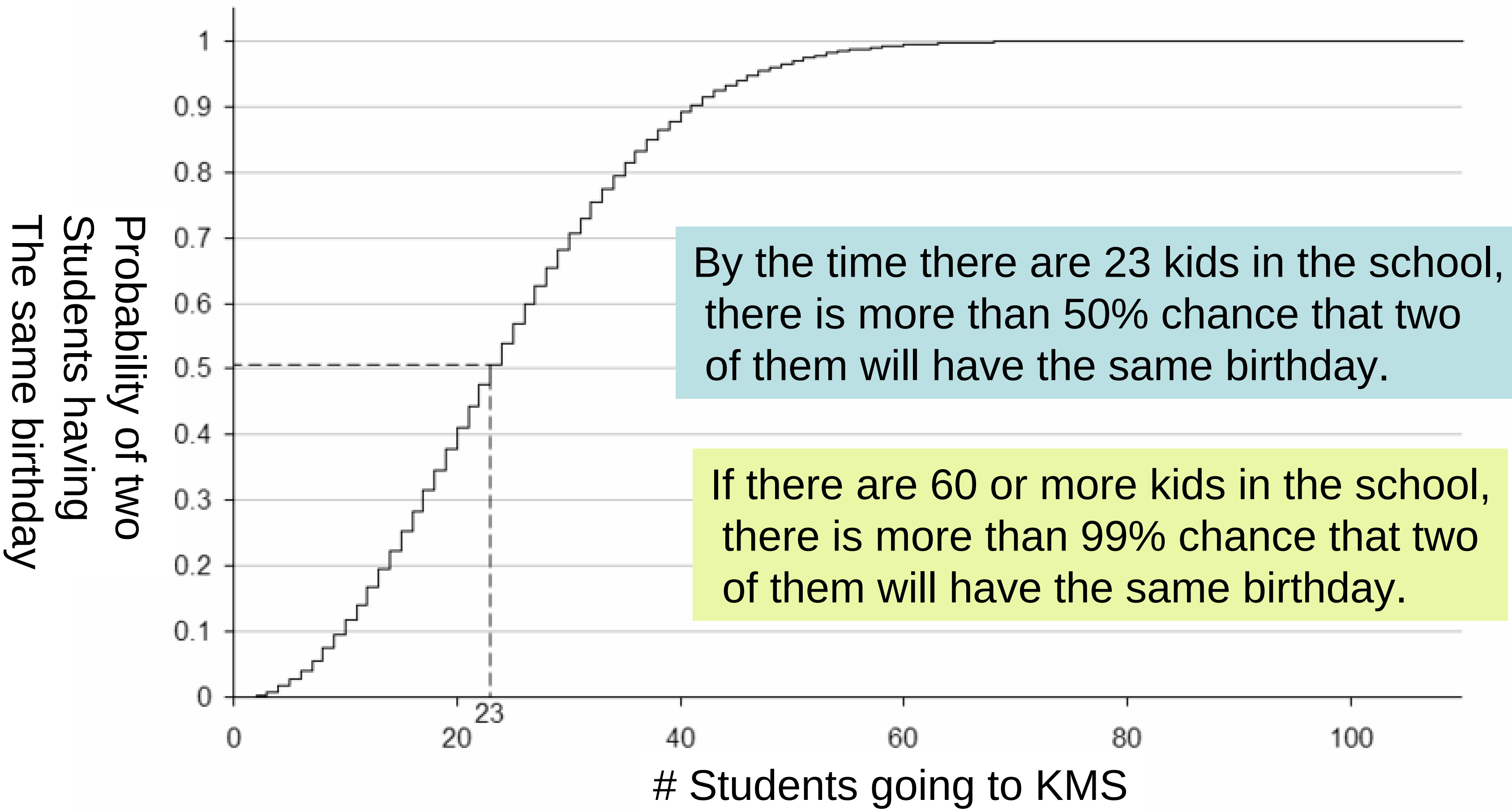
3min Puzzle: You should be Special on your birthday..

- What is the minimum number of kids going to KMS so that we can be *certain* that there are at least two KMS kids who have the same birth day?
- We need 367 students in the school so we can be certain (there are 366 different possible birthdays—including Feb 29th)
- This is called pigeon hole principle
  - If you are trying to put n+1 pigeons in n pigeon holes, there must be at least one hole with two pigeons

..birthdays continued..

