Machine Learning in iOS

Using Core ML & Create ML

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Introducing Apple’s Machine Learning

Core ML

Integrating a trained model into your app

Create ML

Training your own model to be used in your app via Core ML

How much machine learning do I need to know?

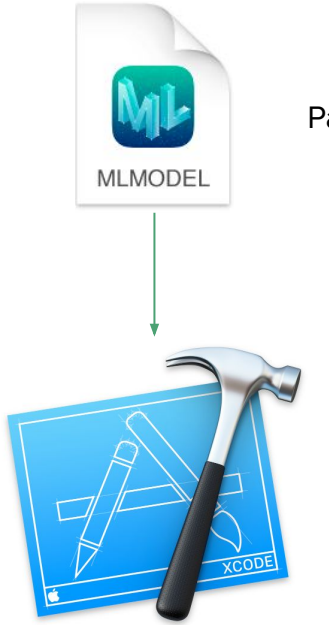
- Practically
  - Cleaning a dataset
- Conceptually
  - High-level approach of machine learning
  - Common ML vocabulary
  - Types of ML algorithms

Short Answer: Not much

Most work is done under the hood by Apple

Overview: What can Core ML do?

- Audio Classification
- Computer Vision
  - Image Classification
  - Object Detection
- Natural Language Processing
- Tabular Data Analysis
  - Regression
  - Classification
  - Recommendations



Package a model into .mlmodel file

Drag it into your Xcode project

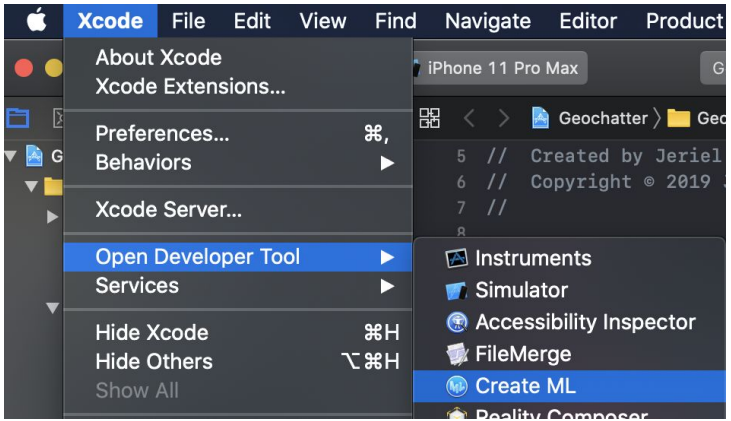
Getting a model - What are my options?

```
import Foundation
import CreateML

let trainingDataUrl = Bundle.main.url(forResource: "MOCK_DATA", withExtension: "csv")!
let trainingDataTable = try MLDataTable(contentsOf: trainingDataUrl)

let testingDataUrl = Bundle.main.url(forResource: "MOCK_DATA-2", withExtension: "csv")!
let testingDataTable = try MLDataTable(contentsOf: testingDataUrl)

if #available(OSX 10.15, *) {
    let recommender = try MLRecommender.init(trainingData: trainingDataTable, userColumn:
    let _ = recommender.evaluation(on: testingDataTable, userColumn: "id", itemColumn: "it
    print("Success")
} else {
    print("Failure")
}
```



