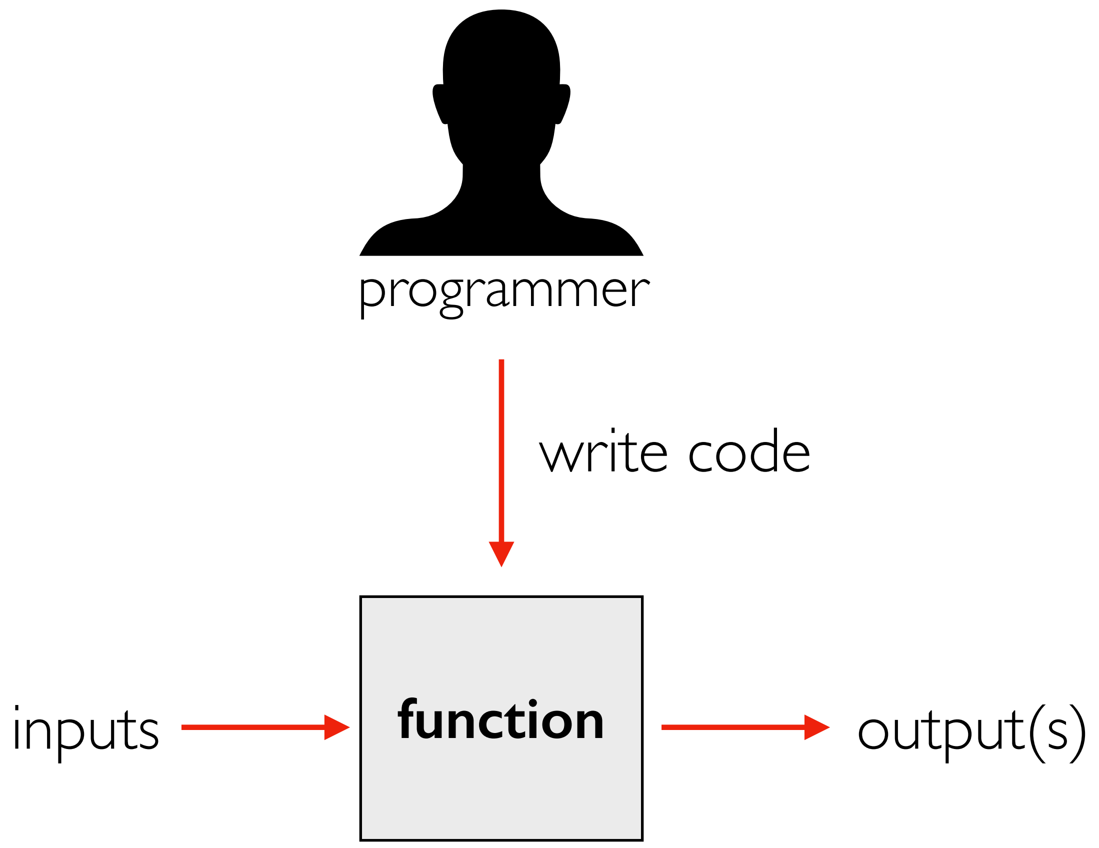
[320] Pre-Machine Learning: Intro

Tyler Caraza-Harter

Functions/Models

How do we make functions?