- How many kids must be going to KMS such that there is more than 50% chance that a pair of kids will share a birthday?
  - 200? 150? 100? 50? 20?
- How many so that there is 99% chance that a pair of kids will share a birthday?
  - 366? 350? 200? 100? 60?

Let’s look at the graph…



By the time there are 23 kids in the school, there is more than 50% chance that two of them will have the same birthday.

If there are 60 or more kids in the school, there is more than 99% chance that two of them will have the same birthday.

Are you surprised? Can we calculate it ourselves?

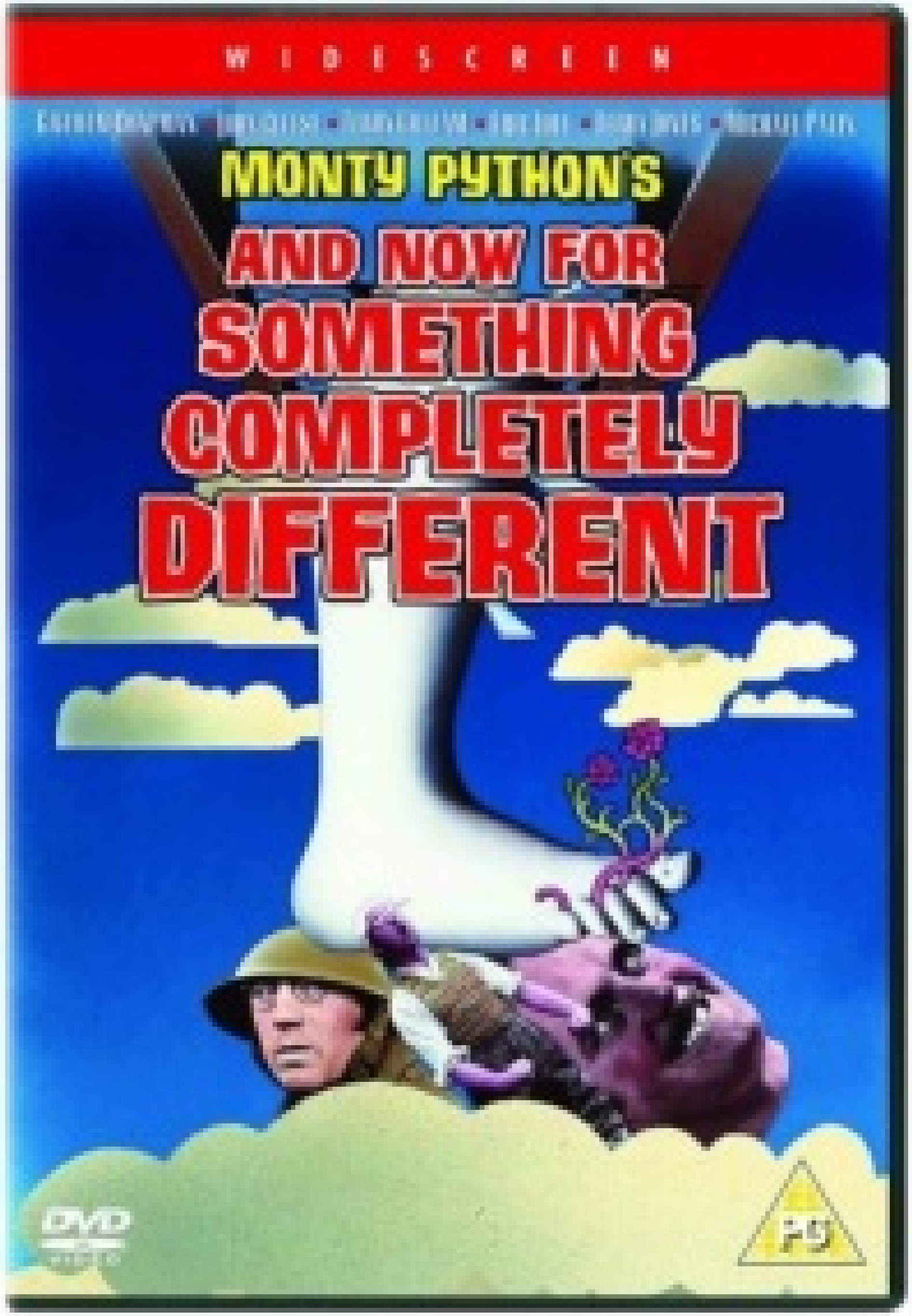
Verifying birthdays..