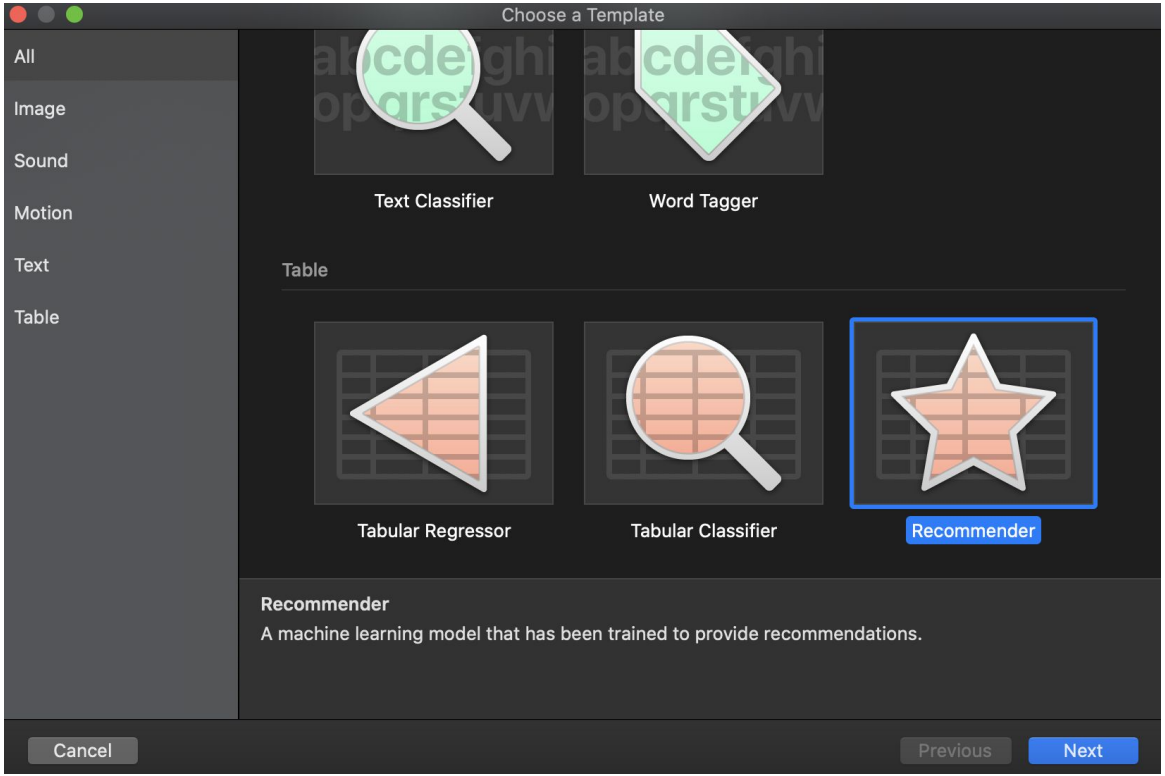
1. Use Create ML in Xcode **playground**

