Supervised Learning

Methods

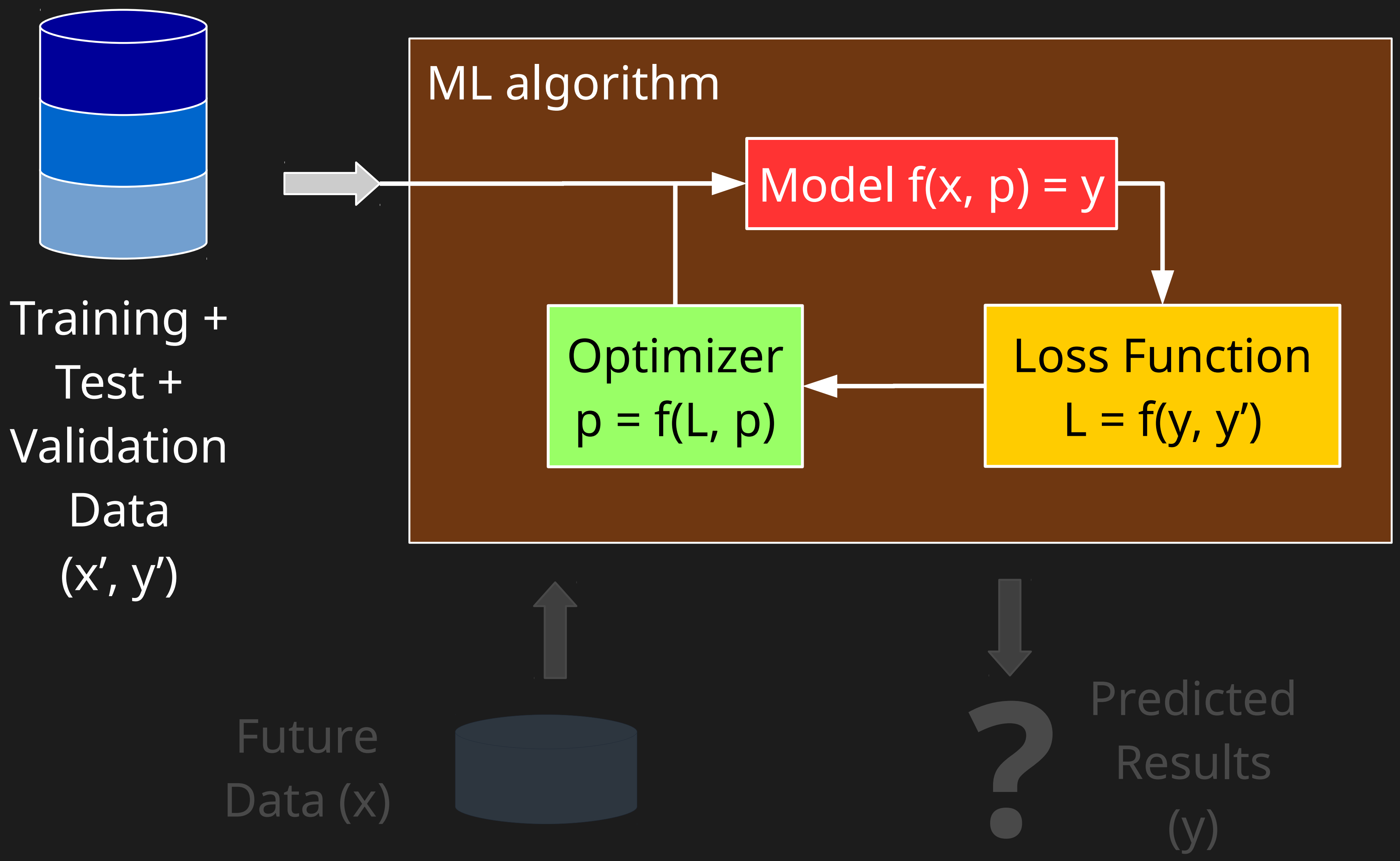
Reminder: Data: Nomenclature

Examples

	Features (input variables)						Targets/Labels (output variables)	
	Weight	Height	Exterior	Wings?	Lika-bility	N_{legs}	Pet?	Type
	0.1	0.1	feath.	true	1	2	true	bird
	3.5	0.3	fur	false	1	4	true	cat
	12.0	0.7	fur	false	1	4	true	dog
	500	1.8	skin	false	2	4	false	rhinoceros
	800	3.0	fur	true	3	4	false	chimera
	2.5	0.5	fur	false	1	4	true	cat
	...	...	...	...	...	...	...	...
Data Type:	continuous	continuous	categorical	binary	ordinal	integer	binary	categorical (multi-class)

classes of label "Type"

