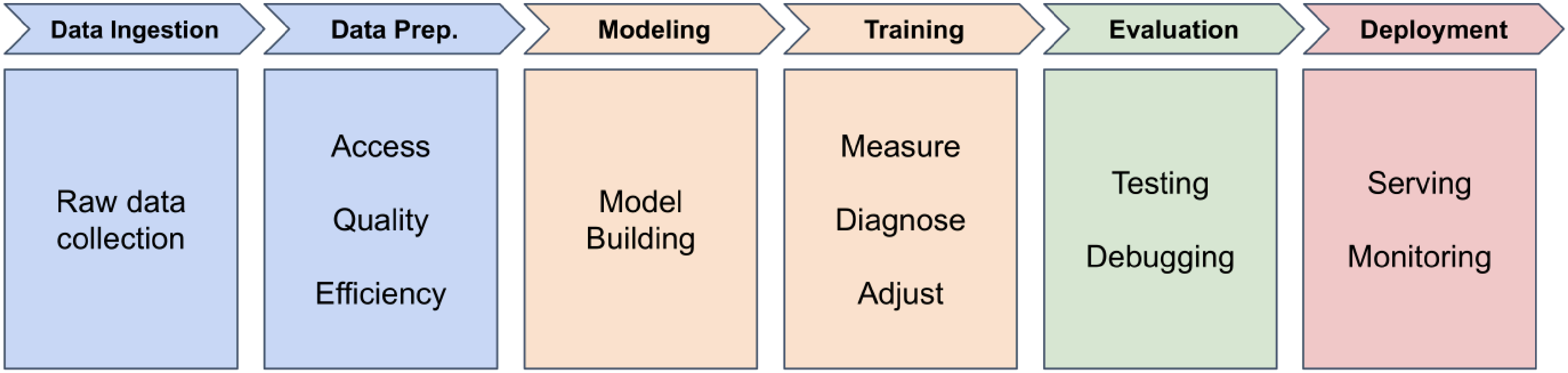
Module 1 - Session 2: The ML Pipeline and Building Your First Model

Session 2

The Machine Learning Pipeline

Six stages from data to deployed model



The Machine Learning Pipeline

Stage 1: Data Ingestion

Gathering and organizing raw data

- Delivery records from company database
- Messy data: inconsistent formats, missing values, errors
- Organize for PyTorch to work efficiently

Stage 2: Data Preparation

Cleaning, transforming, and organizing

- Fix errors (impossible times, duplicates)
- Handle missing values
- Engineer features (addresses → distances)

Most time-consuming stage in real projects

Stage 3: Model Building

Designing the architecture

- How many neurons?
- How are they connected?
- What types of layers?

For delivery predictor: one neuron (simplest architecture)

Stage 4: Training

Teaching the model to make predictions

- Feed examples (8.2 miles → 22 minutes)
- Measure prediction errors
- Adjust parameters to improve
- Repeat for many epochs

Stage 5: Evaluation

Testing on unseen data

- Use test set (held back during training)
- Measure performance (accuracy, error)
- Detect issues and debug

Key question: Does your model work well enough to trust it?

Stage 6: Deployment

Getting your model into the real world

(We'll cover this later in the course)

Building Your First Neural Network

Let’s see it in PyTorch code

Imports

```python
import torch
import torch.nn as nn
import torch.optim as optim
```

- `torch`: core functionality
- `nn`: neural network components
- `optim`: training tools

Preparing Data

```
distances = torch.tensor([[5.0], [6.0], [8.0], [10.0]],
                         dtype=torch.float32)
times = torch.tensor([[22.2], [25.6], [31.2], [38.5]],
                     dtype=torch.float32)
```