programmer

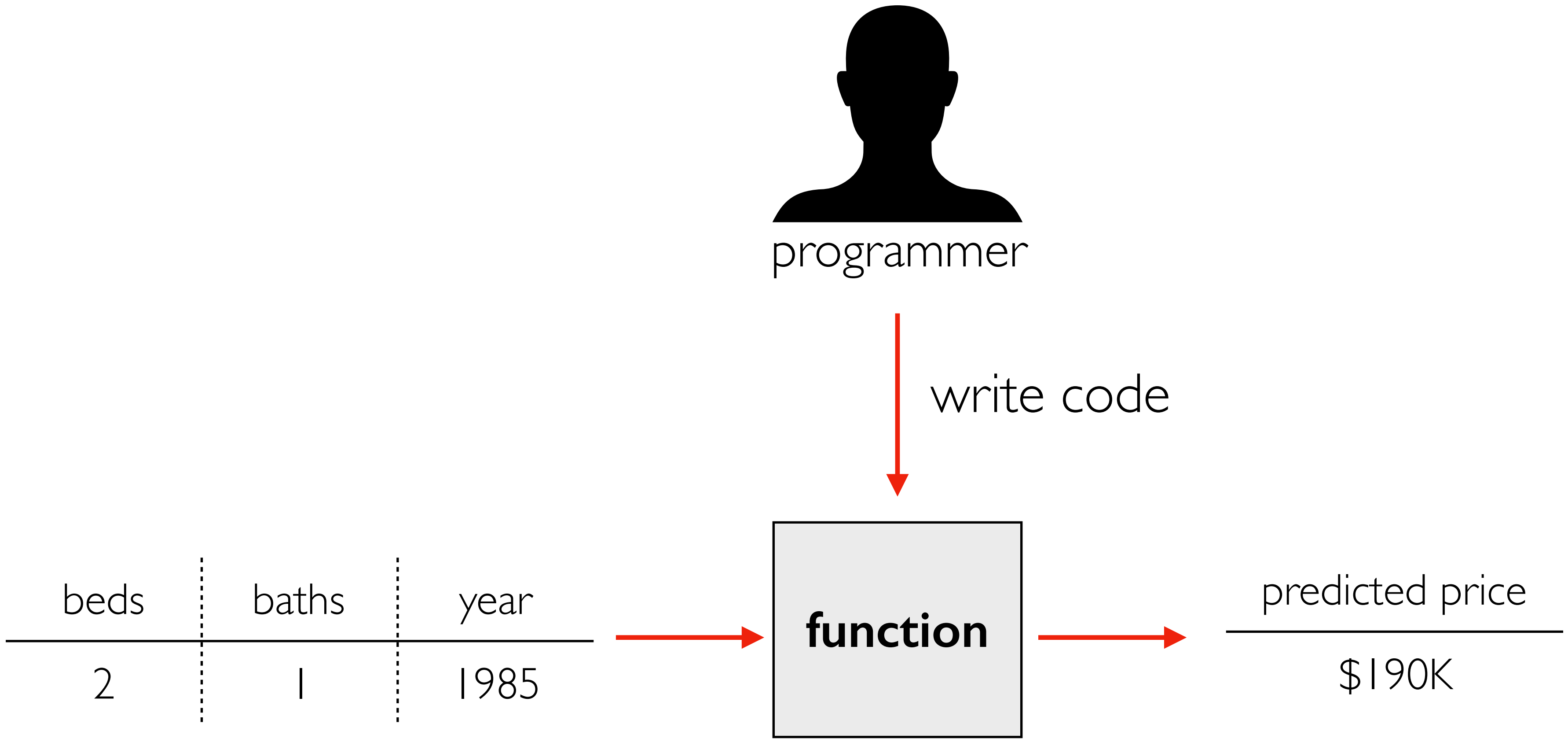
write code

inputs

function

output(s)

How do we make functions?



