Embedded ML

Machine Learning

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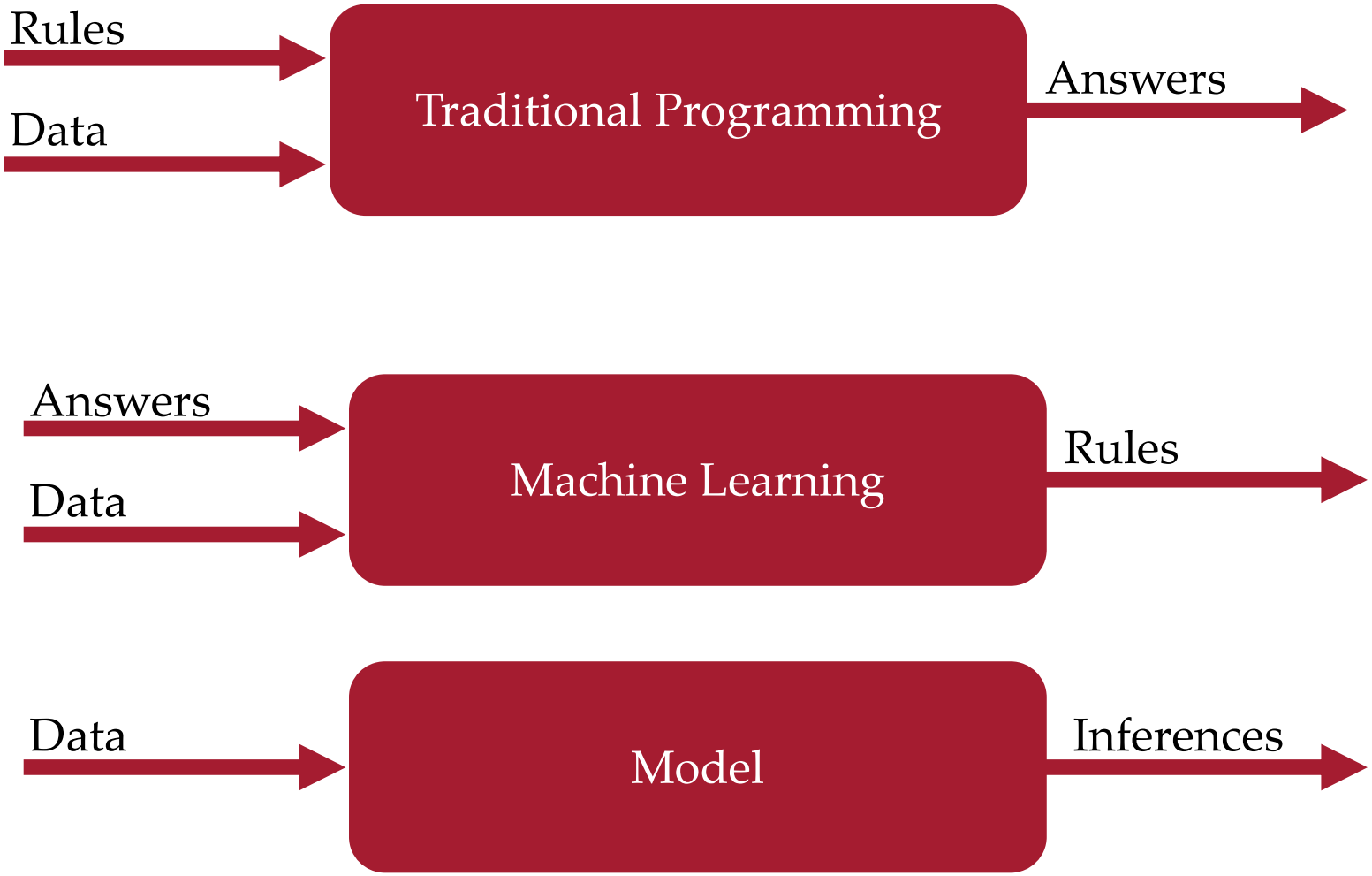
Some slides adopted from Edge Impulse presentations

Machine Learning



Machine Learning

Embedded ML

```
if(speed<4){
    status=WALKING;
}
```

```
if(speed<4){
    status=WALKING;
} else {
    status=RUNNING;
}
```

```
if(speed<4){
    status=WALKING;
} else if(speed<12){
    status=RUNNING;
} else {
    status=BIKING;
}
```

```
// ???
```

```
01010010101001010101001010101001011010101001010
```