2. Use **Create ML app** (Introduced 2019)

3. Generate using **CoreMLTools** in Python

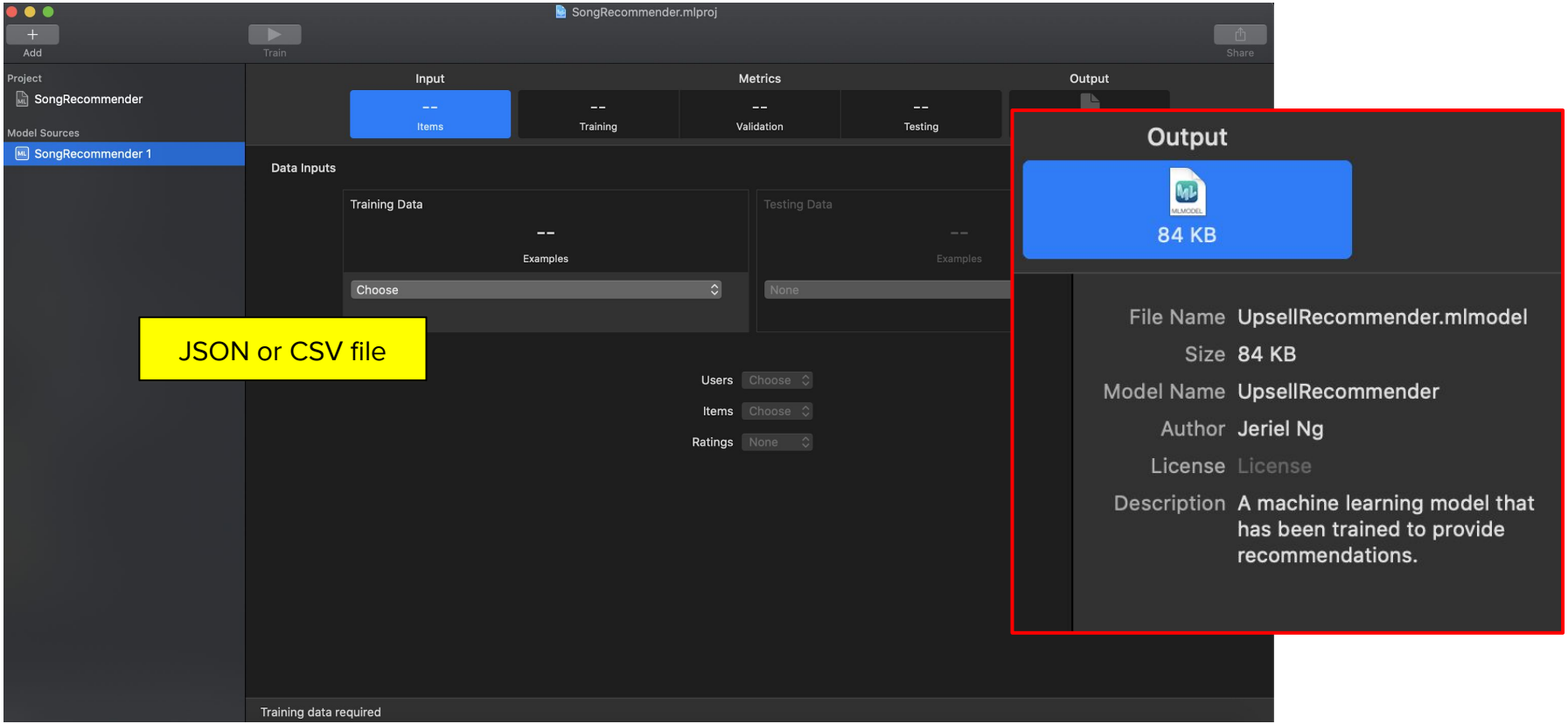
4. Download a pre-trained model

Creating your own model with Create ML

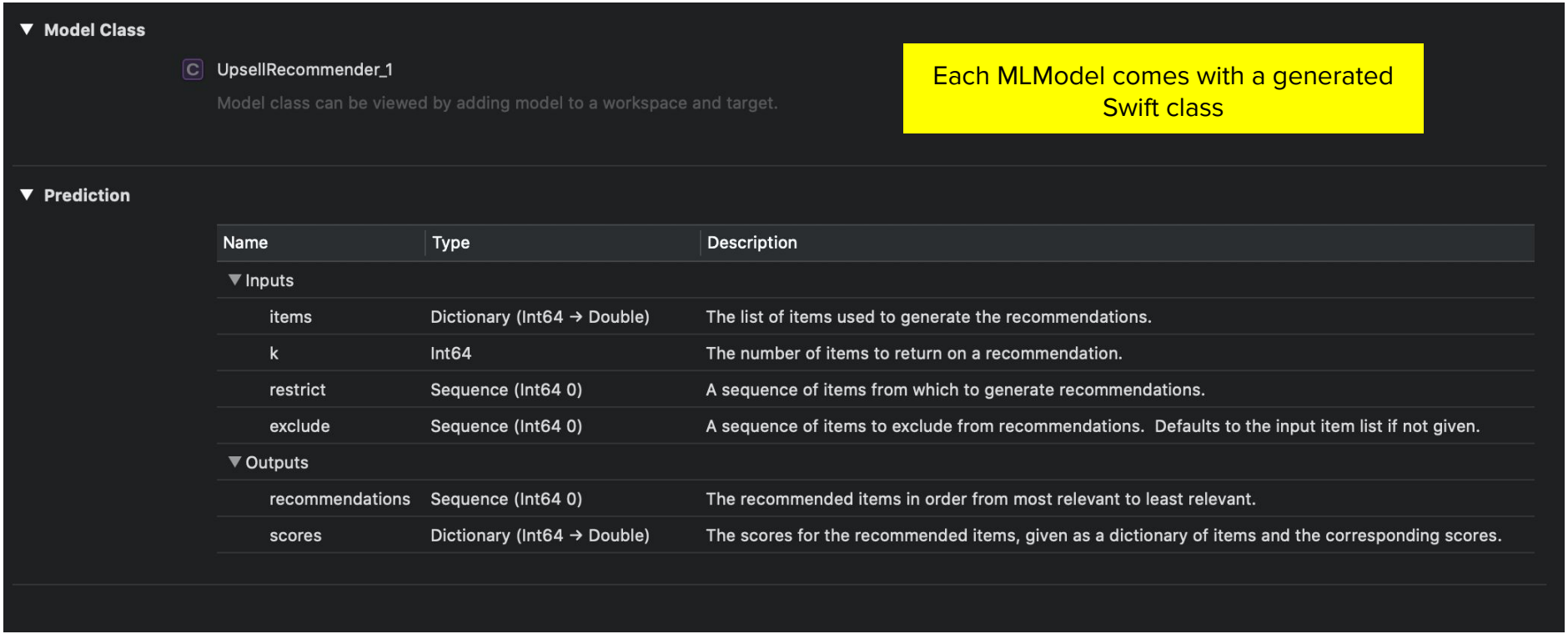


Today, we'll build a recommendation engine in the **Create ML app**

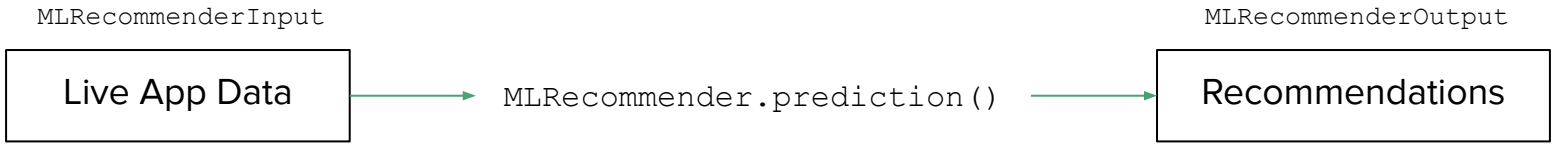
Creating your own model with Create ML



Creating your own model with Create ML