programmer

write code

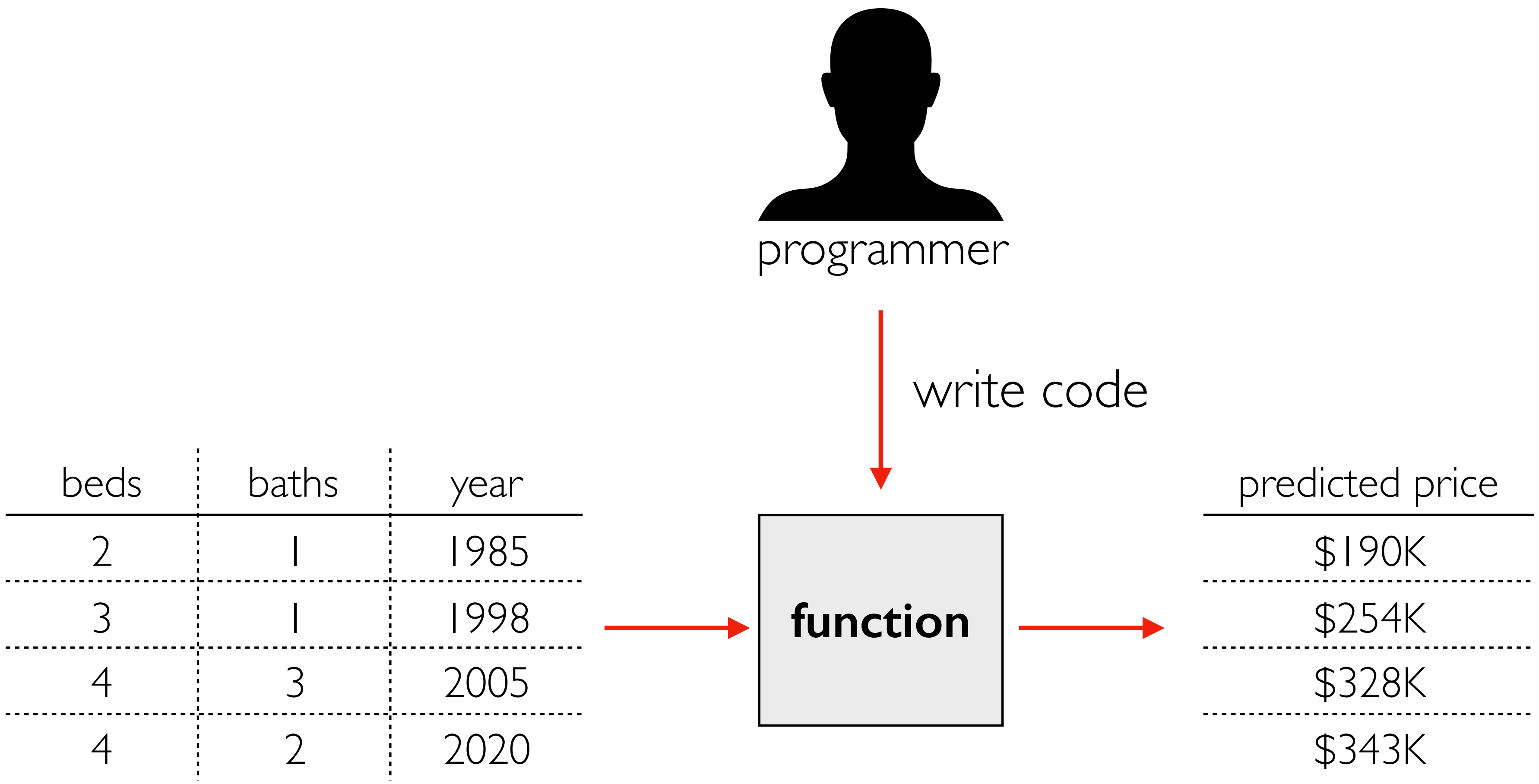
beds	baths	year
2	1	1985

function

predicted price
$190K

many functions are **models** that can be used to predict

How do we make functions?



programmer

write code

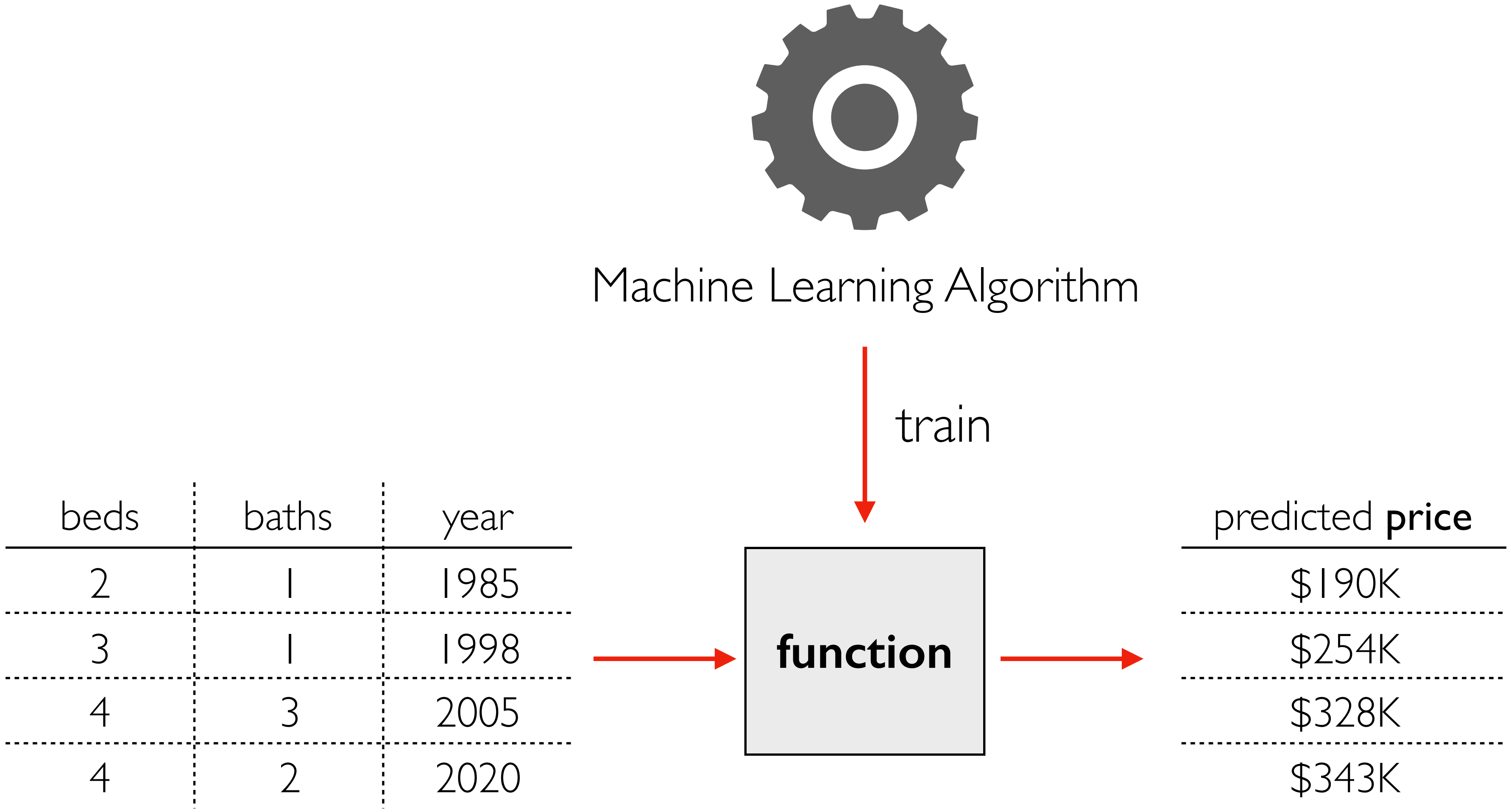
beds	baths	year
2	1	1985
3	1	1998
4	3	2005
4	2	2020

function

predicted price
$190K
$254K
$328K
$343K

many functions are **models** that can be used to predict

How do we make functions?



