# Announcements

## HW1 & Quiz 1

- Graded
- Regrade requests
- Hours, performance

## HW2

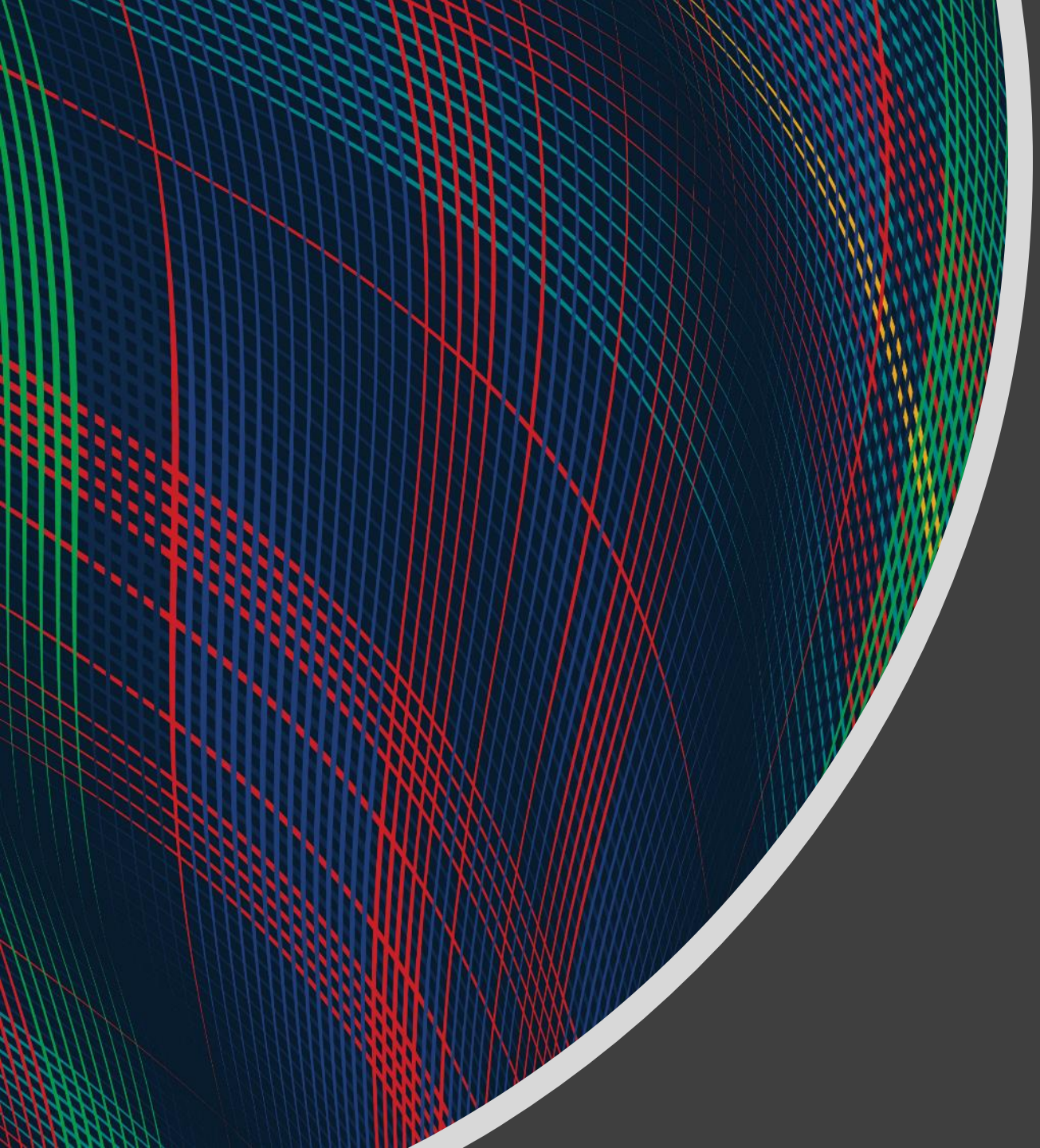
- Due Sat 10/2

## Quizzes

- Mon 10/4,  last 15 min. of class (calculus, optimization, Lagrange)
- Mon 10/11, last 15 min. of class (probability, statistics)

# Constrained Optimization Clarification

## Previous lecture slides



# Mathematical Foundations for Machine Learning

## Probability

Instructor: Pat Virtue

# Plan

## Today

Probability

- Vocab
- Notation
- Discrete distributions
- Continuous distributions
- Chain rule
- Independence