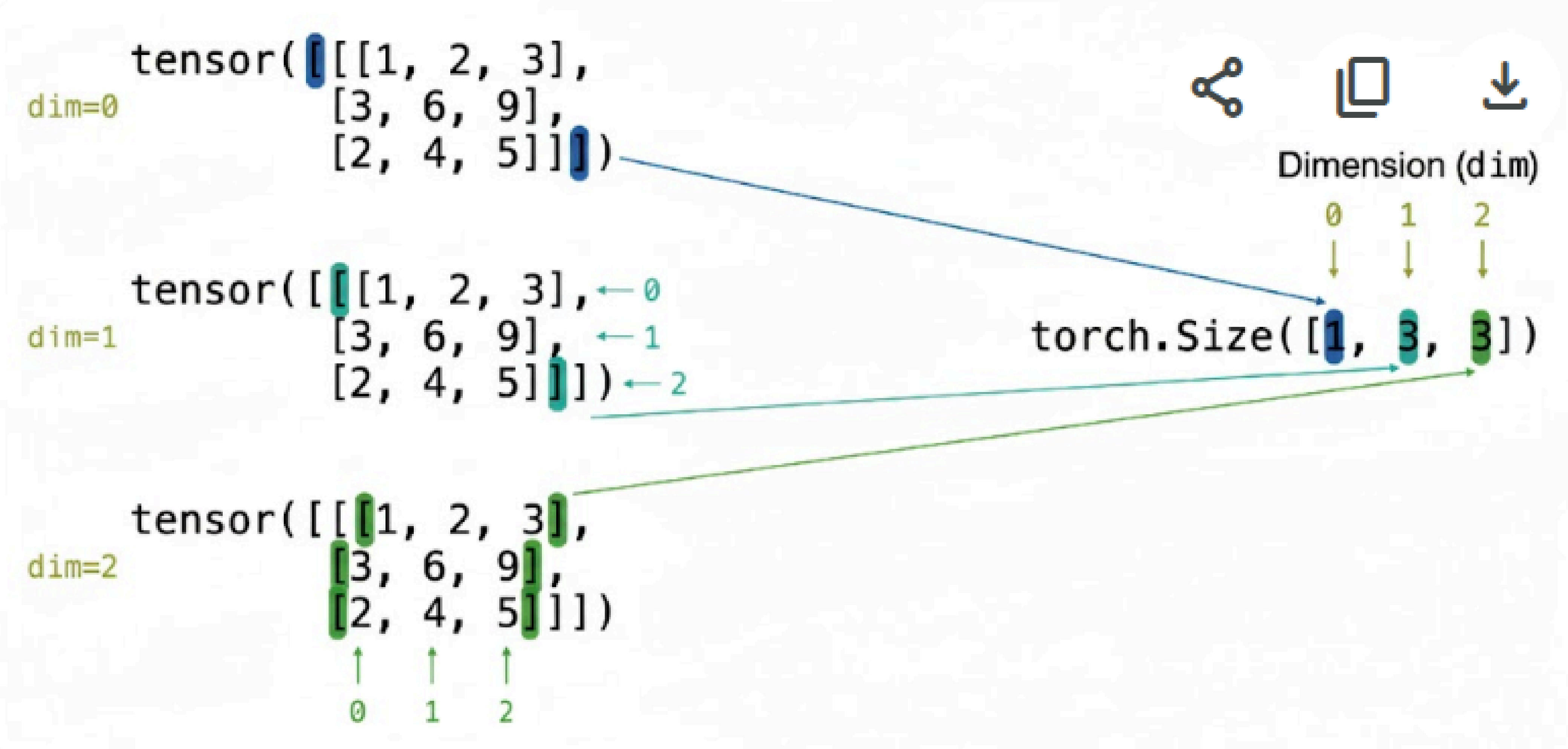
Tensors: optimized containers for neural network math

Understanding Tensor Shapes

```
distances = torch.tensor([[5.0], [6.0], [8.0], [10.0]])
distances.shape  # torch.Size([4, 1])
```

- First dimension: batch size (4 samples)
- Second dimension: features per sample (1 feature)

Tensor Dimensions: 3 dimensions



How to read brackets as dimensions

Creating the Model

```
model = nn.Sequential(
    nn.Linear(1, 1)  # 1 input, 1 output
)
```

Sequential: container that passes data through layers in order

Linear layer: single neuron (weight × input + bias)