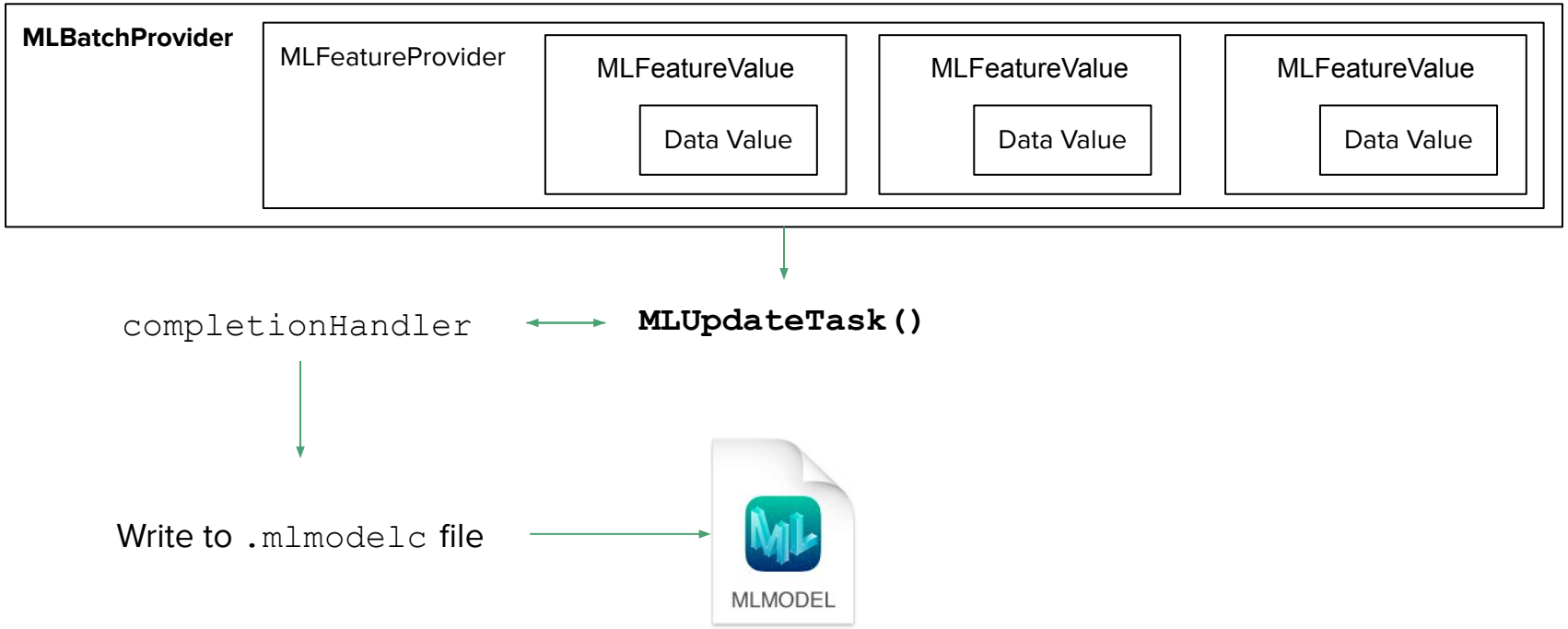


Core ML: Integrating your model




```
private func createSuggestionsMapFromRecommender() -> [Int: [Int64]] {
    var suggestionsMap = [Int: [Int64]]()
    if #available(iOS 13.0, *) {
        var itemsInCart: [Int64: Double] = [:]
        var itemsToExclude: [Int64] = []
        for itemId in cartButler.salesItemIds {
            itemsInCart.updateValue(0, forKey: itemId)
            itemsToExclude.append(itemId)
        }
        let modelInput = UpsellRecommender_1Input(items: itemsInCart, k: 4, restrict_: [], exclude: itemsToExclude)
        guard let output: UpsellRecommender_1Output = try? upsellRecommender.prediction(input: modelInput) else { return [:] }
        suggestionsMap.updateValue(output.recommendations, forKey: 0)
    }
    return suggestionsMap
}
```

