ML Best practices

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Agenda

- ML Best practices
  - Scope
  - Code structure
  - Tests
  - Pipelines
  - ML system monitoring

ML Best Practices

Scope

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  - understand how the problem is solved
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- ML solution development:
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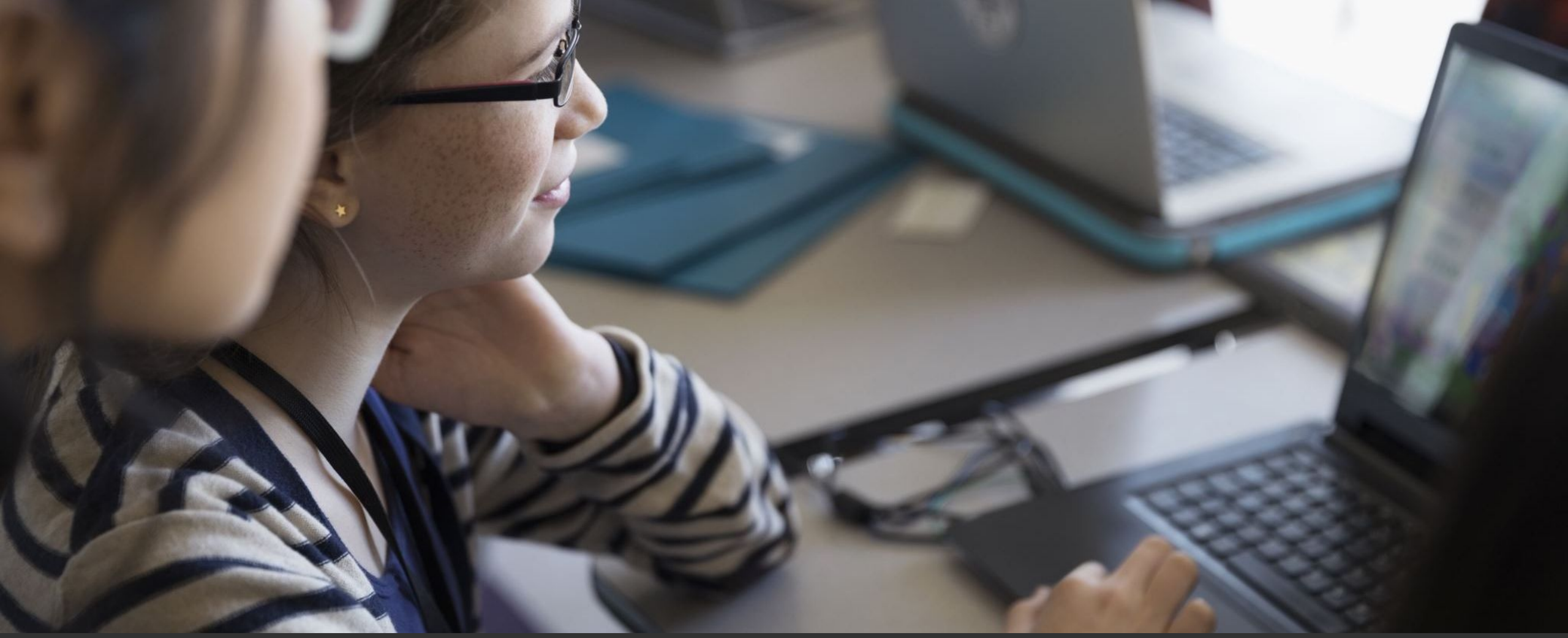
  - design with constraints in mind
- end to end MVP iterations



