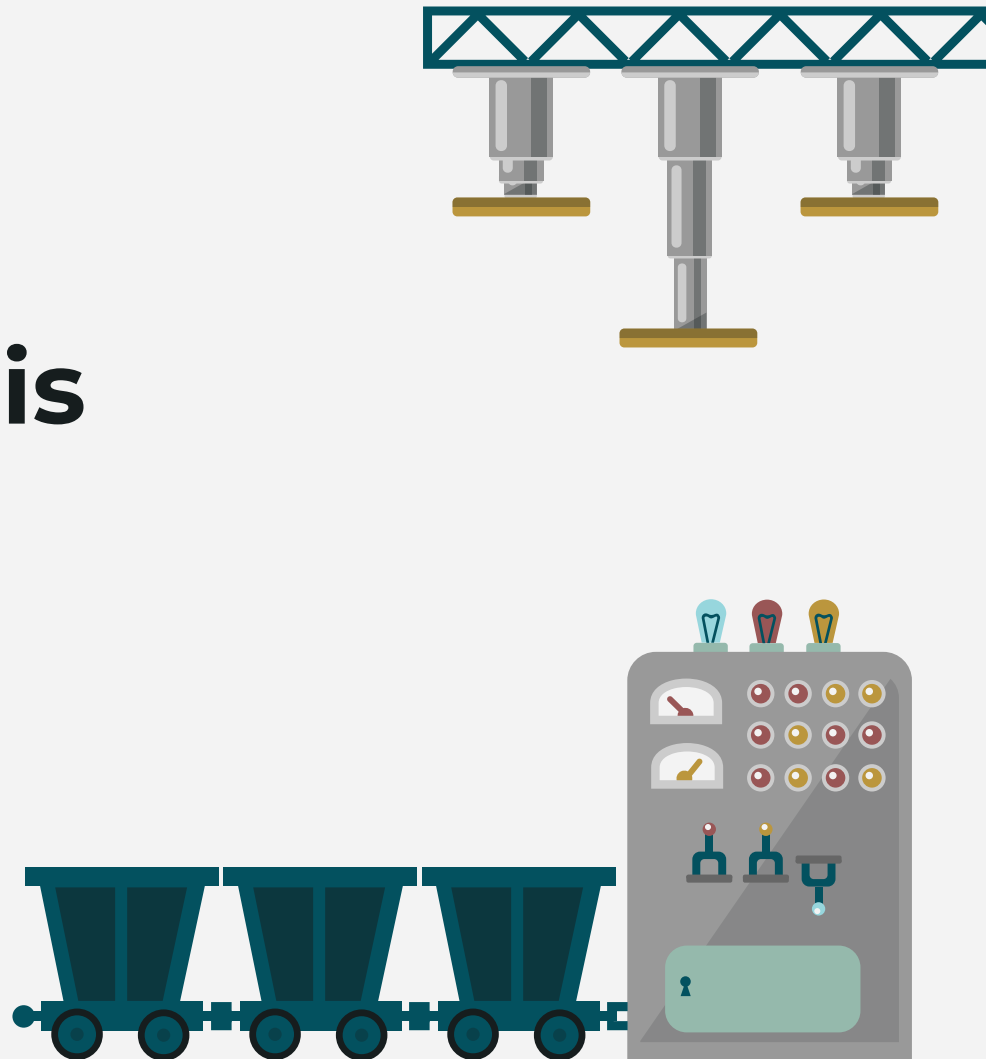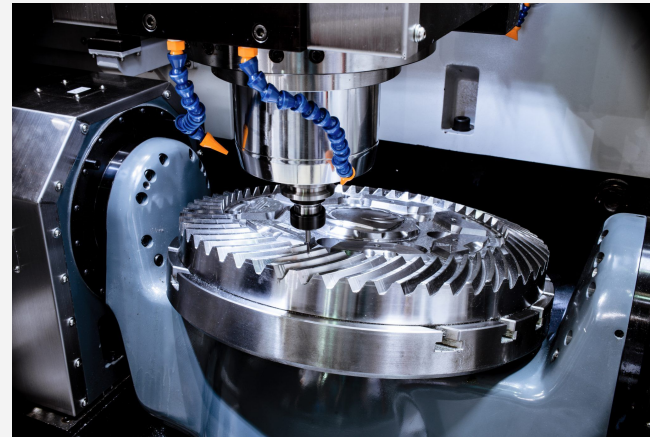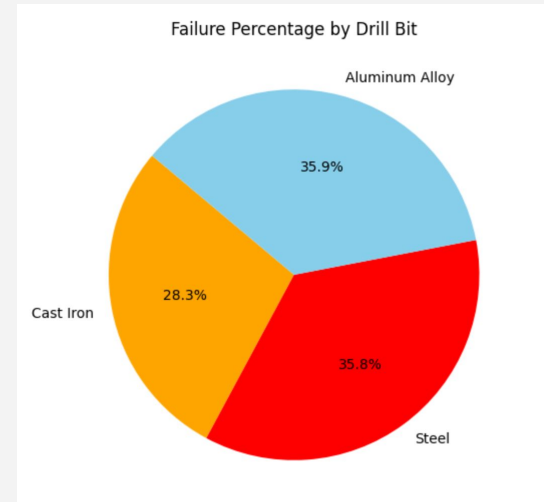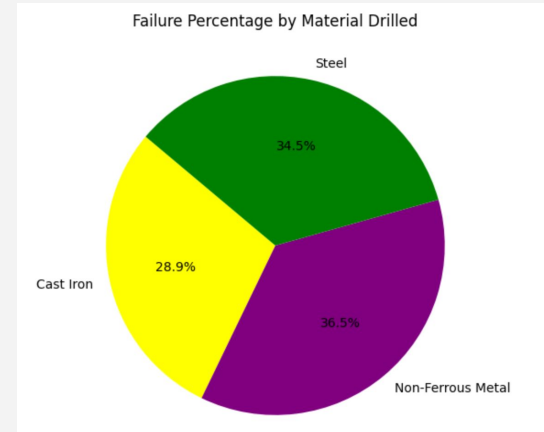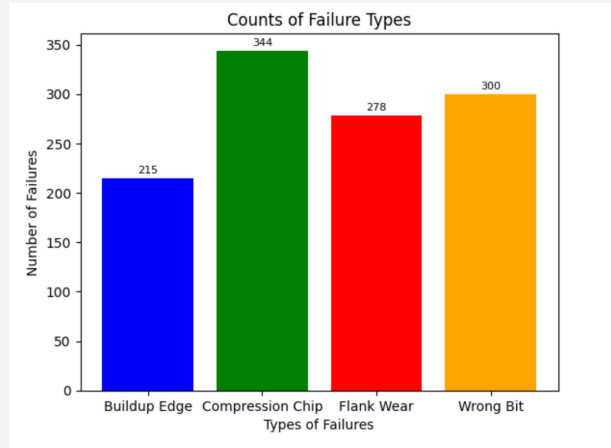# Drill Machine Failure Analysis