- Suppose you have 5 kids in KMS
- Probability q that they all have different birtdays:

  1* (365/366) * (364/366) * (363/366) * (363/366)

- Probability p that they don't all have different birthdays (i.e., at least one pair has the same birthday) = 1 – q
- If you do this for 23 kids, you will get p >0.5; and for 60 kids you will get p >0.99

- How is it intuitively possible that with about 60 kids we have 99% probability that two kids will share a birthday?
- If there are 60 kids, there will be (60 choose 2) = 1,770 different pairs of kids. All you need is for at least one pair of them to have the same birthday..
  - Doesn't look that hard, does it?


WIDESCREEN
MONTY PYTHON'S
AND NOW FOR
SOMETHING
COMPLETELY
DIFFERENT
DVD
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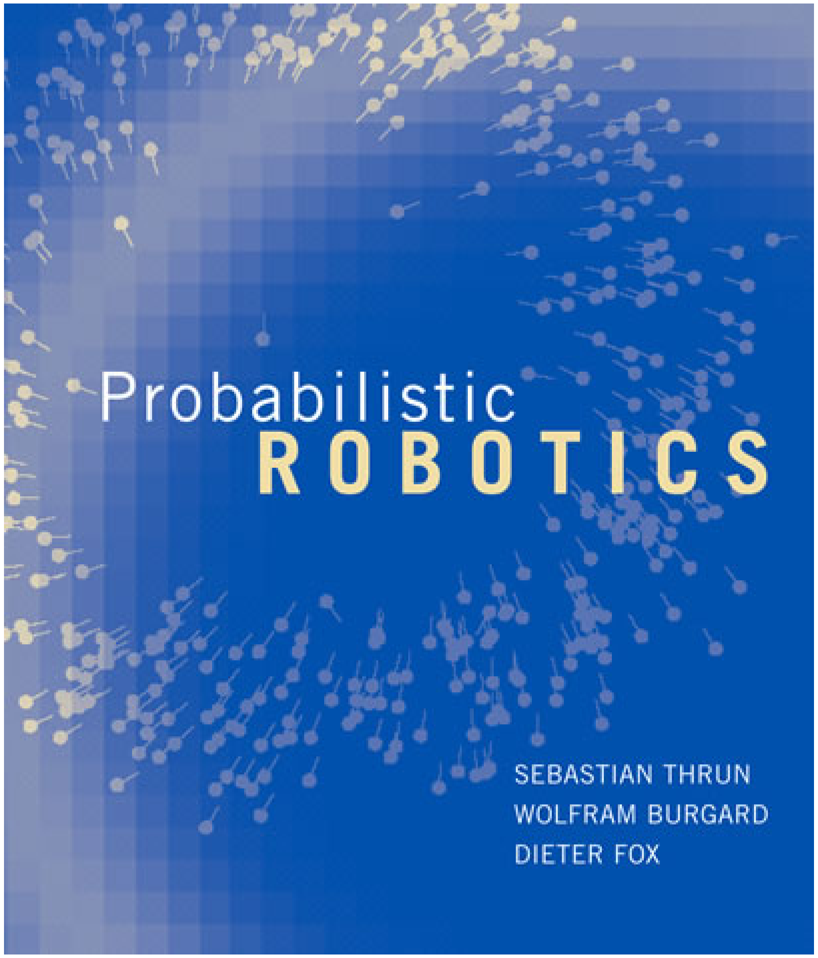
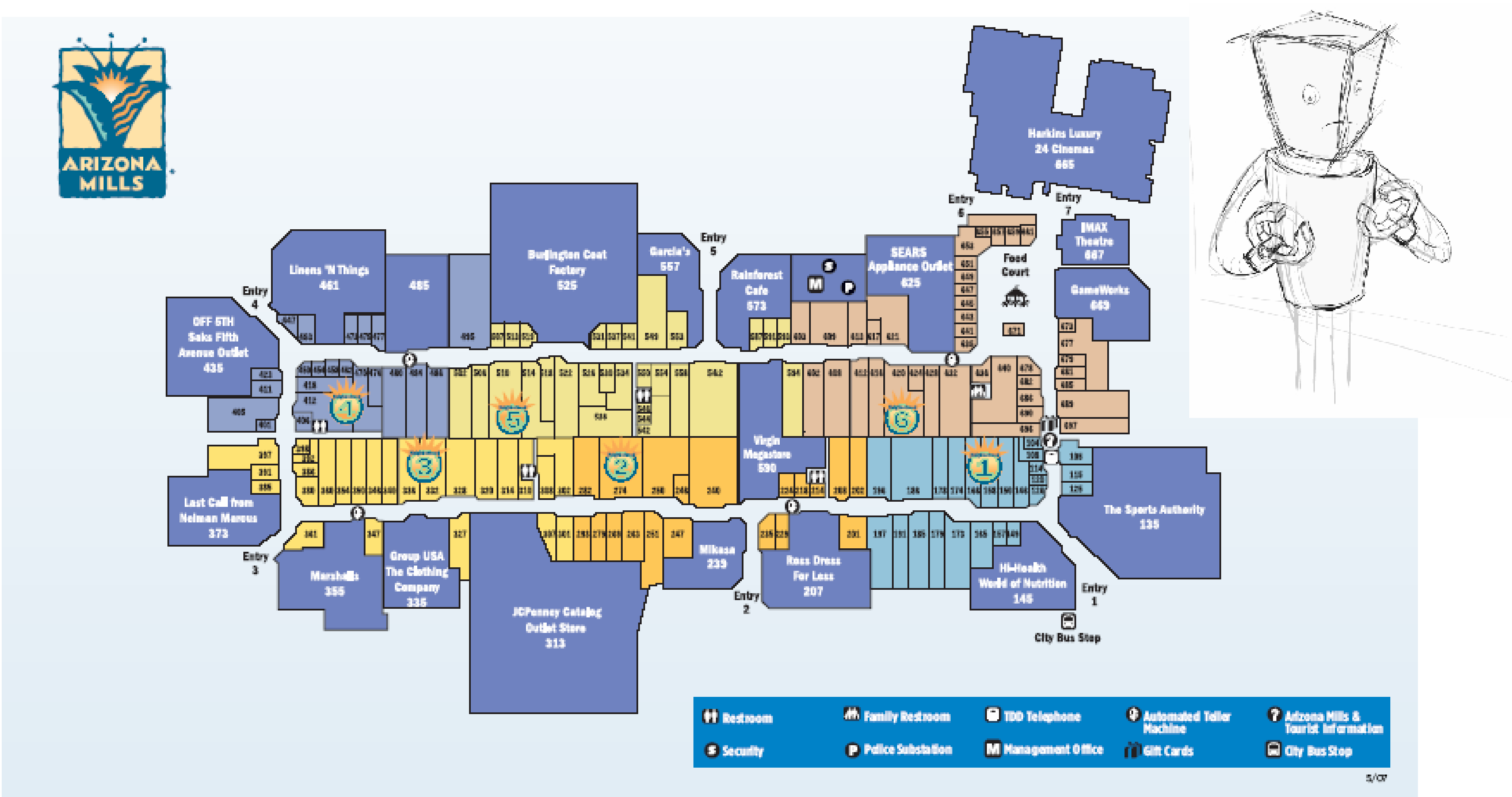
Autonomous Robots

- Autonomous vs. Remote Controlled
- What are some things that are important for autonomous robots?