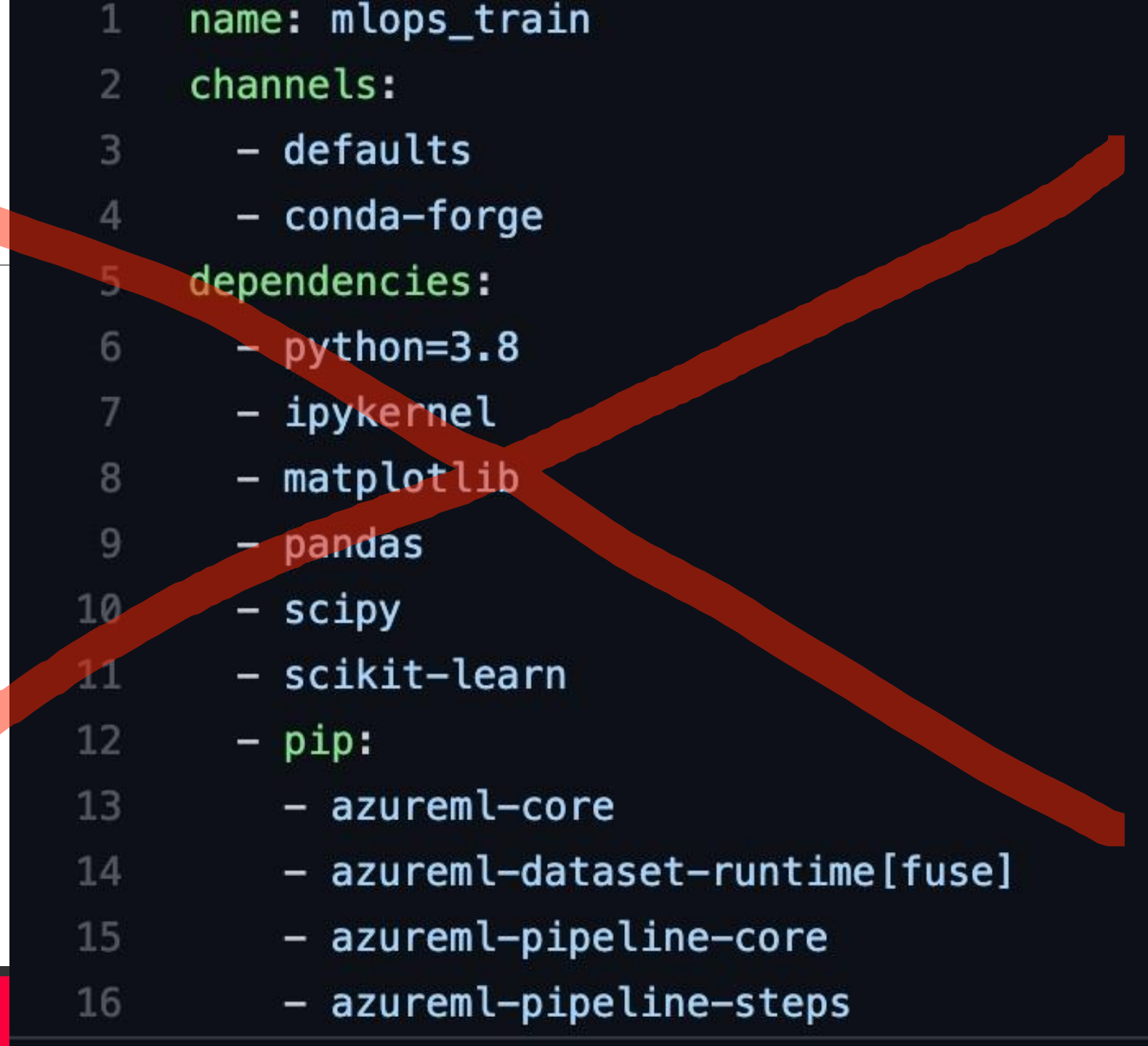
Code structure

notebooks vs modular code

```
## Multiple Linear Regression Regression
from sklearn.linear_model import LinearRegression
regressor = LinearRegression()
regressor.fit(X_train, y_train)

# Predicting Test Set
y_pred = regressor.predict(X_test)
from sklearn import metrics
mae = metrics.mean_absolute_error(y_test, y_pred)
mse = metrics.mean_squared_error(y_test, y_pred)
rmse = np.sqrt(metrics.mean_squared_error(y_test, y_pred))
r2 = metrics.r2_score(y_test, y_pred)

results = pd.DataFrame([['Multiple Linear Regression', mae, mse, rmse, r2]],
                       columns = ['Model', 'MAE', 'MSE', 'RMSE', 'R2 Score'])

## Suport Vector Regression
'Necessary Standard Scaler '
from sklearn.svm import SVR
regressor = SVR(kernel = 'rbf')
regressor.fit(X_train, y_train)

# Predicting Test Set
y_pred = regressor.predict(X_test)
from sklearn import metrics
mae = metrics.mean_absolute_error(y_test, y_pred)
mse = metrics.mean_squared_error(y_test, y_pred)
rmse = np.sqrt(metrics.mean_squared_error(y_test, y_pred))
r2 = metrics.r2_score(y_test, y_pred)

model_results = pd.DataFrame([['Support Vector RBF', mae, mse, rmse, r2]],
                       columns = ['Model', 'MAE', 'MSE', 'RMSE', 'R2 Score'])
```