Machine Learning Algorithm

train

beds	baths	year
2	1	1985
3	1	1998
4	3	2005
4	2	2020

function

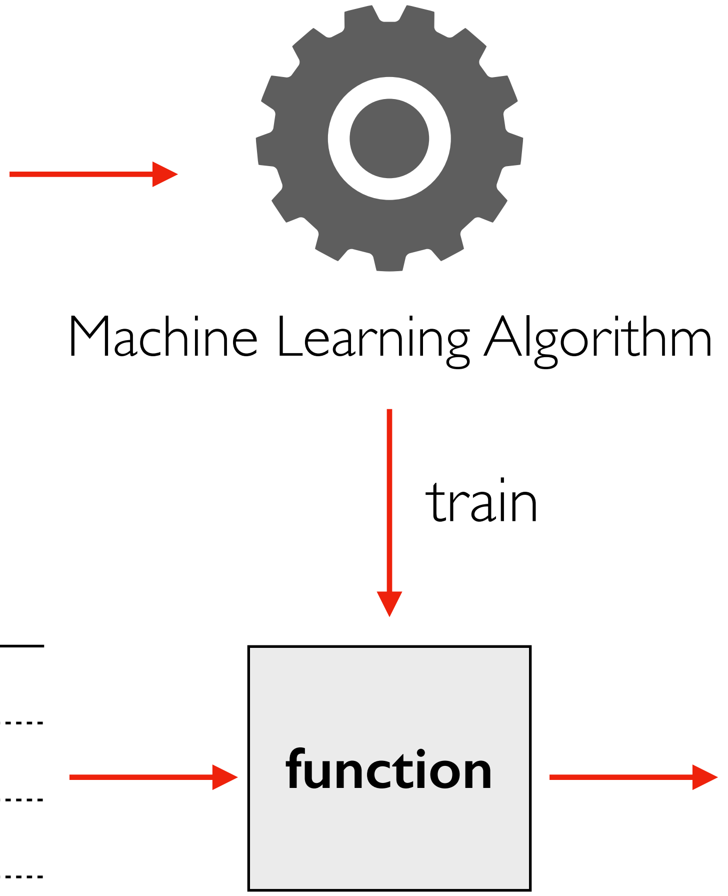
predicted **price**
$190K
$254K
$328K
$343K

many functions are **models** that can be used to predict

How do we make functions?

training data

beds	baths	year	**price**
1	1	1980	$140K
3	1	1990	$240K
3	4	2004	$295K
4	3	2018	$350K



Machine Learning Algorithm

train

function

live data

beds	baths	year
2	1	1985
3	1	1998
4	3	2005
4	2	2020

predicted **price**
$190K
$254K
$328K
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many functions are **models** that can be used to predict

Kinds of Machine Learning

Main Categories of Machine Learning

learning from data

1

Supervised Machine Learning

*data is **labeled**, we know what we want to predict*

2

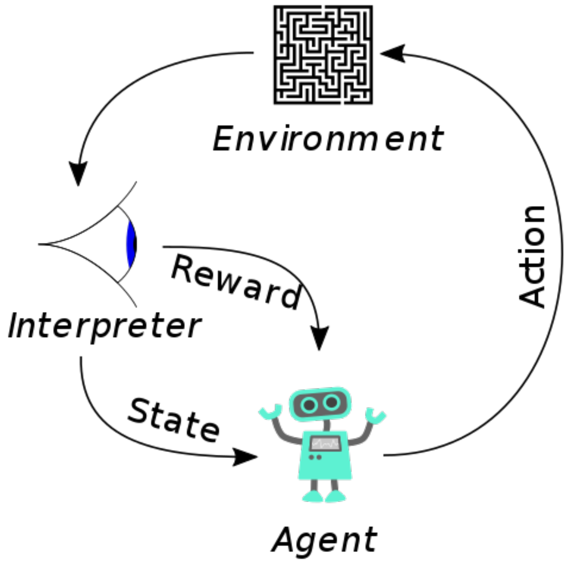
Unsupervised Machine Learning

*data is **unlabeled**, we're just looking for patterns*

3

Reinforcement Learning

not covered in CS 320



https://en.wikipedia.org/wiki/Reinforcement_learning

Main Categories of Machine Learning

learning from data

1 Supervised Machine Learning

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2 Unsupervised Machine Learning

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3 Reinforcement Learning

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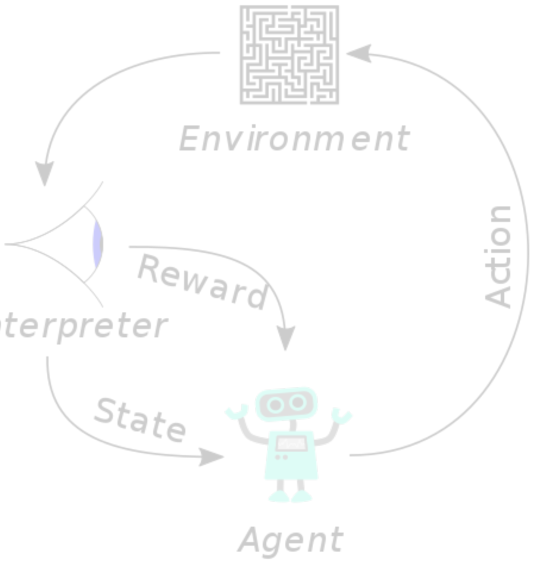