December 6, 2023

Data Source

- CNC machines

- Data consists of 20,000 drilling operations

- Each with 10 features consisting of thing like
  - Process duration
  - Cutting speed
  - Cooling level
  - Power consumption
  - Drill bit type
  - Material being drilled
  - Main failure
    - Subgroup failures

Basic Analysis

Counts of Failure Types

Failure Percentage by Material Drilled
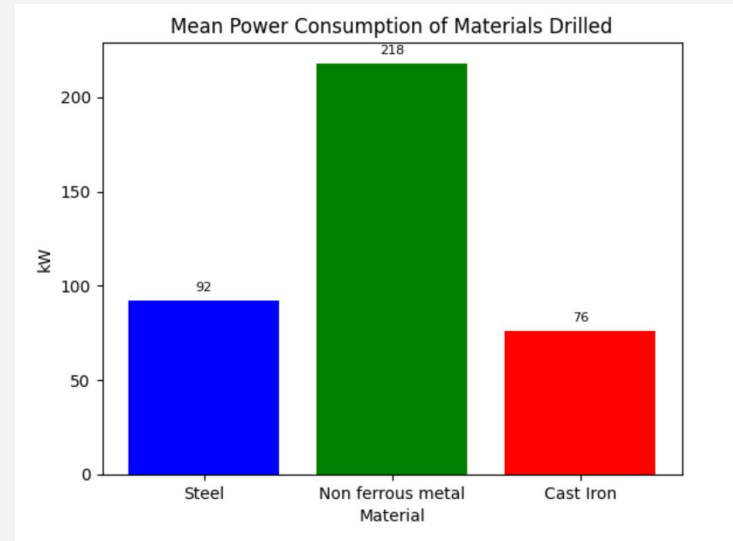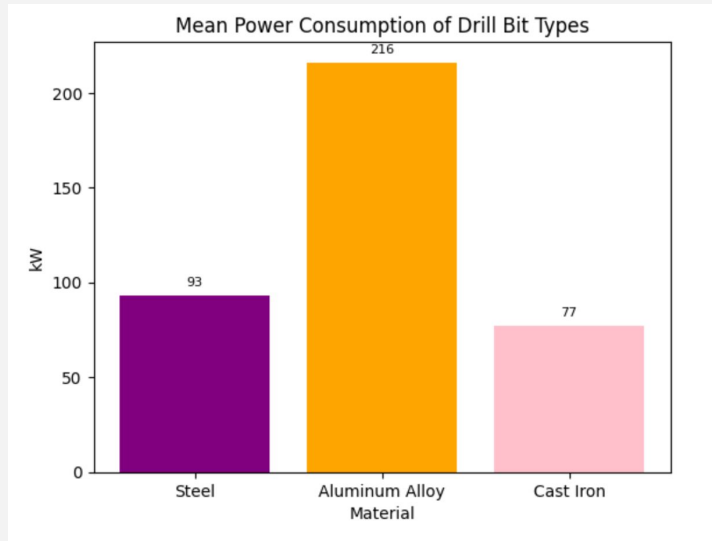

