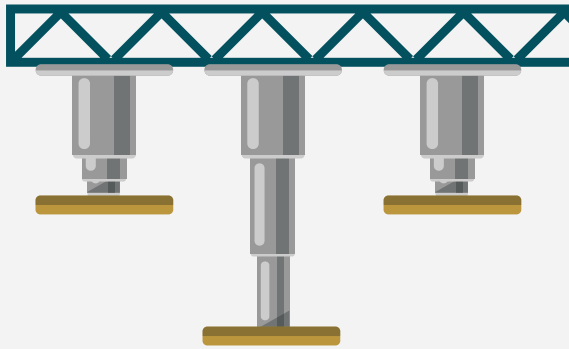
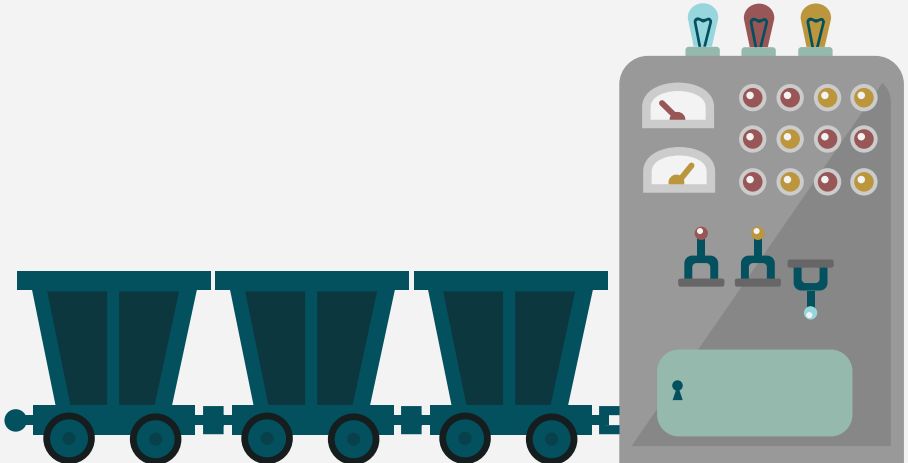
Drill Machine Failure Analysis