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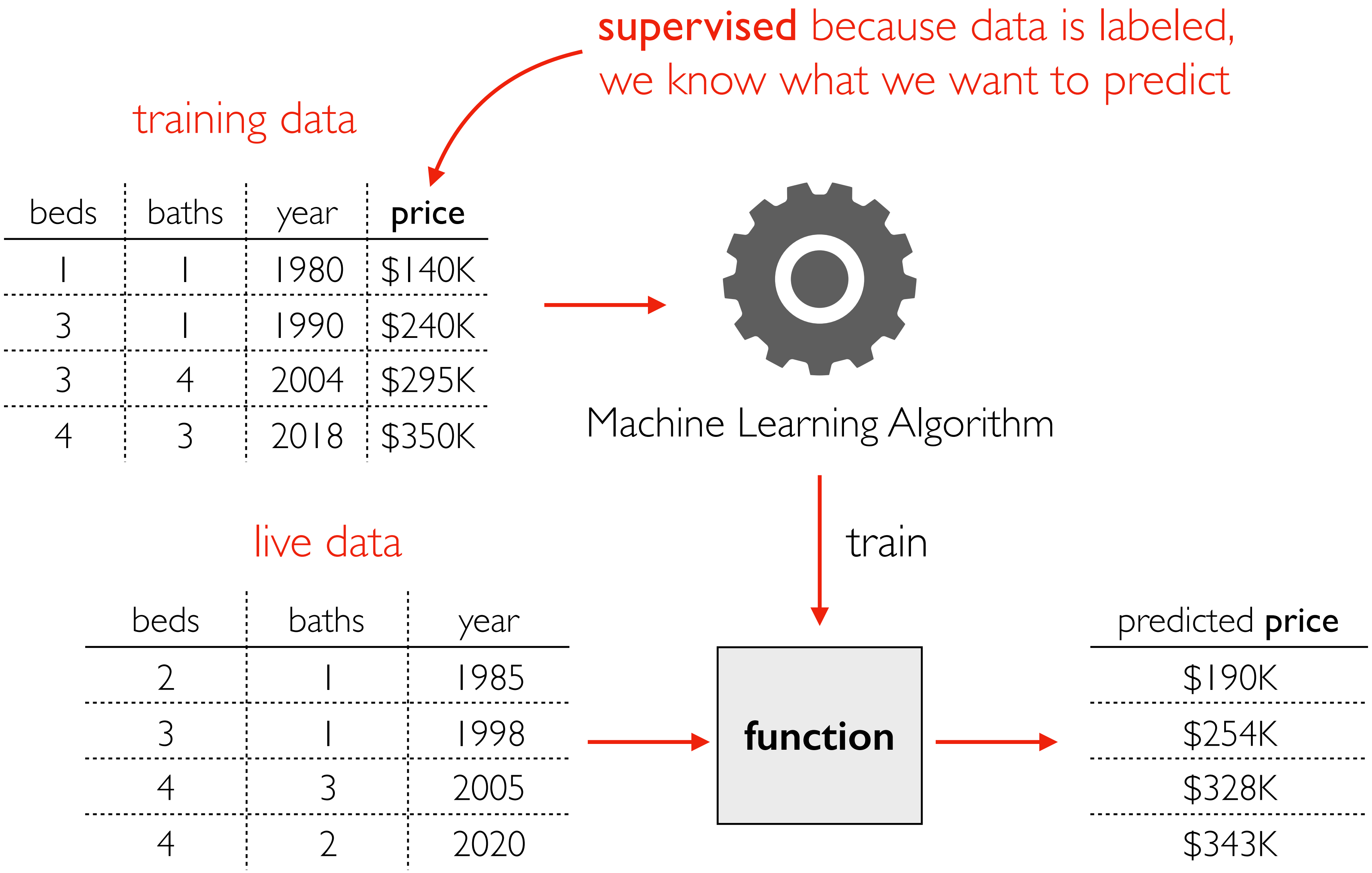
Supervised Learning



supervised because data is labeled, we know what we want to predict

training data

beds	baths	year	**price**
1	1	1980	$140K
3	1	1990	$240K
3	4	2004	$295K
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Machine Learning Algorithm

train

live data

beds	baths	year
2	1	1985
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function