Label = WALKING

```
10101001010010101010101001010001001001111101010111010100111101011
```

Label = RUNNING

```
10010100111110101011010100101111010101011111111000111101010111
```

Label = BIKING

```
11111111110100111010011111010111101010101011111010101010010011110
```

Label = GOLFING

The Machine Learning Paradigm

```
0101001010100101010
1001010101001011101
0100101010010101001
0101001010100101010
```

Label = WALKING

```
1010100101001010101
0101010010010010001
0010011111010101111
1010100100111101011
```

Label = RUNNING

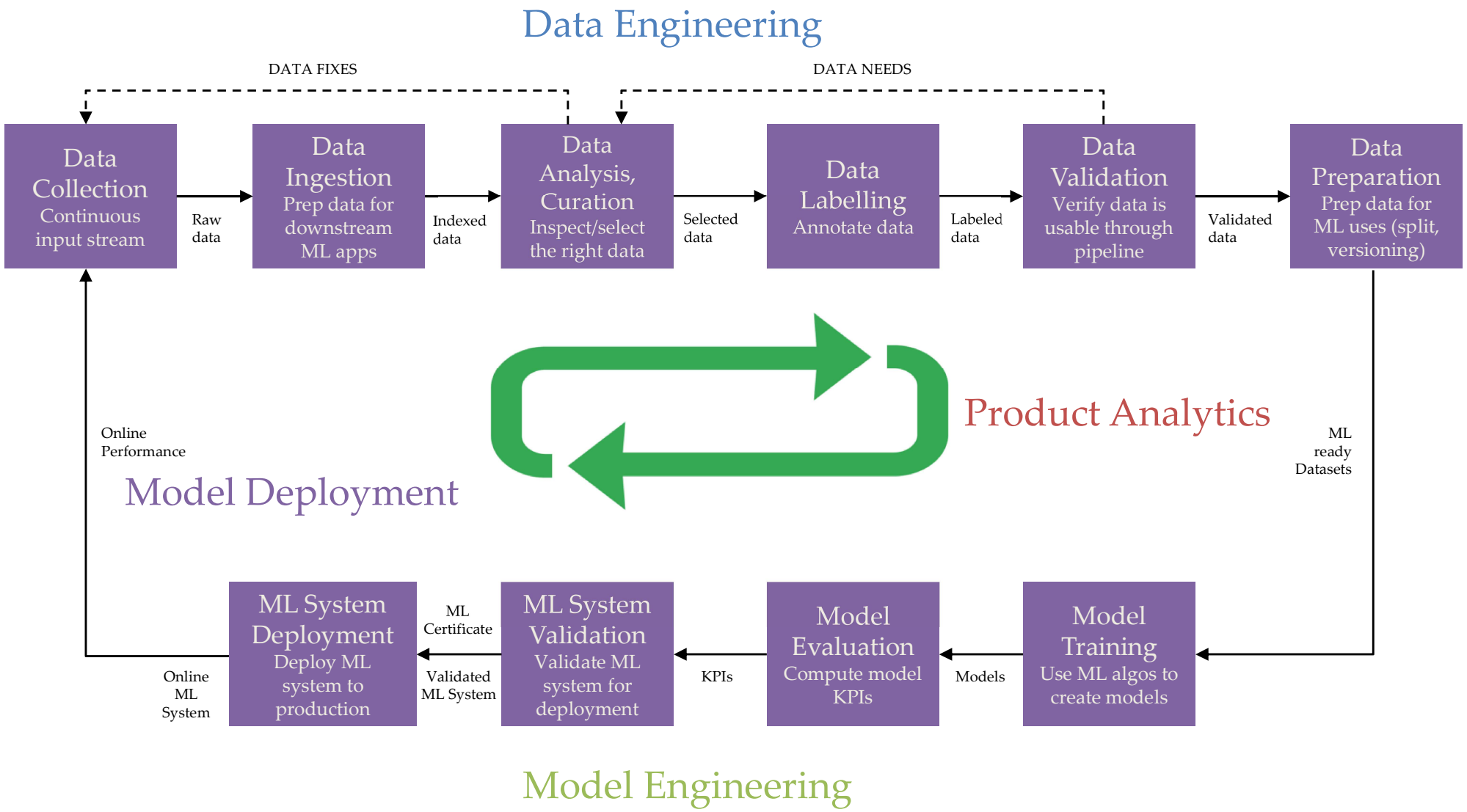
```
1001010011111010101
1101010111010101110
1010101111010101011
1111110001111010101
```