Core ML: Updating your model



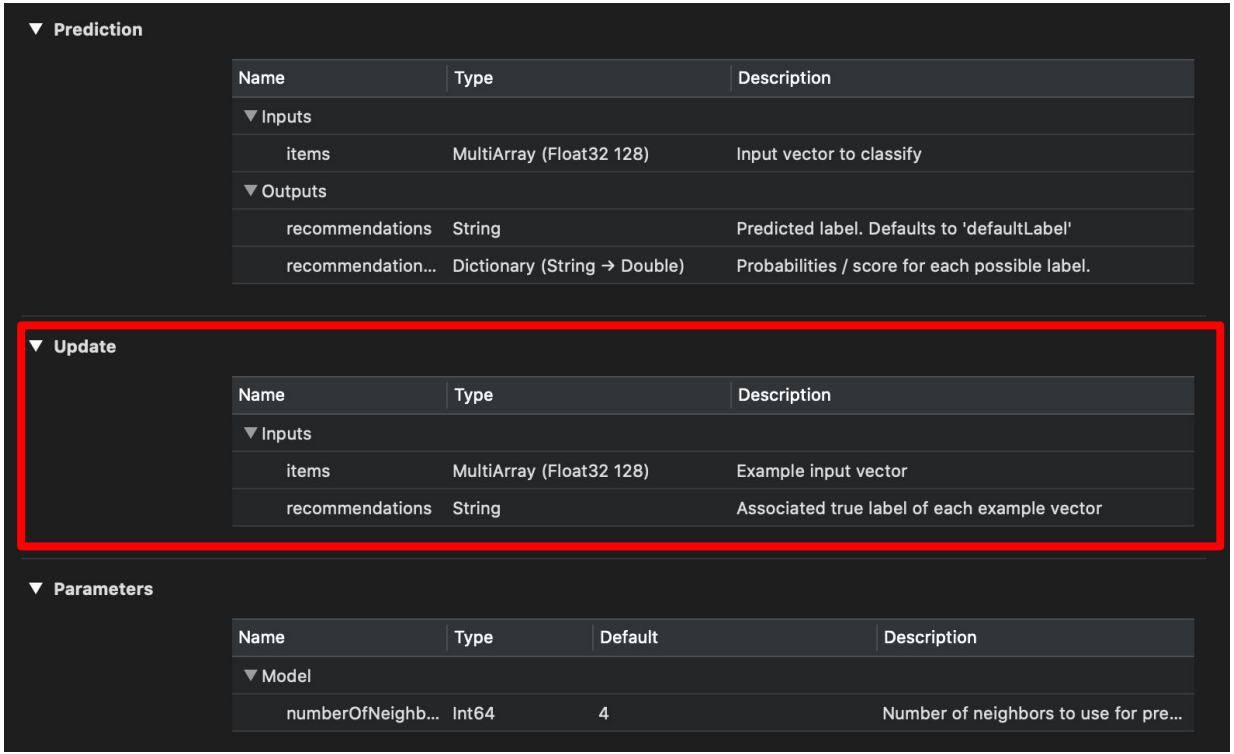
Core ML: Updating your model

```
private func updateRecommenderModel() {
    guard #available(iOS 13.0, *),
        let order = self.order else { return }
    var orderItemsDictionary: [AnyHashable: NSNumber] = [:]
    for orderItem in order.lineItems {
        orderItemsDictionary.updateValue(0, forKey: orderItem.menuItemId)
    }
    guard let updateValues = try? MLFeatureValue(dictionary: orderItemsDictionary) else { return }
    let dataPointFeatures: [String: MLFeatureValue] = ["items": updateValues]
    guard let featureProvider = try? MLDictionaryFeatureProvider(dictionary: dataPointFeatures) else { return }
    let trainingData = MLArrayBatchProvider(array: [featureProvider])
    guard let updateTask = try? MLUpdateTask(forModelAt: UpsellRecommender_1.urlOfModelInThisBundle, trainingData: trainingData, configuration: nil,
        completionHandler: { context in
        let updatedModel = context.model
        do {
            _ = try updatedModel.write(to: UpsellRecommender_1.urlOfModelInThisBundle)
        } catch { return }
    }) else { return }
    updateTask.resume()
}
```

Restrictions:

- MLModel must have `isUpdatable = true`
- Only on k-Nearest Neighbors and Neural Network models (Not available through Create ML)

Core ML: How to tell if your model is updatable?



▼ Prediction

Name	Type	Description
▼ Inputs		
items	MultiArray (Float32 128)	Input vector to classify
▼ Outputs		
recommendations	String	Predicted label. Defaults to 'defaultLabel'
recommendation...	Dictionary (String → Double)	Probabilities / score for each possible label.

▼ Update

Name	Type	Description
▼ Inputs		
items	MultiArray (Float32 128)	Example input vector
recommendations	String	Associated true label of each example vector

▼ Parameters

Name	Type	Default	Description
▼ Model			
numberOfNeighb...	Int64	4	Number of neighbors to use for pre...

Drawbacks: Framework is still very new

- Core ML features limited to certain devices and iOS versions
- Some features limited to only certain types of models
- Structure of data can be highly specific
  - Must follow specific columns
  - Must follow specific data types
- Create ML tooling limited to certain versions of macOS

Further Resources

- Pre-trained open source models
- CoreMLTools: Train a model using Python
- Core ML Tutorials
  - Using your model to make predictions
  - Updating your existing model

Questions