predicted **price**
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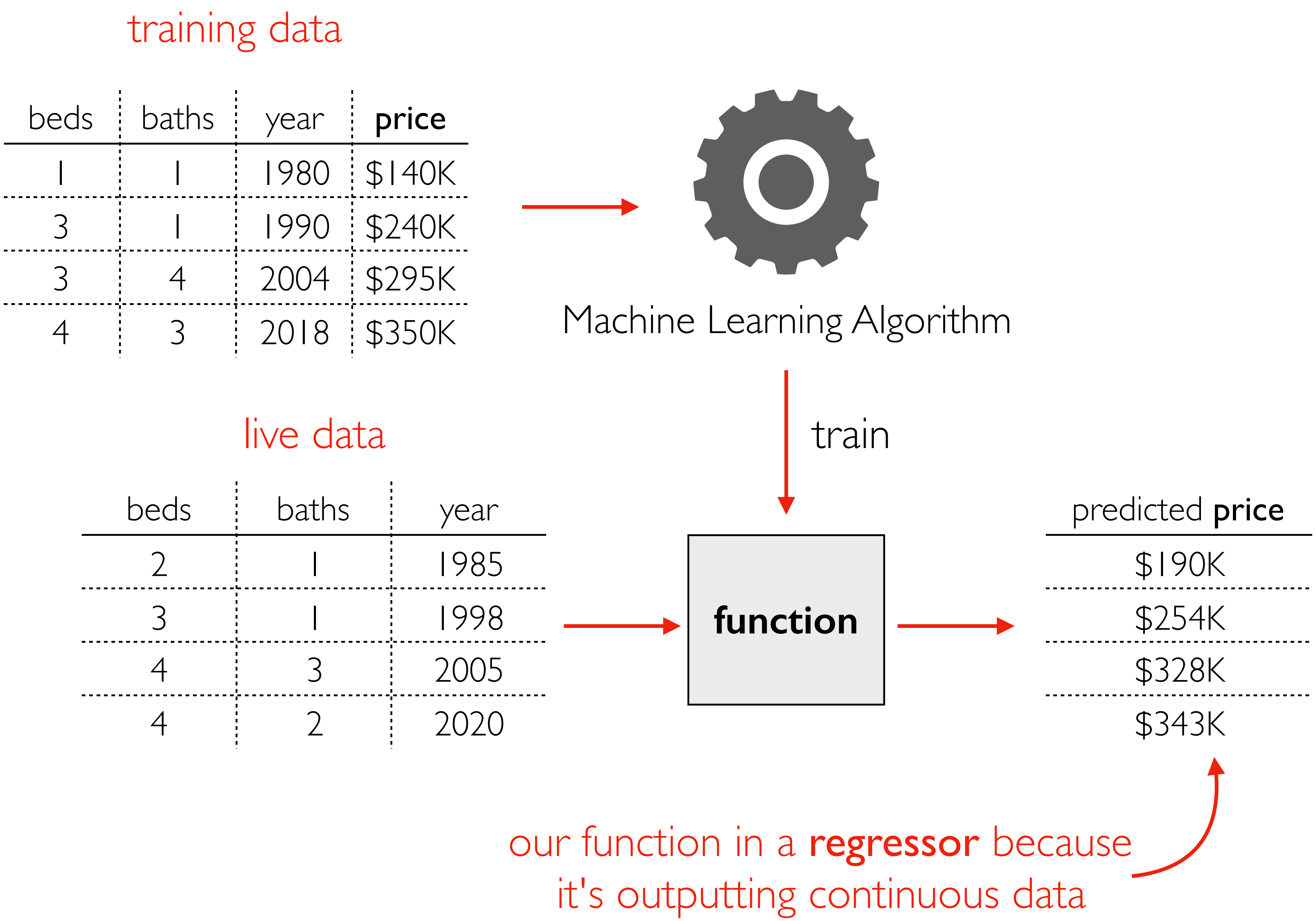
Supervised Learning: Regression



training data

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Machine Learning Algorithm

train

live data

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function

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our function in a **regressor** because
it's outputting continuous data

Supervised Learning: Classification

training data

photo	**label**
	dog
	dog
	cat

Machine Learning Algorithm

train

live data

photo

function

classification
dog
dog
cat

our function in a **classifier** because it's outputting distcrete data

https://en.wikipedia.org/wiki/Dog https://en.wikipedia.org/wiki/Cat

Main Categories of Machine Learning

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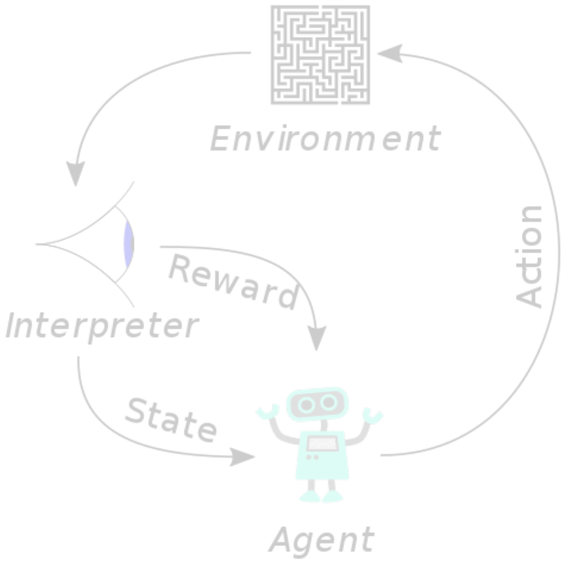