Loss Function

```
loss_function = nn.MSELoss()
```

Mean Squared Error: measures how wrong predictions are

- Bigger errors → bigger loss
- Perfect predictions → loss = 0

Optimizer

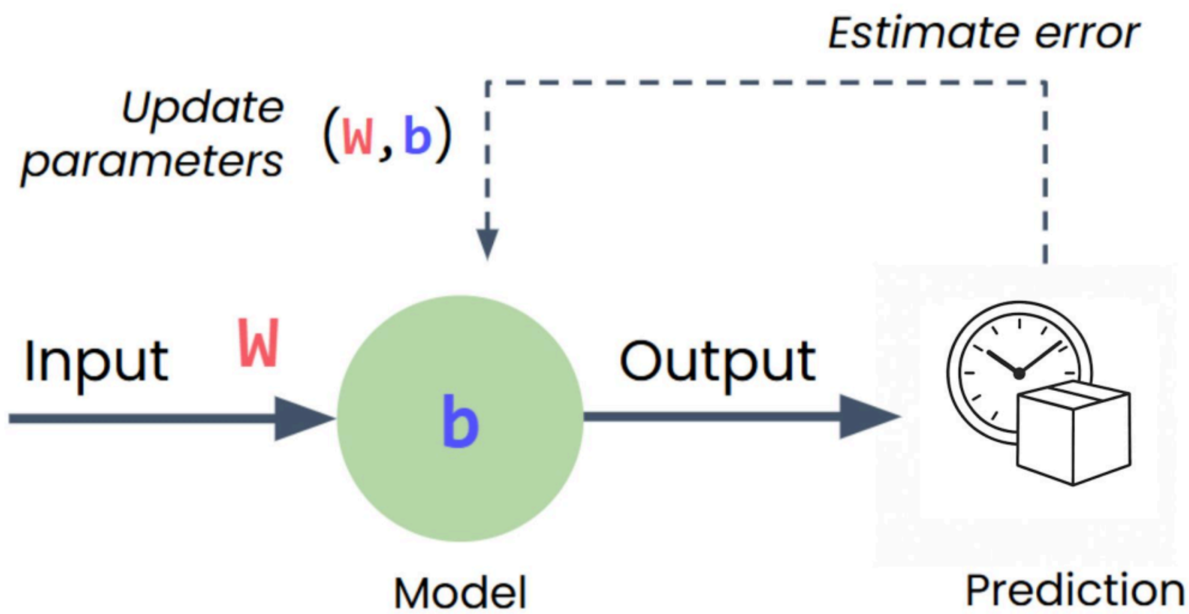
```
optimizer = optim.SGD(model.parameters(), lr=0.01)
```

SGD (Stochastic Gradient Descent):

- Figures out which direction to adjust weights/bias
- `lr` (learning rate): controls step size

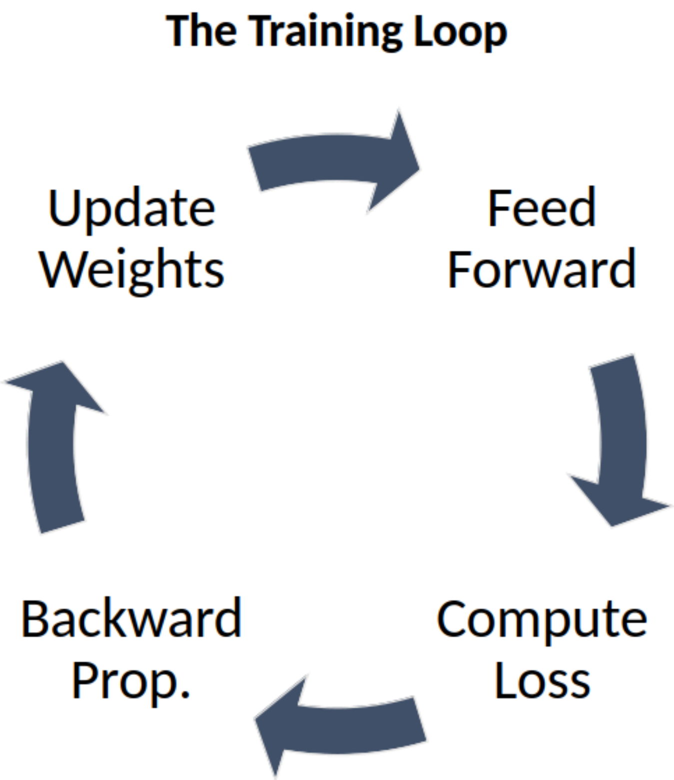
The Training Loop

```python
for epoch in range(500):
    optimizer.zero_grad()       # Clear old calculations
    outputs = model(distances) # Make predictions
    loss = loss_function(outputs, times)  # Measure error
    loss.backward()             # Calculate gradients
    optimizer.step()            # Update weights/bias
```



Each epoch: one full pass through training data

Training Loop Breakdown



`outputs = model(distances)` - Model uses distance as input

`loss = loss_function(outputs, times)` - Compares predictions to real times

`loss.backward()` - Figures out how to adjust weight/bias (backpropagation)

`optimizer.step()` - Makes the adjustments

Making Predictions (Inference)

```
with torch.no_grad():
    new_distance = torch.tensor([[7.0]])
    prediction = model(new_distance)
    print(prediction)
```

`torch.no_grad()`: skip training overhead for faster inference

Lab 1: Building a Simple Neural Network

> “What I hear, I forget. What I see, I remember. What I do, I understand.”

START WITH LAB 1

What's Next?

In **Session 3: Activation Functions** we learn:

- Why linear models fail for complex patterns
- Introducing non-linearity with activation functions
- ReLU and other activation functions