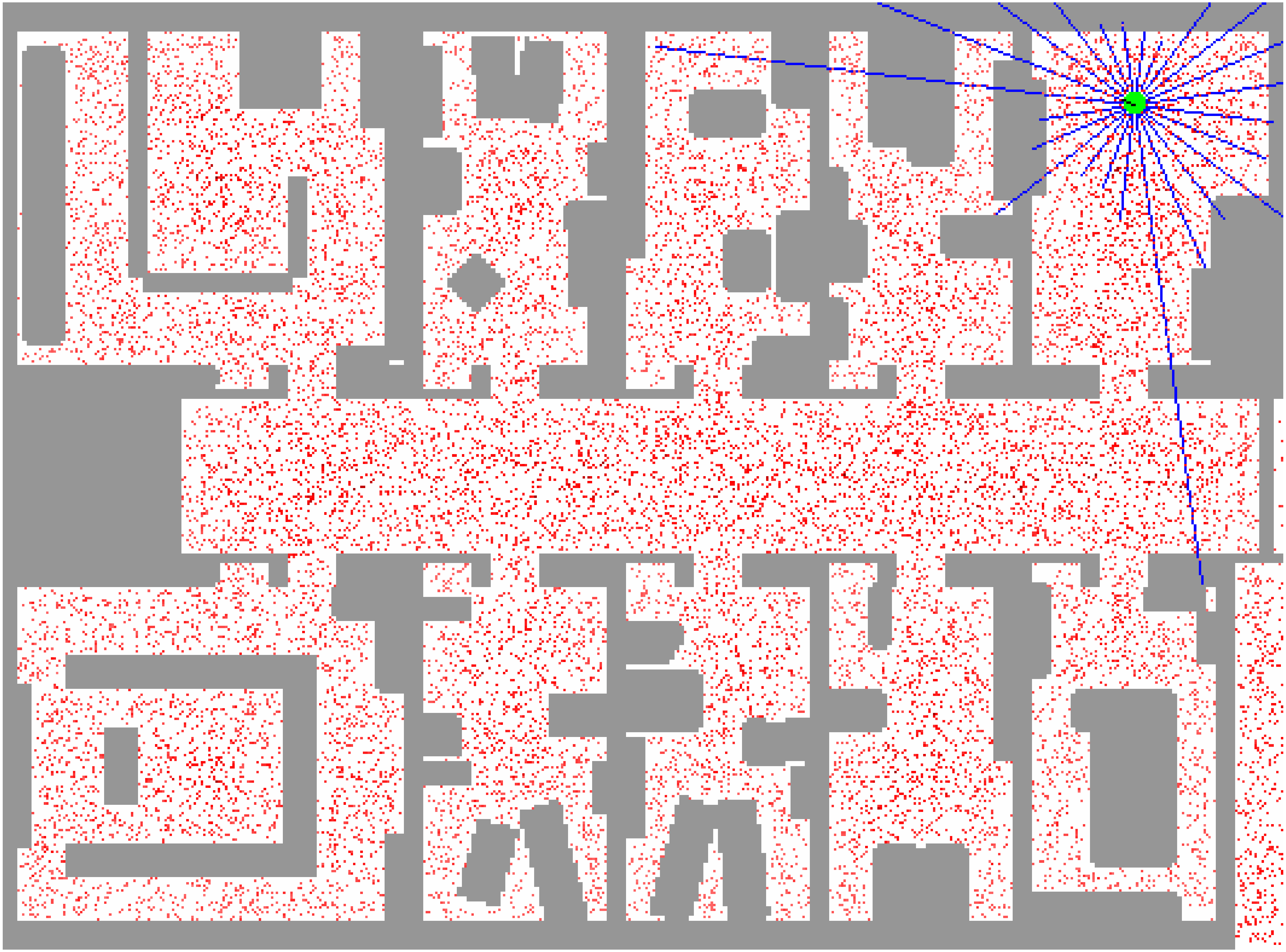
KMS Kid at the Mall



You are dropped off in the middle of a mall and are given a printed map.
Can you find your way to the IMAX theater?