Failure Percentage by Drill Bit

Material and drill bit type needed more analysis...

Hypothesis: Does power consumption differ across drill bits and materials?
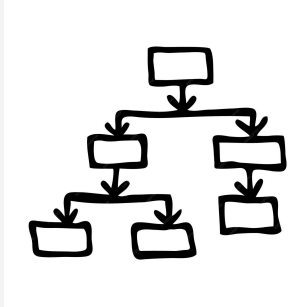
Hypothesis testing showed that that it did differ.

Further exploration showed it differed A LOT.
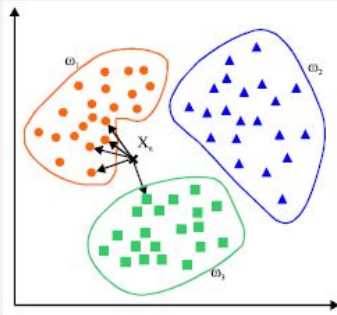
Classic ML

Decision Tree
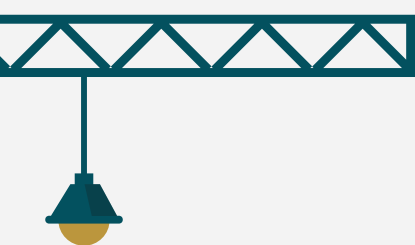

Accuracy=99.5

KNN

Accuracy = 97.5

Random Forest

Accuracy = 99.7

Attempted to predict machine failures. All performed extremely well. Grid search on the random forest dropped accuracy to 99.6

Deep Learning

Custom ANN

```
Model: "sequential"

Layer (type)          Output Shape        Param #
dense (Dense)         (None, 64)              640
dense_1 (Dense)       (None, 32)            2,080
dense_2 (Dense)       (None, 1)                33

Total params: 2,753 (10.75 KB)
Trainable params: 2,753 (10.75 KB)
Non-trainable params: 0 (0.00 B)
```

Training Accuracy: 0.9829
Testing Accuracy: 0.9907

Further tuning (smaller and with different activation function)

```
Model: "sequential"

Layer (type)          Output Shape        Param #
dense (Dense)         (None, 32)              320
dense_1 (Dense)       (None, 1)                33

Total params: 353 (1.38 KB)
Trainable params: 353 (1.38 KB)
Non-trainable params: 0 (0.00 B)
```

Training Accuracy: 0.9441
Testing Accuracy: 0.9678
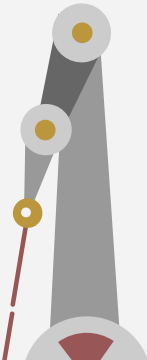
Results/Takeaways

- Best performing model was the baseline random forest.

- This analysis used synthetic data. Real data could present much more noise and complexity that would be able to better showcase the power of deep learning.

Intended uses:

- Predicting operations that strain drilling machines.
- Predicting operation that cause machines to fail
- Predicting catastrophic failures (multiple failure types at once).
- Create more effective scheduled maintenance schedule.
- Identifying which operations in which to take equipment precautions.

"An ounce of prevention is worth a pound of cure."

Thank You*!*

https://github.com/JoeyBarlia

—Joey Barlia