Reminder: Learning Stage



Training +
Test +
Validation
Data
(x’, y’)

ML algorithm

Model f(x, p) = y

Optimizer
p = f(L, p)

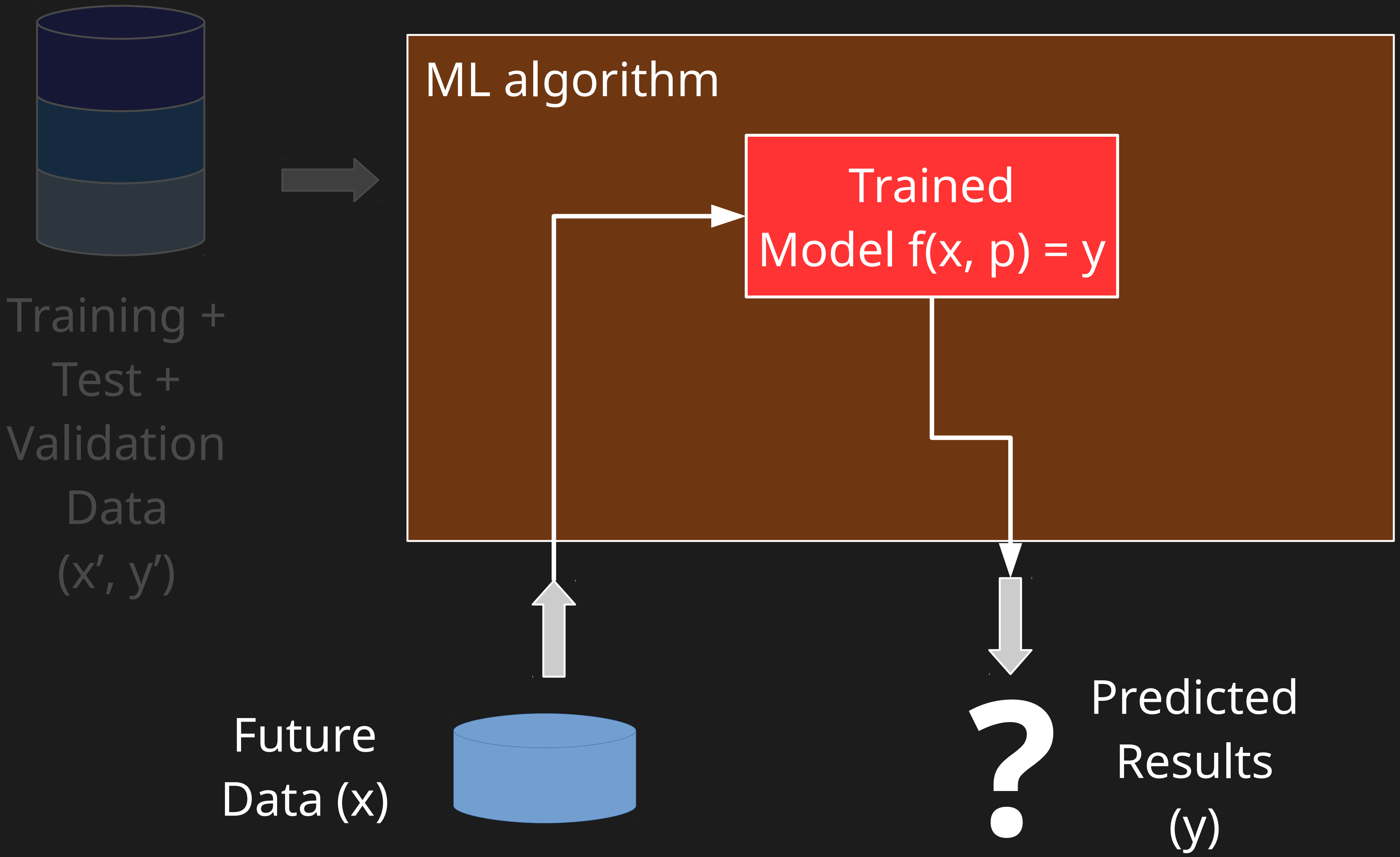
Loss Function
L = f(y, y’)

Future
Data (x)

?