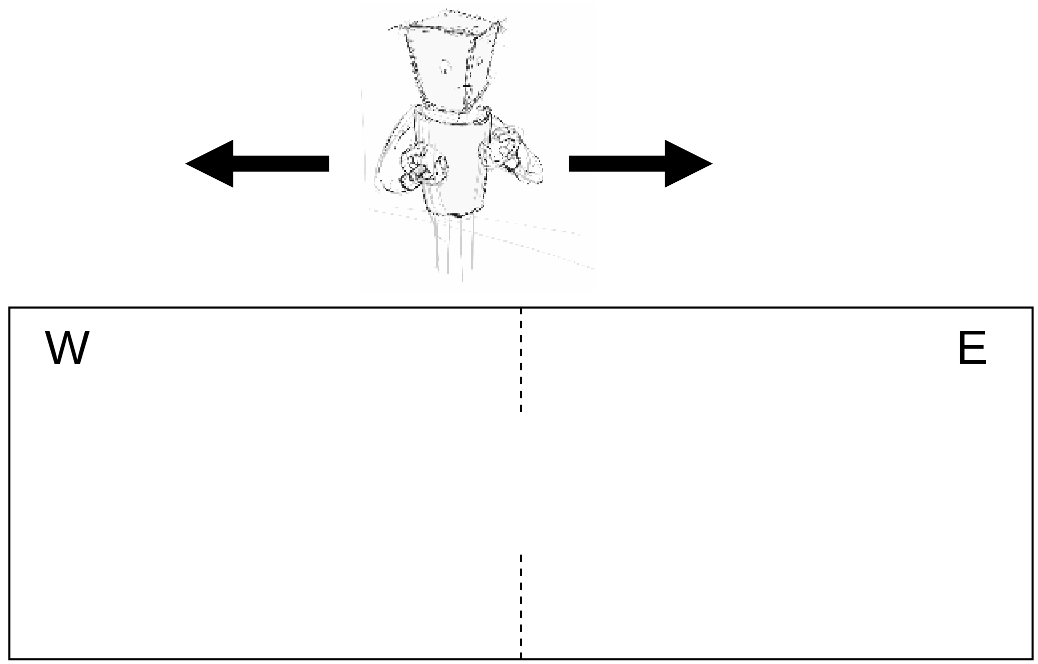
What if you lost your glasses and can't read well?

What if you are too tired and can't walk straight?



A Blind Robot

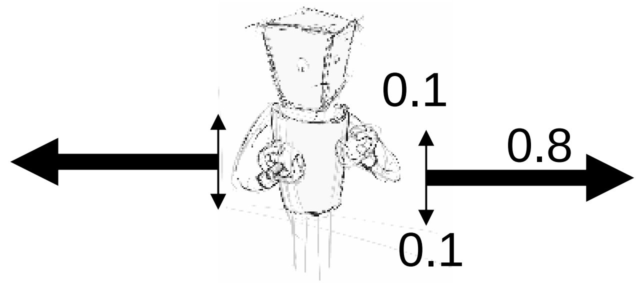
“Belief State”



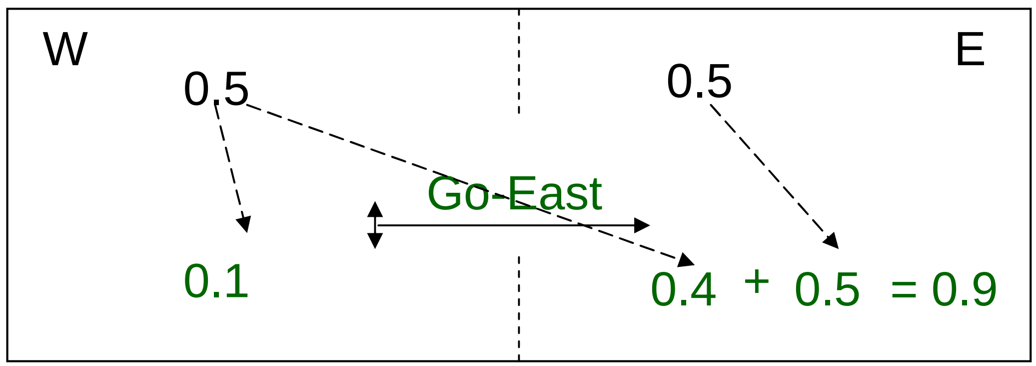
Robot initially can be in either room. P(W) = P(E) =
What is the probability that robot is in East room

It does have motors and wheels and it can tell its wheels to go east or west.
When it bangs into the walls, it will stop. The motors do what you tell them.
Can you make P(E)=1 ?