Label = BIKING

```
1111111111010011101
0011111010111110101
0101110101010101110
1010101010100111110
```

Label = GOLFING

Life cycle of ML



ML Infrastructure

Embedded ML

Data Engineering

- Defining data **requirements**
- **Collecting** data
- **Labelling** the data
- Inspect and **clean** the data
- Prepare data for **training**
- **Augment** the data
- **Add more data**

Model Engineering

- **Training** ML models
- Improving training **speed**
- Setting **target** metrics
- **Evaluating** against metrics
- **Optimizing** model training

ML Infrastructure

Model Deployment

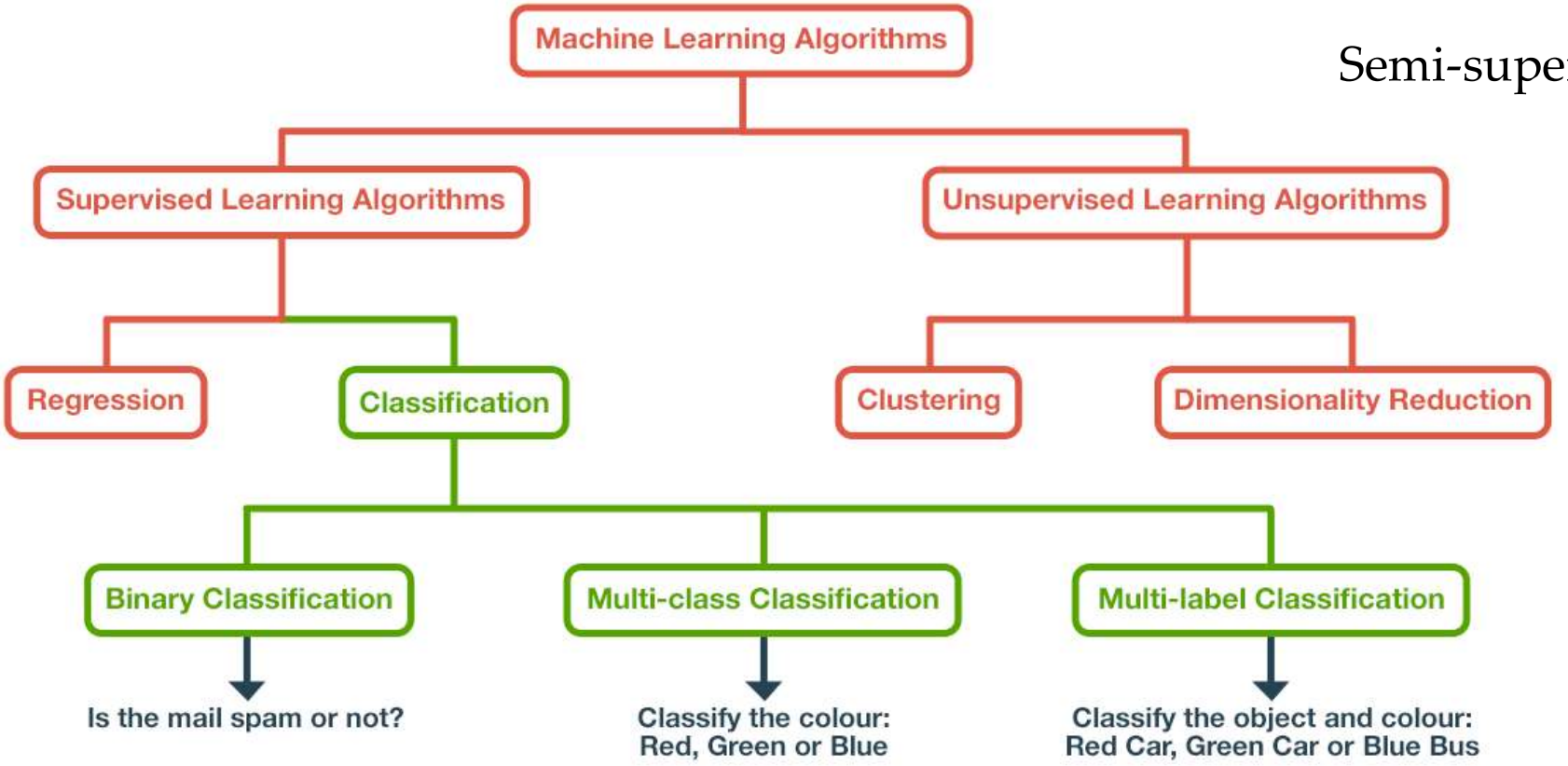
- Model **conversion**
- **Performance** optimization
- **Energy-aware** optimizations
- **Security** and **privacy**
- **Inference** serving APIs
- **On-device** fine-tuning

