Modeling the Weight Sensor

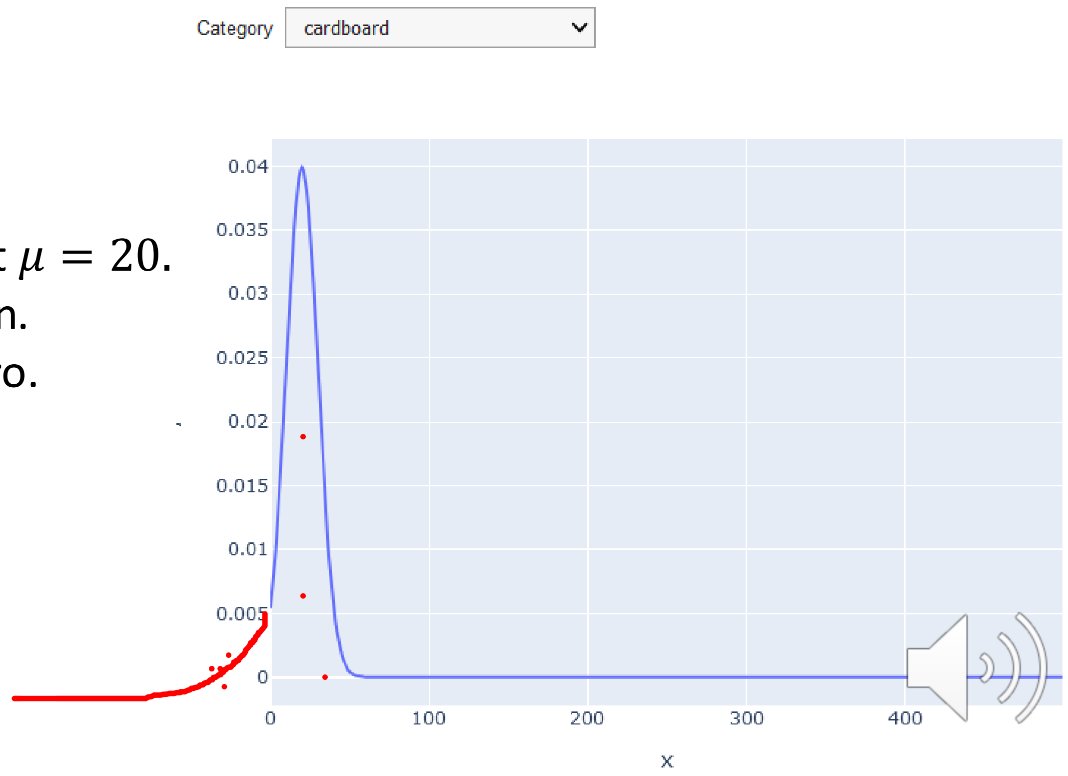
CS 3630

The weight sensor (aka scale)

- The weight of an object can be considered as a continuous random variable.
- The Gaussian distribution would be a reasonable choice, except for the fact that weight can never be less than zero. Nevertheless, we'll use the Gaussian distribution to model weight.
- Each object category has its own Gaussian distribution:

Category	**Mean μ**	**Variance σ^2**
Cardboard	20	10
Paper	5	5
Can	15	5
Scrap metal	150	100
Bottle	300	200

Cardboard:
- Distribution centered at $\mu = 20$.
- Very narrow distribution.
- Notice truncation at zero.



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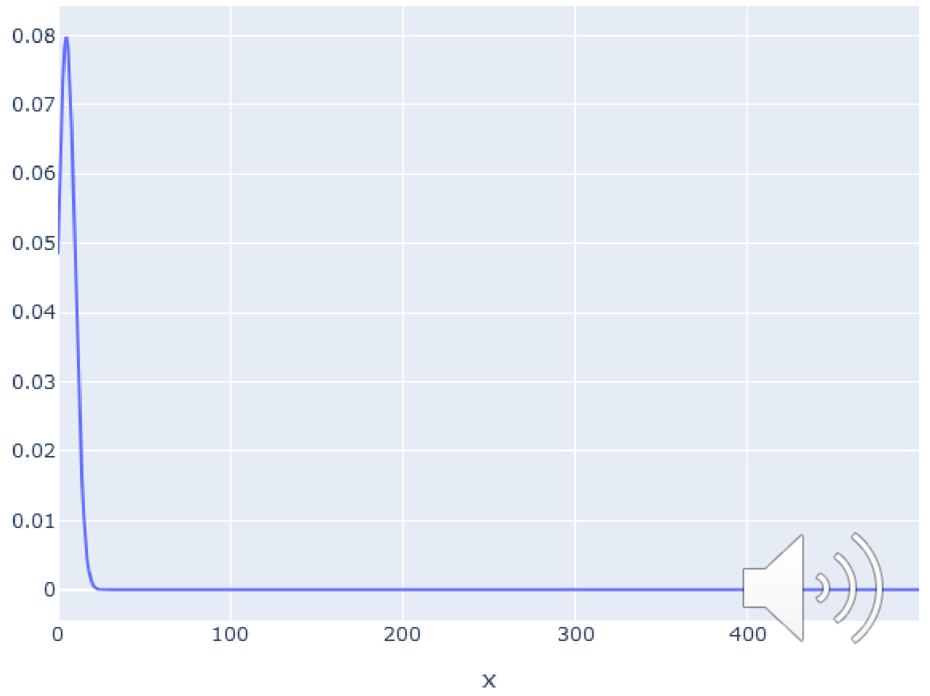
Cardboard	20	10
Paper	5	5
Can	15	5
Scrap metal	150	100
Bottle	300	200

<u>Paper</u>:
- Distribution centered at $\mu = 5$.
- *Very* narrow distribution.
- Notice truncation at zero.