A Blind Robot with bad motors



Tossing a coin a few times blindly and being sure you got at least one heads

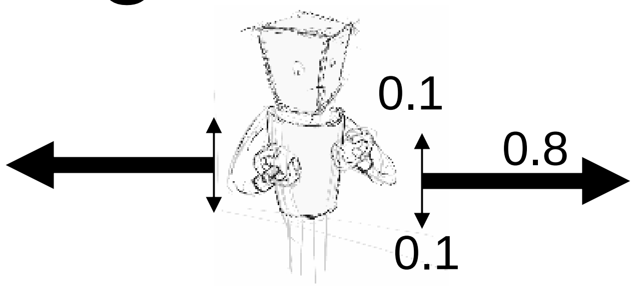


Now the robot also has bad motors. When it tries to go East, it actually goes east 80% of the time, goes north 10% of time and goes south 10% of time

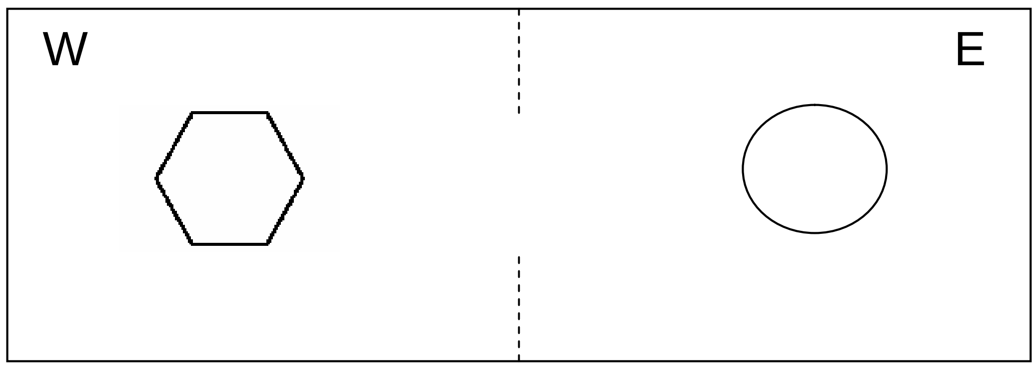
Qn: If robot does a single “go east” action, what is its “belief state”?

Qn: Can it ever be sure that it has reached the East room?

The Robot gets a Cheap Camera



Now suppose the robot got a cheap camera. The west room has a big picture of a hexagon, The east room has a big picture of a circle.



Sort of like tossing a coin until you see “heads”

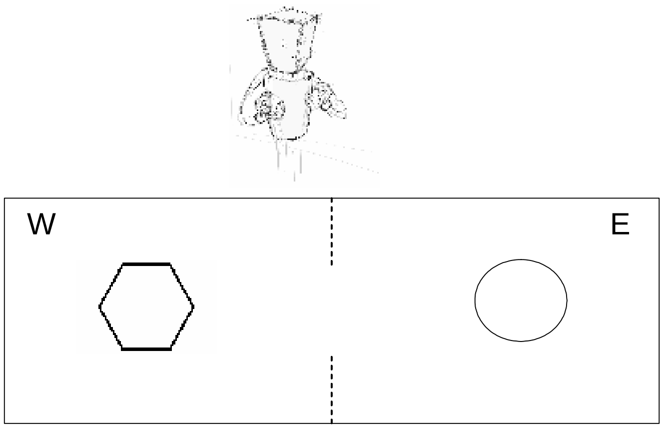
Suppose the camera is too grainy and it sometimes mistakes hexagon to be a circle (and vice versa)? We can "model" this using probabilities.

P(camera saw a hexagon| Robot is in west room) = 0.9
P(camera saw a hexagon| Robot is in east room) = 0.2