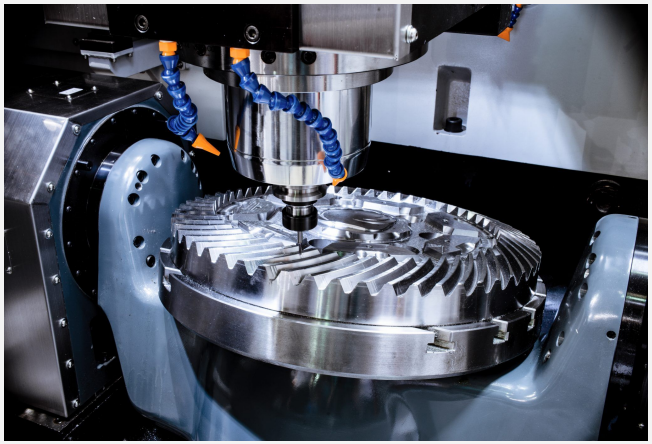


December 6, 2024

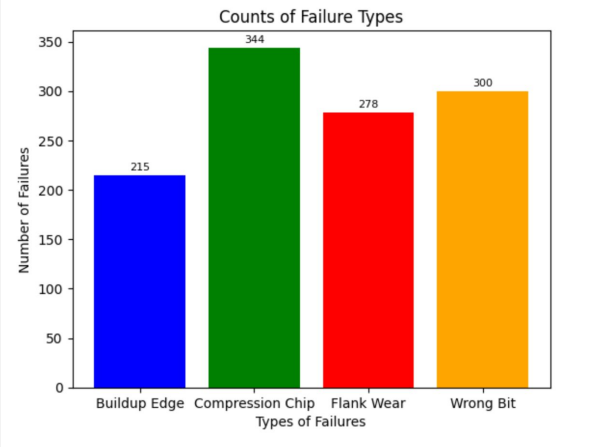


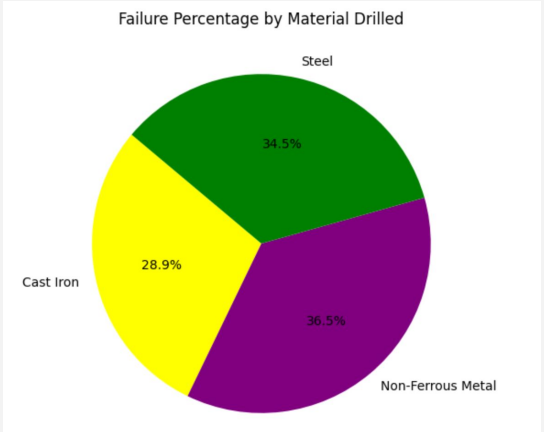
Data Understanding

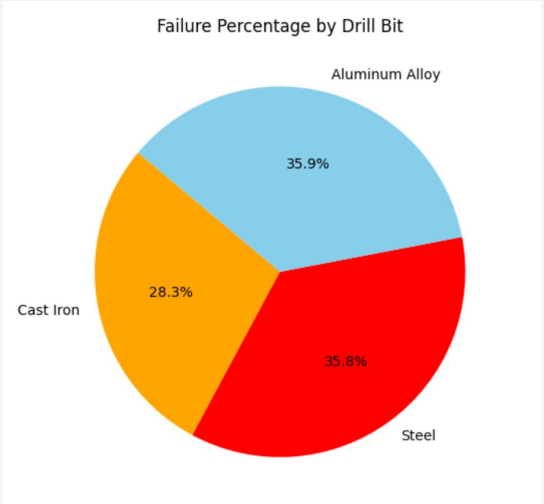
- CNC machines
- Data consists of 20,000 drilling operations
- Each with 10 features consisting of thing like
  - Process duration
  - Cutting speed
  - Power consumption
  - ➢ Drill bit type
  - ➢ Material being drilled
  - ★ Main failure
    - ■ Subgroup failures



Basic Analysis





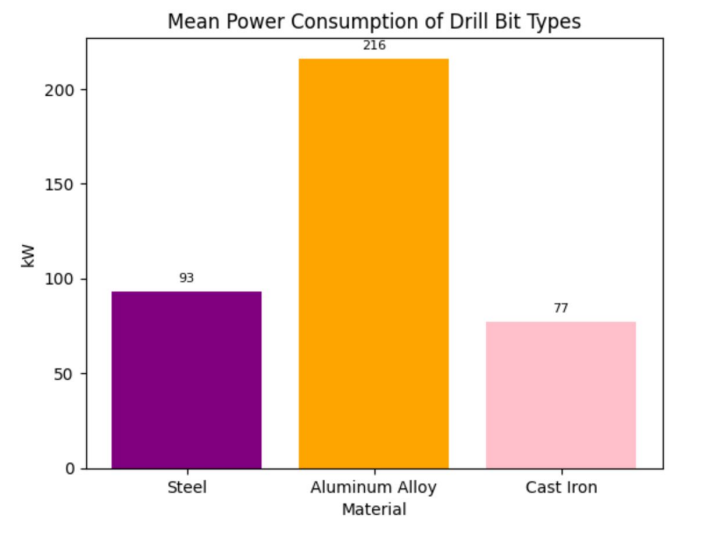


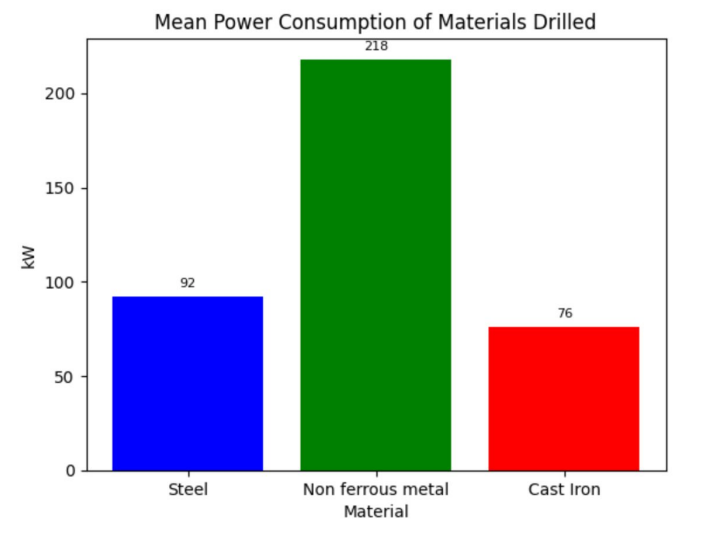
Material and drill bit type needed more analysis…

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.

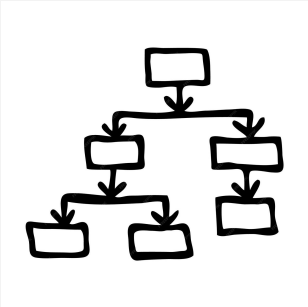




Classic ML

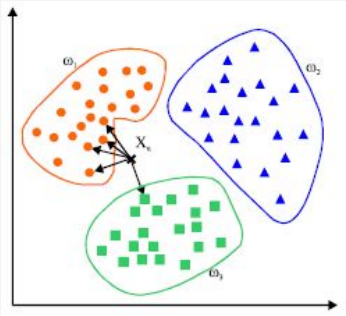
Predicting Machine failures

Decision Tree



Accuracy=99.5

KNN



Accuracy = 97.5

Random Forest

Accuracy = 99.7

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:

Help technicians….

- Prevent operations that strain drilling machines.
- Identify which operations in which to take precautions.
- Prevent catastrophic failures (multiple failure types at once).
- Create more effective scheduled maintenance schedules.

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

Thank You!

https://github.com/JoeyBarlia

—Joey Barlia