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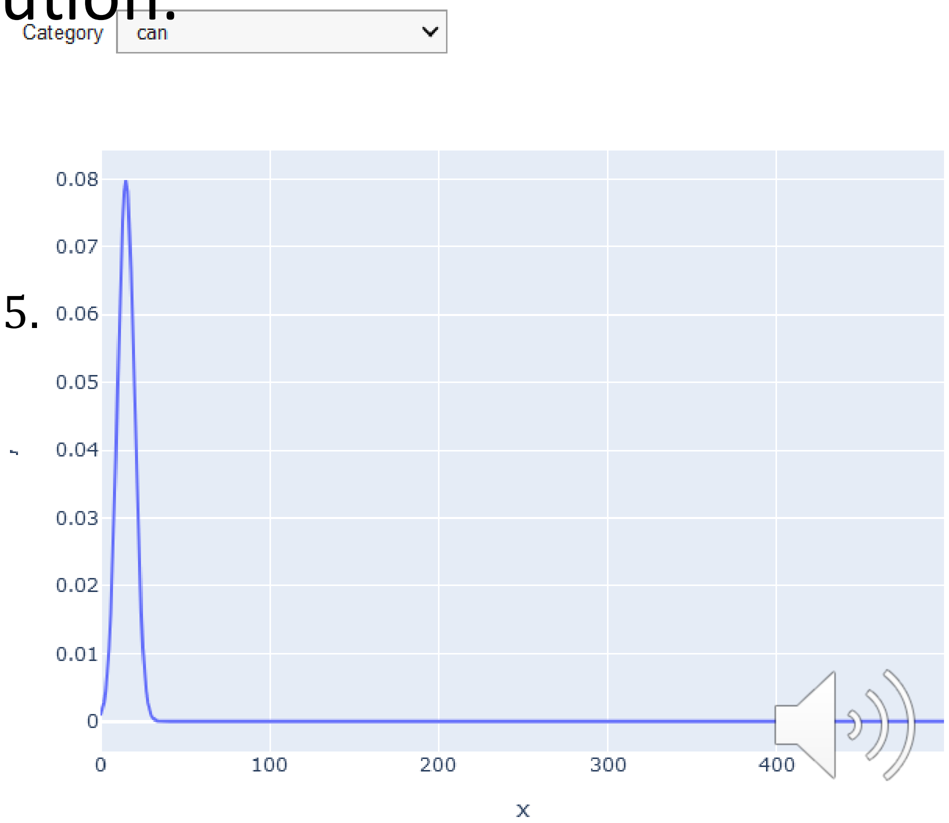
Cardboard	20	10
Paper	5	5
Can	15	5
Scrap metal	150	100
Bottle	300	200

<u>**Can**</u>:

- Distribution centered at $\mu = 15$.
- Very narrow distribution.
- Notice truncation at zero doesn't really chop off much probability mass.



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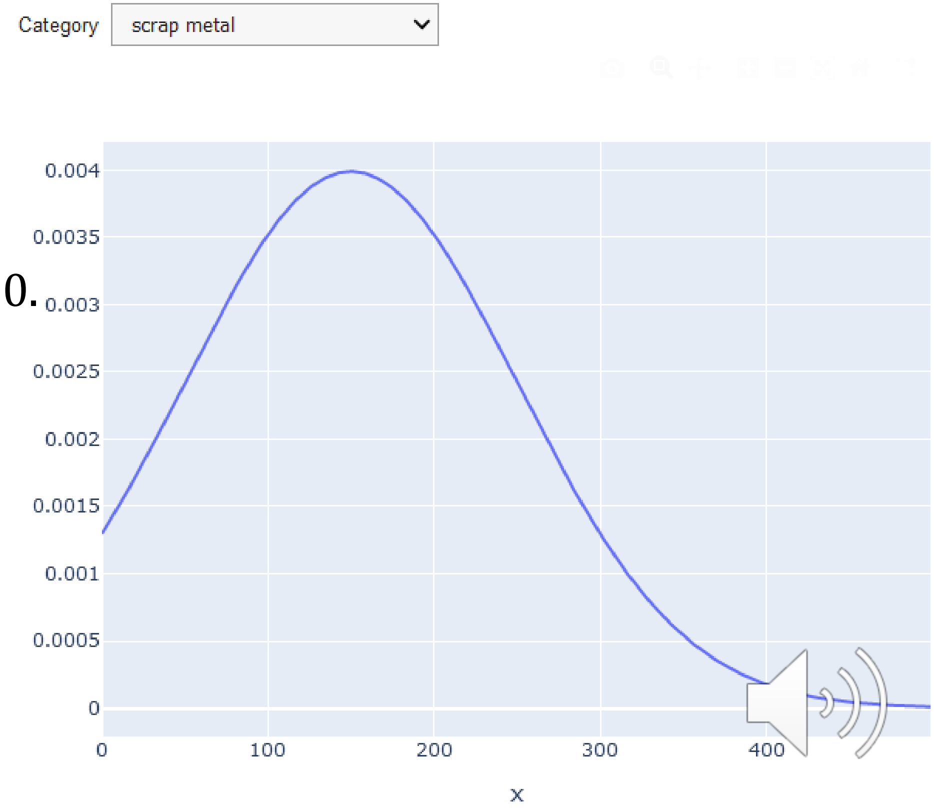
Category	**Mean μ**	**Variance σ^2**
Cardboard	20	10
Paper	5	5
Can	15	5
Scrap metal	150	100
Bottle	300	200

