**Online Machine Learning**

* A model that learns continuously from streaming data, one instance (or mini-batch) at a time, without needing to retrain from scratch.
* If your data never stops, your environment keeps changing, or your system needs fast adaptation, online ML is the right choice.

When to use ML

* Continuous Data Streams: Data is coming constantly (e.g., sensor data, user clicks, financial transactions)
* Huge or Infinite Datasets: The dataset is too large to fit in memory or even storage
* Concept Drift: The data distribution changes over time (e.g., customer preferences shift) and you need the model to adapt quickly
* Real-Time Prediction: You need instant model updates to predict with the latest data (e.g., fraud detection, stock prediction)
* Limited Memory or Compute: You can't store all historical data; you only process one or a few points at a time
* Cost or Time Constraints: Retraining offline models takes too long or is too expensive to repeat frequently

Real-World Examples

* Online Ad Click Prediction (Google, Facebook ads)
* Fraud Detection in Banking (credit card transactions)
* Recommendation Systems (Netflix, YouTube real-time suggestions)
* Self-Driving Cars (constantly updating based on sensor input)
* Industrial IoT Monitoring (factory sensors adjusting models as environment changes)
* Stock Trading Bots (learns from the market ticks immediately)

You Should NOT Use Online ML If:

* Your data is static (e.g., customer records don't change)
* You need very complex models that require batch learning (e.g., big deep learning models)
* You want maximum accuracy over model adaptability (offline batch training can fine-tune better)
* Model updating needs strong validation before deploying (online learning is riskier if model drifts badly)

Typical Online ML Algorithms:

* Online Gradient Descent
* Hoeffding Trees (Online Decision Trees)
* Passive-Aggressive Classifier
* Stochastic Gradient Descent (SGD) Classifier
* Adaptive Boosting with online updates (OzaBoost)
* Libraries: River, Vowpal Wabbit, scikit-multiflow