Predicted
Results
(y)

Reminder: Prediction Stage



Training + Test + Validation Data (x′, y′)

ML algorithm

Trained Model f(x, p) = y

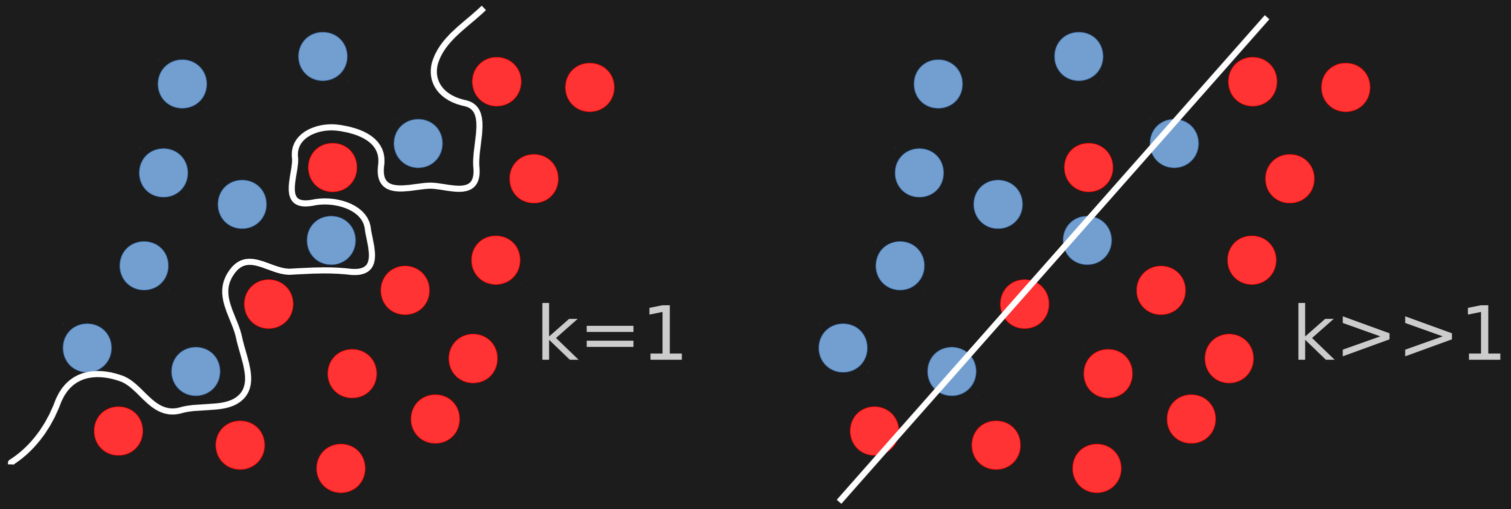
Future Data (x)

?