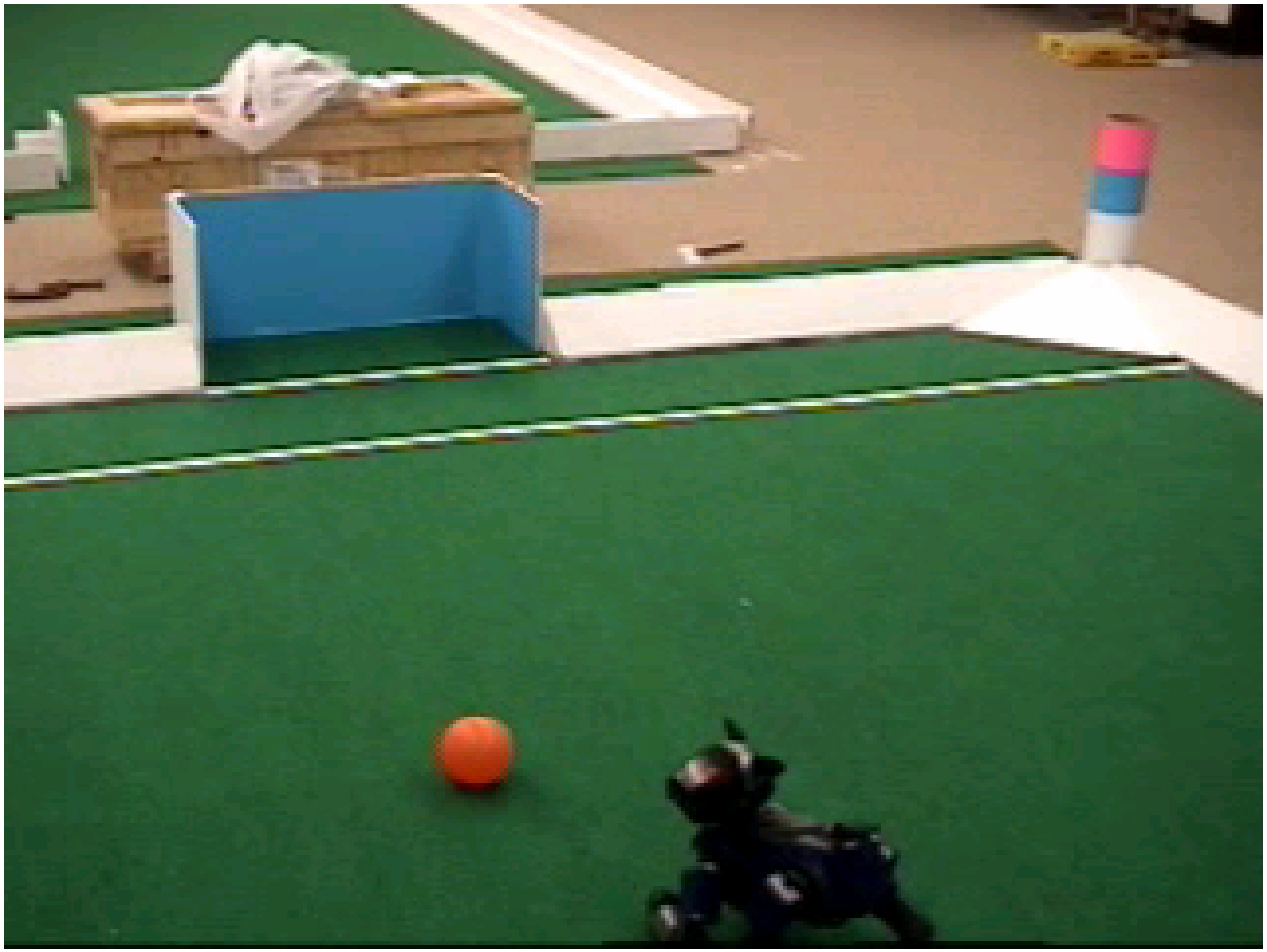
Tossing as before but you have bad eye sight

Changing Beliefs..

- Robot's *original* belief is that it is in East or West room with probability 0.5, 0.5
- The robot "Goes East"
  - Its new belief is 0.1 that it is in West room, and 0.9 that it is in East room
- The robot's camera says it is seeing a hexagon.
  - If the camera is perfect, then the robot's belief changes to: 1.0 it is in West room, and 0.0 it is in east room
  - If the camera is not perfect, then it will be something like 0.2 in west room, and 0.8 in east room



State Estimation for a Cute Doggie Robot



Some Times Doggie Follows People In Orange T-shirts

So…

- Robots use probabilities a lot.
  - Probabilities of where they believe they are
  - Probabilities of their motors going the right direction
  - Probabilties of their cameras/laser finders detecting things correctly
- They use the action and sensing probabilities to continually compute where they believe they really are..

Thanks for listening..!

If you have more questions after class, e-mail to rao@asu.edu

Robot Soccer at RoboCup