<u>Scrap Metal</u>:

- Distribution centered at $\mu = 150$.
- Wide distribution.
- Notice truncation at zero chops off significant probability mass.



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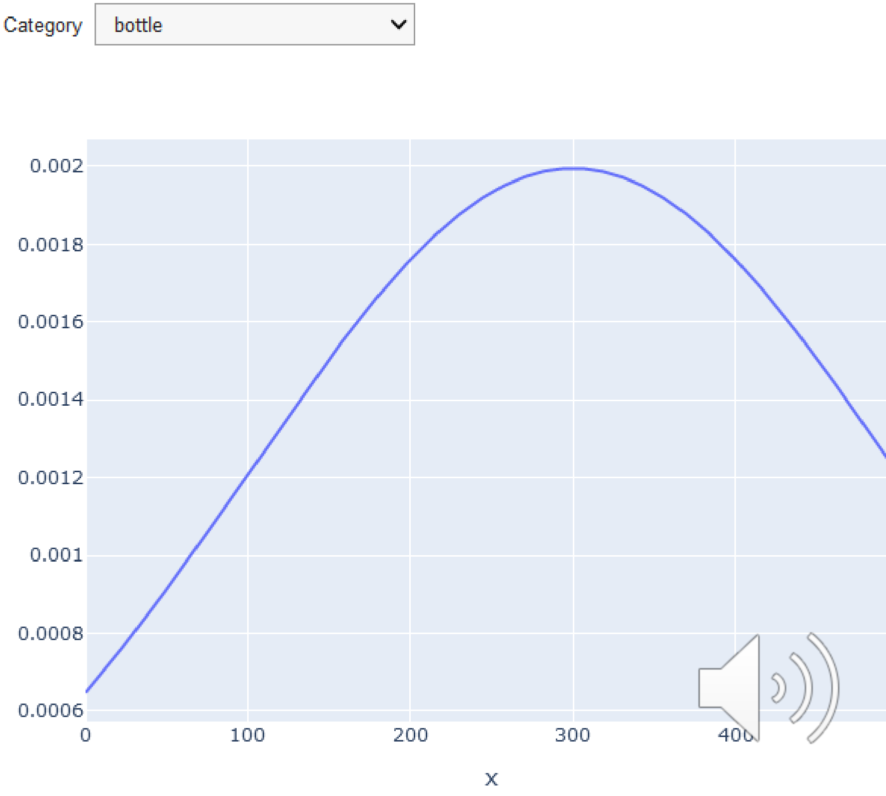
Category	Mean μ	Variance σ^2
Cardboard	20	10
Paper	5	5
Can	15	5
Scrap metal	150	100
Bottle	300	200

<u>Bottle</u>:

- Distribution centered at $\mu = 300$.
- Wide distribution.
- Notice truncation at zero doesn't exclude much probability mass.
- Truncation on the right is merely an artifact of the display. This pdf continues all the way to $+\infty$.



Conditional distributions

- Instead of thinking about five individual pdfs for the different objects, we can think of weight as a random variable characterized by conditional probability distributions:

Category	Mean μ	Variance σ^2
Cardboard	20	10
Paper	5	5
Can	15	5
Scrap metal	150	100
Bottle	300	200

Category (C)	$f_{W\|C}(W\|C)$
Cardboard	$N(20, 10)$
Paper	$N(5, 5)$
Can	$N(15, 5)$
Scrap metal	$N(150, 100)$
Bottle	$N(300, 200)$

$$f_{X|C}(x|C = Scrap\ Metal) = \frac{1}{10\sqrt{2\pi}} e^{-\frac{(x-150)^2}{200}}$$

Simulation by sampling

- We can simulate the sensor readings that will occur during operation of our trash sorting robot.
- The idea is a simple extension of the sampling algorithm we developed earlier
  1. Generate a sample category $c \sim P(C)$ using probabilistic sampling
  2. Generate a sample sensor value by sampling the conditional distribution $s \sim f_{X|C}(x|C = c)$, where $f_{X|C}$ is the conditional density (or pmf) associated to the desired sensor.