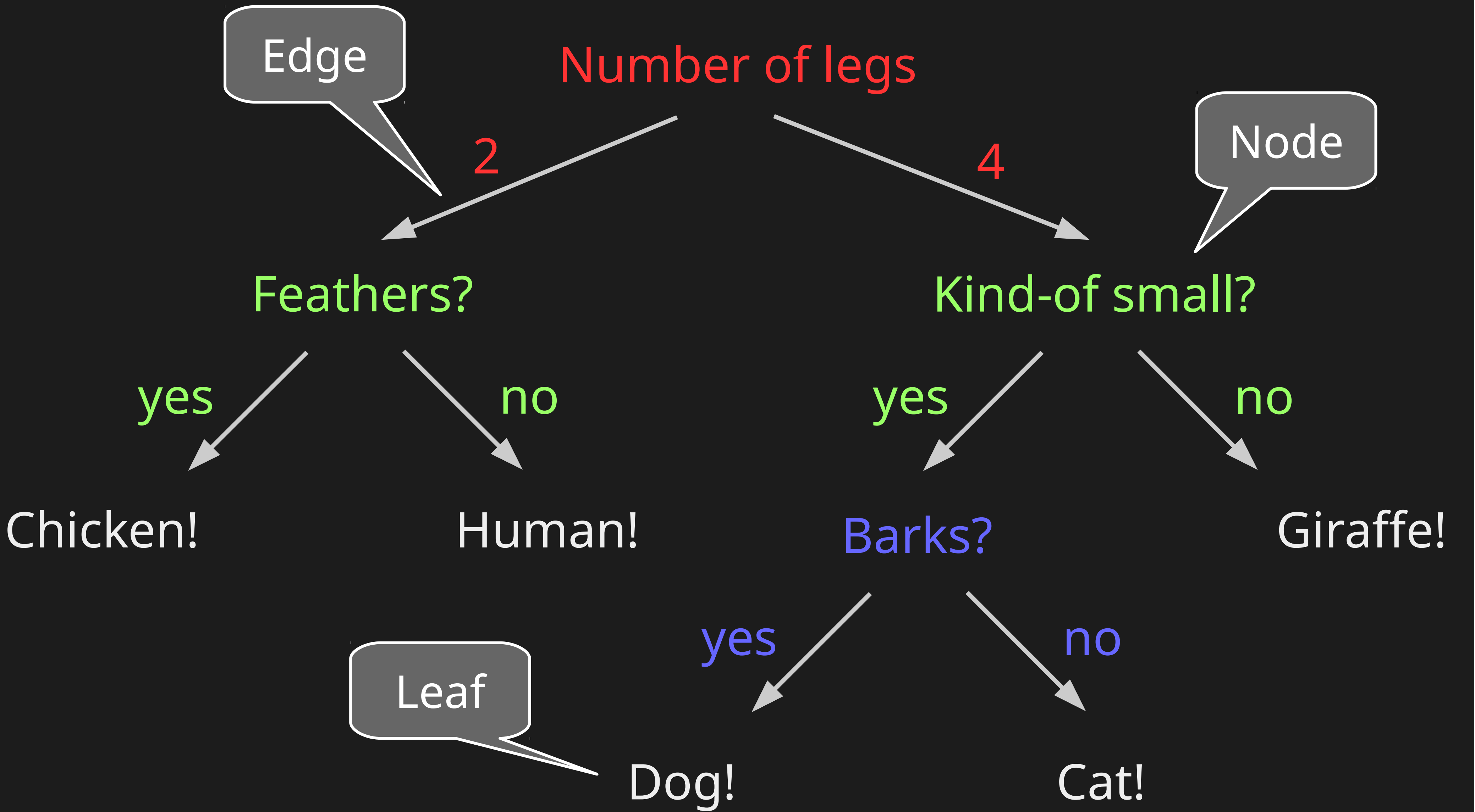
Predicted Results (y)

k Nearest Neighbors

- Non-parametric classifier/regressor
- Classification: output is class affiliation based on class majority among k nearest neighbors
- Regression: output is mean value of k nearest neighbors
- Hyperparameter k controls regularization



Decision Trees



Edge

Number of legs

Node

2

4

Feathers?

Kind-of small?

yes

no

yes

no

Chicken!

Human!

Barks?

Giraffe!

yes

no

Leaf

Dog!

Cat!

