KNN Distances

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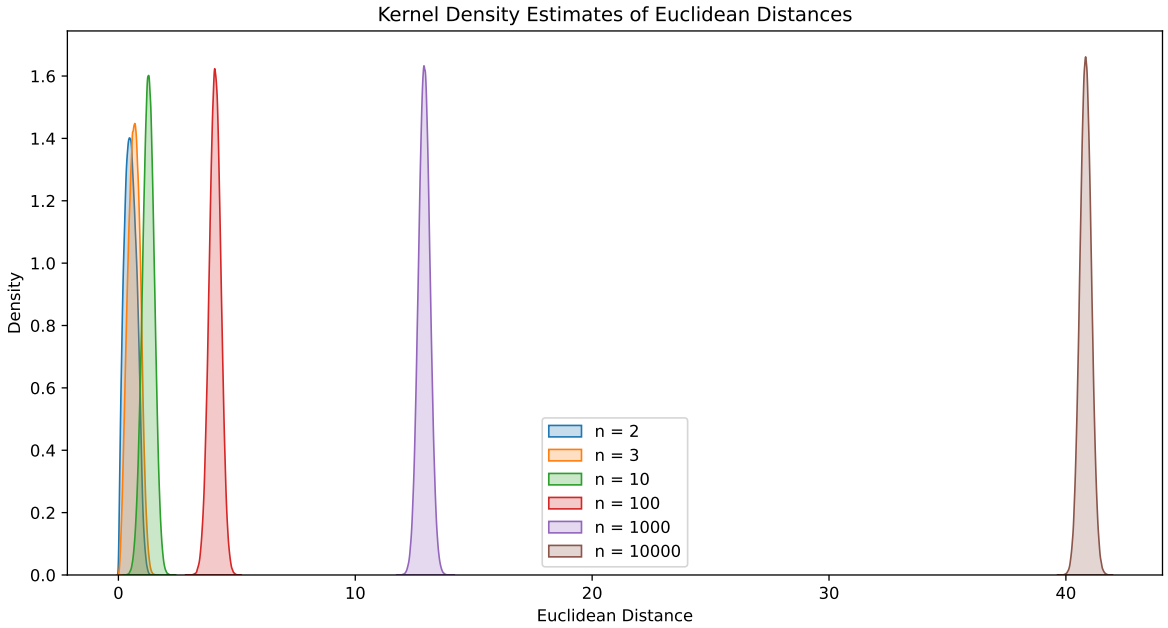
Import notebook funcs

```
from notebookfuncs import *
```

```
import torch
import matplotlib.pyplot as plt
import seaborn as sns

def generate_n_dimensional_tensor(n, num_points=1000):
  """Generates an n-dimensional tensor of random numbers.

  Args:
    n: The desired number of dimensions.
    num_points: The number of data points to generate.

  Returns:
    An n-dimensional PyTorch tensor.
  """

  return torch.rand(num_points, n)

def euclidean_distance(p1, p2):
  """Calculates the Euclidean distance between two tensors.

  Args:
    p1: The first tensor.
    p2: The second tensor.

  Returns:
    The Euclidean distance between the two tensors.
  """
```

```
  return torch.norm(p1 - p2, dim=-1)

def plot_distance_histograms(distances_list, dimensions):
  """Plots histograms of the Euclidean distances on a single plot.

  Args:
    distances_list: A list of lists, each containing distances for a specific
 ↪  dimension.
    dimensions: A list of dimensions.
  """

  plt.figure(figsize=(12, 6))
  for i, (distances, n) in enumerate(zip(distances_list, dimensions)):
    sns.kdeplot(distances, fill=True, label=f"n = {n}")

  plt.xlabel("Euclidean Distance")
  plt.ylabel("Density")
  plt.title("Kernel Density Estimates of Euclidean Distances")
  plt.legend()
  plt.show()

# Define the desired dimensions
dimensions = [2, 3, 10, 100, 1000, 10000]

# Generate and print the arrays
distances_list = []
for n in dimensions:
  tensor = generate_n_dimensional_tensor(n)
  num_points = tensor.shape[0]

  distances = []
  for i in range(num_points):
    for j in range(i + 1, num_points):
      distance = euclidean_distance(tensor[i], tensor[j]).item()
      distances.append(distance)
  distances_list.append(distances)

plot_distance_histograms(distances_list, dimensions)
```




```
printlatex("$\\text{The Curse of Dimensionality } \\implies \\text{ As }n \\to
 ↪  \\infty, \\text{ distances between points increase.}$")
```

The Curse of Dimensionality $\implies$ As $n \to \infty$, distances between points increase.

Reference: 1. https://www.cs.cornell.edu/courses/cs4780/2022fa/slides/KNN_annotated.pdf

```
allDone();
```

```
<IPython.lib.display.Audio object>
```