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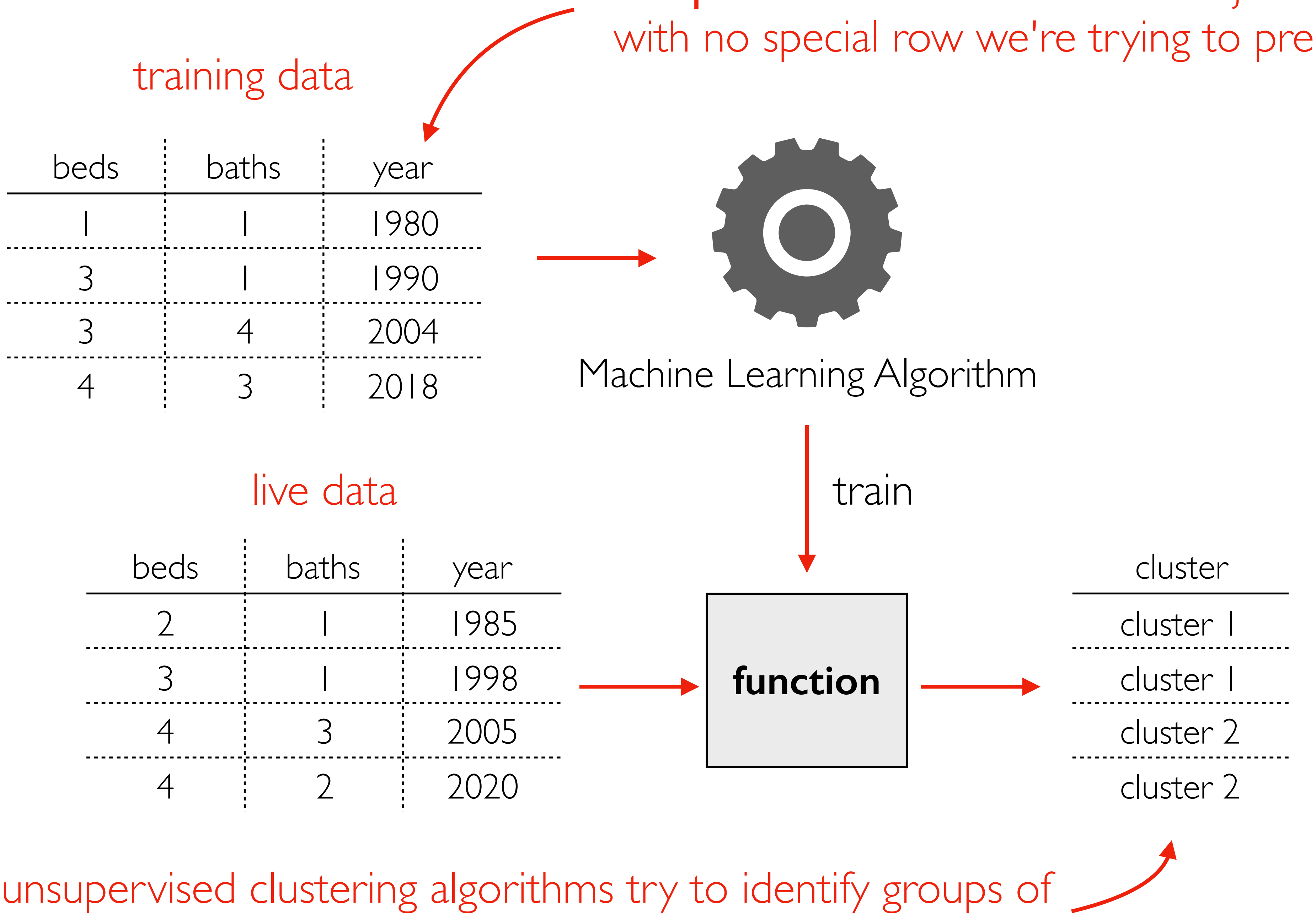
Unsupervised Learning



unsupervised because each row is just data, with no special row we're trying to predict

training data

beds	baths	year
1	1	1980
3	1	1990
3	4	2004
4	3	2018

Machine Learning Algorithm

train

live data

beds	baths	year
2	1	1985
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function

cluster
cluster 1
cluster 1
cluster 2
cluster 2

unsupervised clustering algorithms try to identify groups of similar data. The algorithm decides the groups.