Product Analytics

- **Dashboards**
- Field data **evaluation**
- **Value-added** for business
- Opportunities for **advancement** and **improvements**

Classification of ML Algorithms

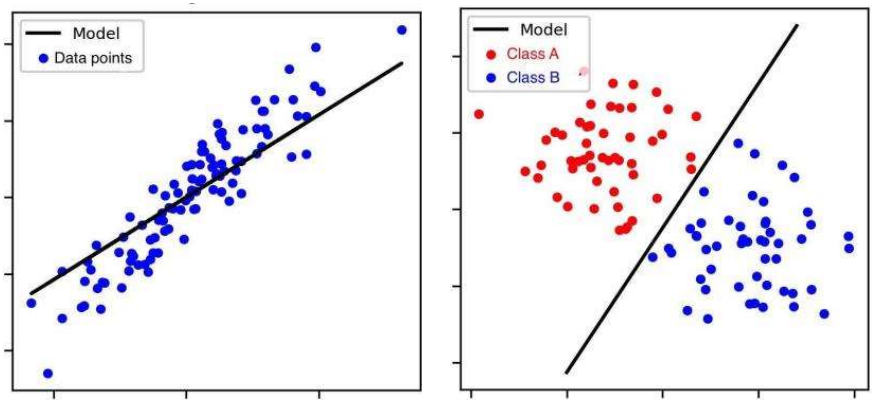
Embedded ML



Semi-supervised

Supervised Machine Learning

2 types of problems it tries to solve:



Regression

- predict numerical (continuous) value
- Linear, Nonlinear Regression

Classification:

- predict categorical (discrete) value
- Naive Bayes Classifier, Support Vector Machines, Logistic Regression, ...

Decision Tree, Random Forest, k-NN, Neural Networks, etc...can solve both problems

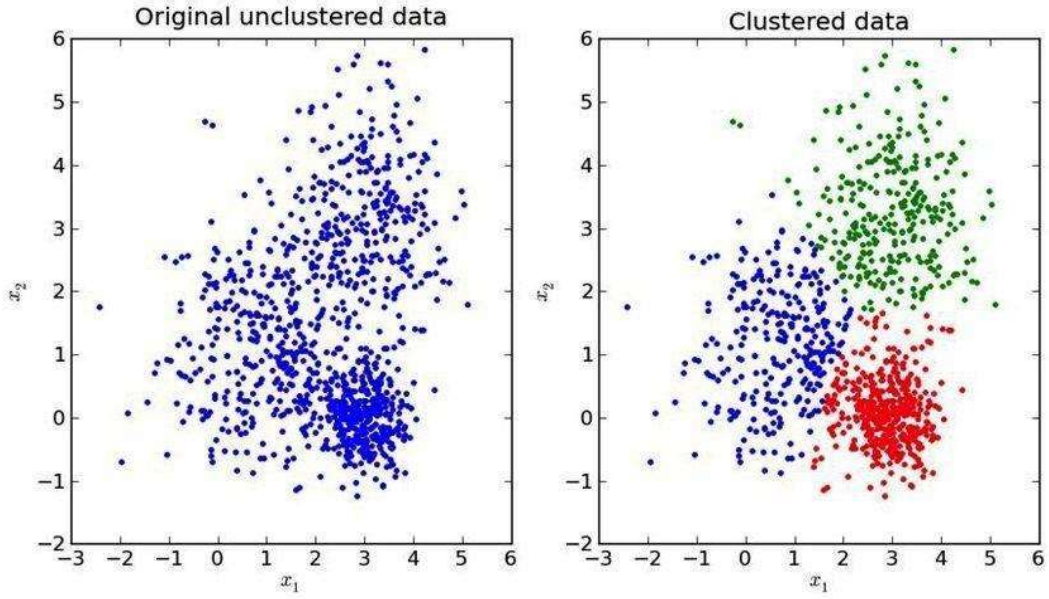
Unsupervised Machine Learning

Embedded ML

Training data: Unlabeled data

Training:

- extract features and patterns from data itself
- clustering: these features used to label and classify the data into clusters



k-Means clustering, ...