pin the libraries

use docker



```yaml
name: mlops_train
channels:
  - defaults
  - conda-forge
dependencies:
  - python=3.8
  - ipykernel
  - matplotlib
  - pandas
  - scipy
  - scikit-learn
  - pip:
    - azureml-core
    - azureml-dataset-runtime[fuse]
    - azureml-pipeline-core
    - azureml-pipeline-steps
```

docs, type hinting, pre-commit

```python
def my_func(a, b):
    return a.lower() + b.upper()

#Rename function and its parameters
def mix_lower_upper_case(first_param, second_param):
    return first_param.lower() + second_param.upper()

#We can add type hints for readability purposes
def mix_lower_upper_case(first_param: str, second_param: str) -> str:
    """ Concatenate two strings, cast the first string to lowercase and the second string to uppercase"""
    return first_param.lower() + second_param.upper()

# Add casting to a str to make sure that the function returns what expected
def mix_lower_upper_case(first_param: str, second_param: str) -> str:
    """ Concatenate two strings, cast the first string to lowercase and the second string to uppercase"""
    return str(first_param).lower() + str(second_param).upper()
```

print vs logging, error handling

```
1  def implementDivision(a, b):
2    try:
3      value = a/b
4      print(value)
5    except FileNotFoundError:
6      print("The File Cannot be Found")
7    except ZeroDivisionError:
8      print("Number Cannot be Divided by Zero")
9    except:
10     print("This is the Generic Error")
```

sys, argparse, configargparse, click, typer

```
parser = argparse.ArgumentParser()
parser.add_argument('-ff', '--feature_file', type=str, required=True)
parser.add_argument('-fcf', '--feature_class_file', type=str, required=True)
parser.add_argument('-of', '--outcome_file', type=str, required=True)
parser.add_argument('-op', '--output_prefix', type=str, required=True)
parser.add_argument('-m', '--model', type=str, required=True, choices=MODEL_NAMES)
```

automation

```
remove-environment:
	@echo ""
	@echo "$(ccso)--> Remove conda environment $(ccend)"
	conda env remove --name $(CONDA_ENV_NAME)

remove-kernel:
	@echo ""
	@echo "$(ccso)--> Remove ipykernel from Jupyter lab $(ccend)"
	$(CONDA_ACTIVATE) && jupyter kernelspec uninstall $(CONDA_ENV_NAME)
```

Tests

unit, integration, functional, regression tests

```python
# positive case
def test_filter_not_equal_2():
    input_df = pd.DataFrame([(1, 2), (2, 8)], columns=["A", "B"])
    test_df = filter_not_equal(input_df, "B", 2)
    expected_df = pd.DataFrame([(2,8)], columns=["A", "B"])
    pd.testing.assert_frame_equal(test_df.reset_index(drop=True), expected_df.reset_index(drop=True))

# positive case
def test_filter_not_equal_0():
    input_df = pd.DataFrame([(1, 2), (2, 8)], columns=["A", "B"])
    test_df = filter_not_equal(input_df, "B", 0)
    expected_df = pd.DataFrame([(1, 2), (2, 8)], columns=["A", "B"])
    pd.testing.assert_frame_equal(test_df.reset_index(drop=True), expected_df.reset_index(drop=True))

# negative case
def test_filter_column_not_exist():
    with pytest.raises(KeyError):
        input_df = pd.DataFrame([(1, 2), (2, 8)], columns=["A", "B"])
        test_df = filter_not_equal(input_df, "C", 0)


def filter_not_equal(df: pd.DataFrame, column_name: str, val: int) -> pd.DataFrame:
    df = df.copy()
    new_df = df.loc[df[column_name]!= val]
    return new_df
```

data-specific tests

```
@MetaPandasDataset.column_map_expectation
def expect_column_value_word_counts_to_be_between(self, column, min_value=None, max_value=None):
    def count_words(string):
        word_list = re.findall("(\S+)", string)
        return len(word_list)

    word_counts = column.map(lambda x: count_words(str(x)))

    if min_value is not None and max_value is not None:
        return word_counts.map(lambda x: min_value <= x <= max_value)
    elif min_value is not None and max_value is None:
        return word_counts.map(lambda x: min_value <= x)
    elif min_value is None and max_value is not None:
        return word_counts.map(lambda x: x <= max_value)
    else:
        return word_counts.map(lambda x: True)
```

model-specific tests

```
def test_model_return_object():
    """
    Tests the returned object of the modeling function
    """
    X,y = random_data_constructor()
    scores = train_linear_model(X,y)

    #================================
    # TEST SUITE
    #================================
    # Check the return object type
    assert isinstance(scores, dict)
    # Check the length of the returned object
    assert len(scores) == 2
    # Check the correctness of the names of the returned dict keys
    assert 'Train-score' in scores and 'Test-score' in scores
```