Decision Trees

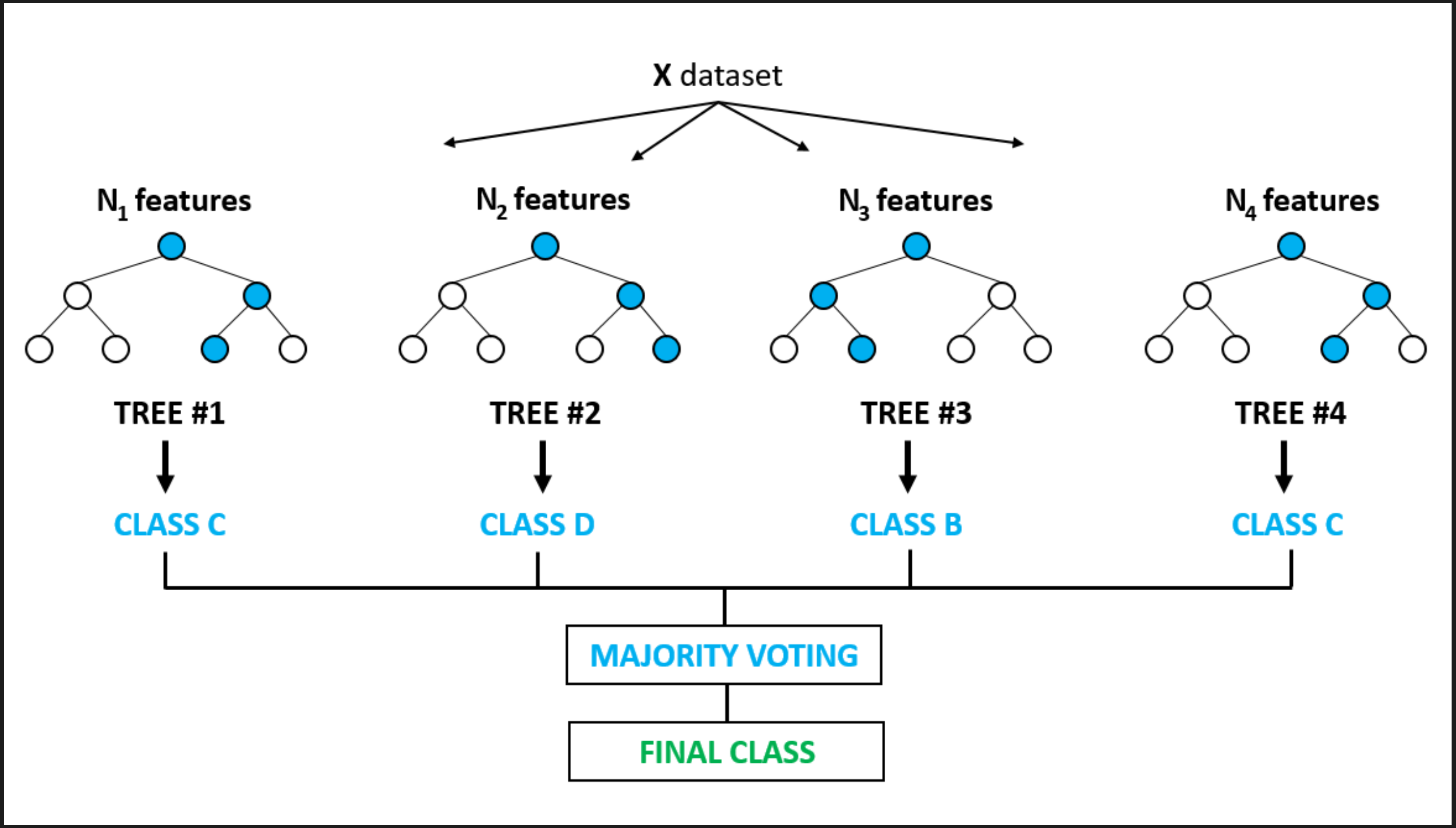
- Non-parametric model for classification and regression
- Hyperparameters (Complexity/Regularization):
  - maximum depth
  - maximum number of features
  - minimum number of samples for split
  - minimum number of samples for leaf
- Great interpretability but unlikely to generalize well

Ensemble Models

- Combine the results from different models to compensate for shortcomings
- Final results through averaging, weighted averaging, or majority vote
- Individual models are “weak models” with low complexity

Random Forest

- Combination of N decision trees
- Good generalization by keeping depths and number of features low



The Fancy Stuff: Gradient-Boosted Tree-based Models

- Build individual trees in a random forest such that THEIR SUM minimizes the loss function
- Models like xgboost or lightGBM – if tuned properly – can perform as well as deep learning models
- Python implementations for both models have sklearn interfaces – you can use them like all the other models we used