# Probability

# Probability Vocab

Outcomes

Sample space

Events

Probability

Random variable

Discrete random variable

Continuous random variable

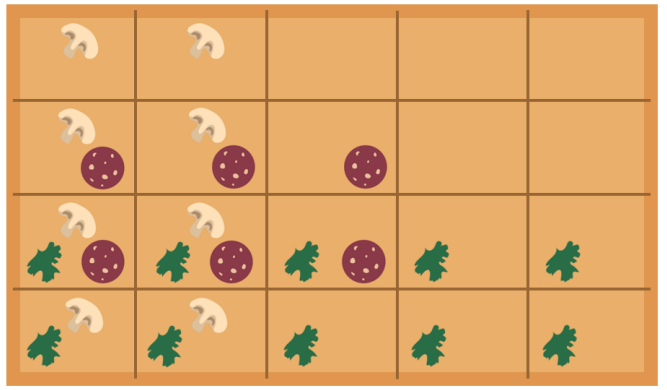
Probability mass function

Probability density function

Parameters

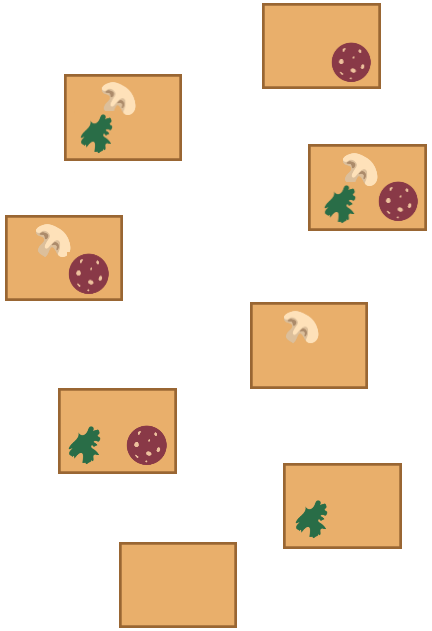
# Example

## Random variable for spinach or no spinach



Random variable

Distribution

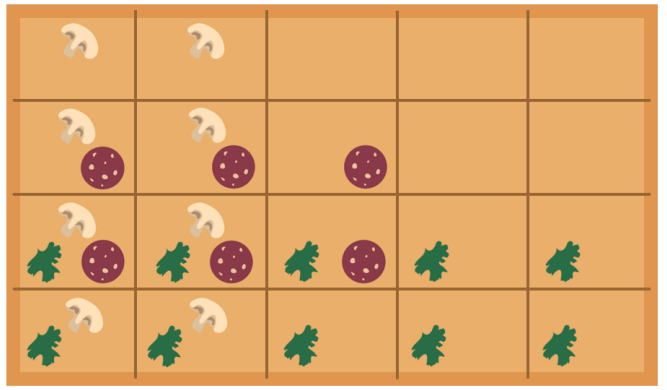


Sample space → Values → Probabilities or Densities

Icons: CC, https://openclipart.org/detail/296791/pizza-slice

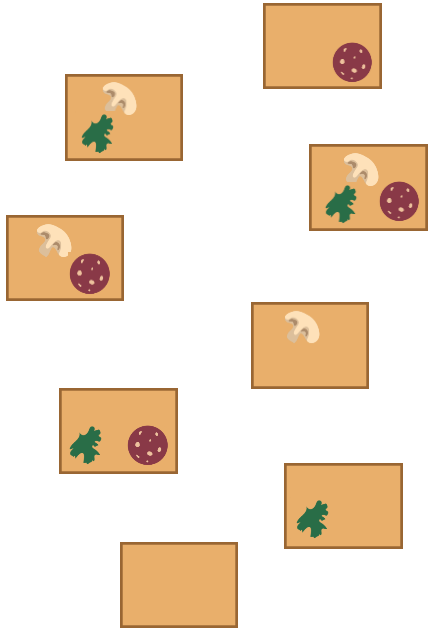
# Example

Random variable for topping type with three categories: none, non-meat, meat



Random variable

Distribution



Sample space → Values → Probabilities or Densities

Icons: CC, https://openclipart.org/detail/296791/pizza-slice

# Example

Random variable for number of heads after two flips of a fair coin

Random variable

Distribution


Icons: CC, https://openclipart.org/detail/296791/pizza-slice

# Example

Random variable for number of heads after two flips of a *biased* coin that lands heads 75%

Random variable

Distribution


Icons: CC, https://openclipart.org/detail/296791/pizza-slice

# Example

Random variable for cat in picture or not

Random variable

Distribution

Sample space → Values → Probabilities or Densities

Icons: CC, https://openclipart.org/detail/296791/pizza-slice

# Example

Random variable for animal species in picture assuming one animal picture and available species: dog, cat, pig

Random variable

Distribution


Icons: CC, https://openclipart.org/detail/296791/pizza-slice

# Example

## Random variable for height of student

Random variable

Distribution

Sample space → Values → Probabilities or Densities

Icons: CC, https://openclipart.org/detail/296791/pizza-slice

# Probability Vocab

Outcomes

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Parameters

# Example Discrete Distributions

Bernoulli

Categorical

Binomial

Multinomial

Uniform

# Example Continuous Distributions

Gaussian

Beta

Laplace

# Probability Vocab

Marginal

Joint

Conditional

# Notation

## Notation doc

# Probability Toolbox

- Algebra
- Three axioms of probability
- Theorem of total probability
- Definition of conditional probability
- Product rule
- Bayes' theorem
- Chain rule
- Independence
- Conditional independence

# Tools Summary

## Adding to our toolbox

1. Definition of conditional probability

$$P(A|B) = \frac{P(A,B)}{P(B)}$$

2. Product Rule

$$P(A,B) = P(A|B)P(B)$$

3. Bayes' theorem

$$P(B|A) = \frac{P(A|B)P(B)}{P(A)}$$

4. Chain Rule…