Generates data and runs the function

Focused test suite checking returned object properties

Pipelines

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- Model evaluation (performance, latency, size, compute, interpretability, bias, time to develop, time to retrain, maintenance overhead)

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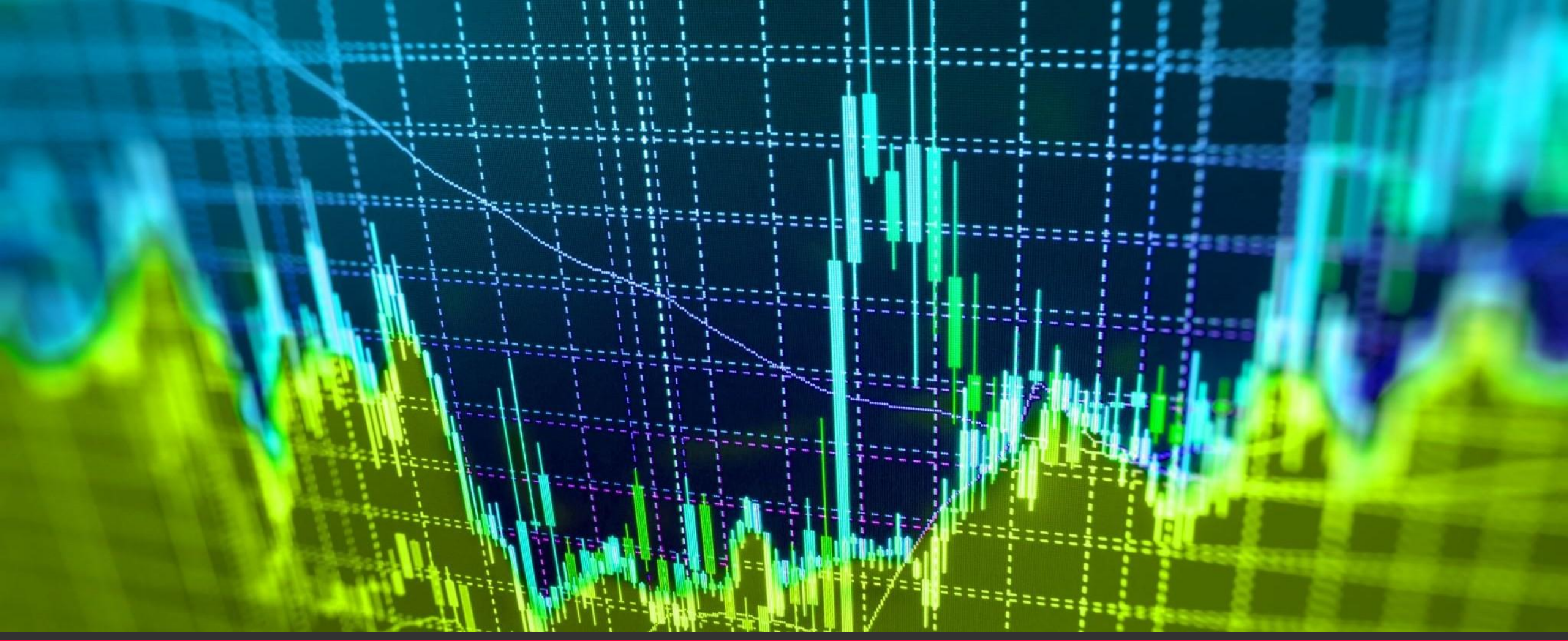
- DataOps (get data, join, validate, prepare, split, feature engineering)
- Model training
- Model evaluation (performance, latency, size, compute, interpretability, bias, time to develop, time to retrain, maintenance overhead)
- Model deployment (build, release pipelines)



ML system monitoring

ML system monitoring

- overall ML system health
- model performance (data drift, feature drift, concept drift)
- monitoring solution (alert, inspect, act)