Sometimes (but often not) they'll correspond to things we describe. E.g., cluster 1: old houses with few bathrooms; cluster 2: new houses with many bathrooms

Foundations

Important Packages

We'll be learning the following to do ML and related calculations efficiently:

1. numpy
2. pytorch
3. scikit-learn

```
pip3 install numpy torch torchvision scikit-learn
```

Linear Algebra

beds	baths	year
2	1	1985
3	1	1998
4	3	2005
4	2	2020

$$\longrightarrow \boxed{\textbf{function}} \longrightarrow$$

predicted **price**
$190K
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with matrices...

$$\begin{bmatrix} 2 & 1 & 1985 \\ 3 & 1 & 1998 \\ 4 & 3 & 2005 \\ 4 & 2 & 2020 \end{bmatrix} \longrightarrow \boxed{\mathbf{y = Ax + b}} \longrightarrow \begin{bmatrix} 190000 \\ 254000 \\ 328000 \\ 343000 \end{bmatrix}$$

Linear Algebra

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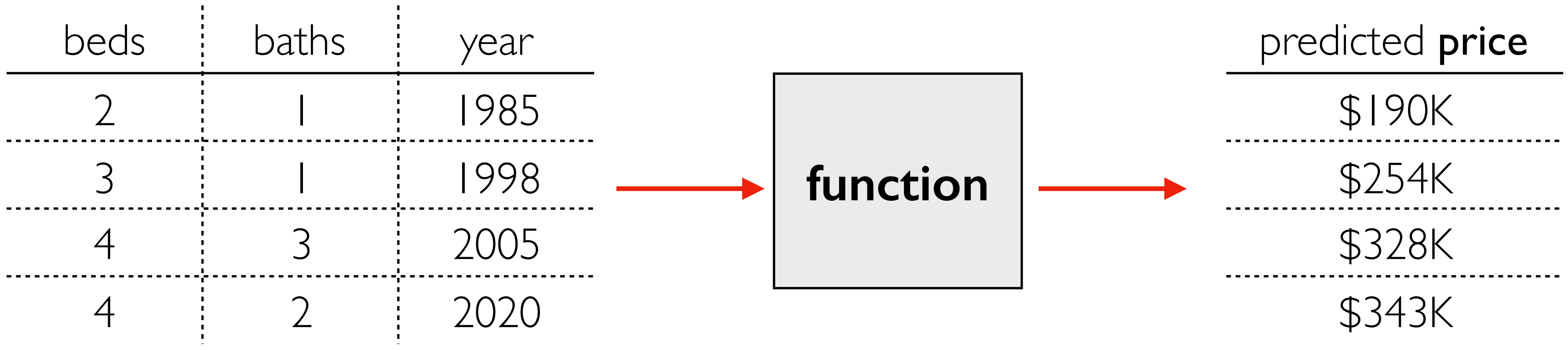
$$\boxed{\overset{A}{\begin{bmatrix} 2 & 1 & 1985 \\ 3 & 1 & 1998 \\ 4 & 3 & 2005 \\ 4 & 2 & 2020 \end{bmatrix}} \underset{\text{dot product}}{\cdot} \overset{x}{\begin{bmatrix} 41.46 \\ 10.36 \\ 1.70 \end{bmatrix}} + \overset{b}{-3292.31}}$$

Linear Algebra



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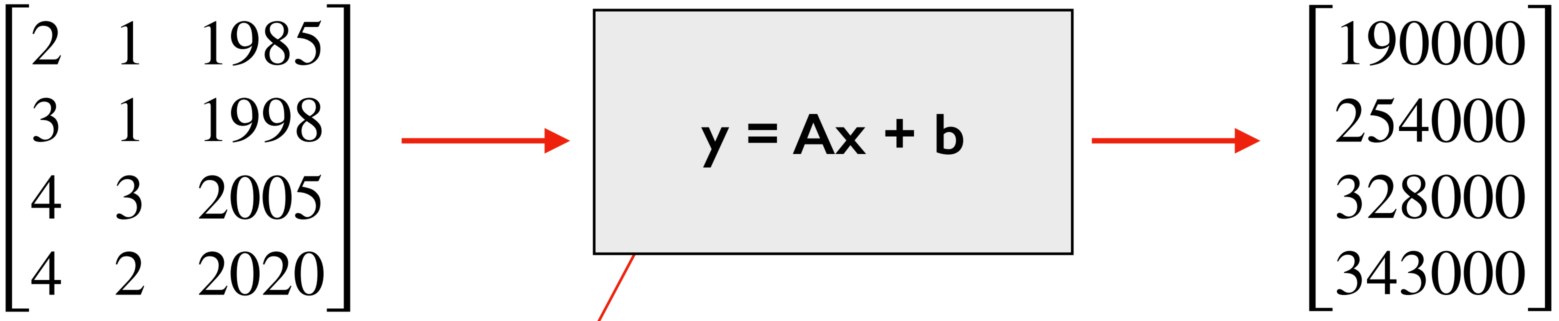
with matrices...



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dot product

```
import numpy as np
A = df.values
y = np.dot(A, x) + b
```

Linear Algebra

```
y = x ** 2
```

not linear

```
y = 3*x0 + -2*x1 + 0.5*x2 + ... + 10*x49
```

linear

with matrices...

$$\begin{bmatrix}2 & 1 & 1985\\ 3 & 1 & 1998\\ 4 & 3 & 2005\\ 4 & 2 & 2020\end{bmatrix} \longrightarrow \boxed{\mathbf{y = Ax + b}} \longrightarrow \begin{bmatrix}190000\\ 254000\\ 328000\\ 343000\end{bmatrix}$$

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dot product

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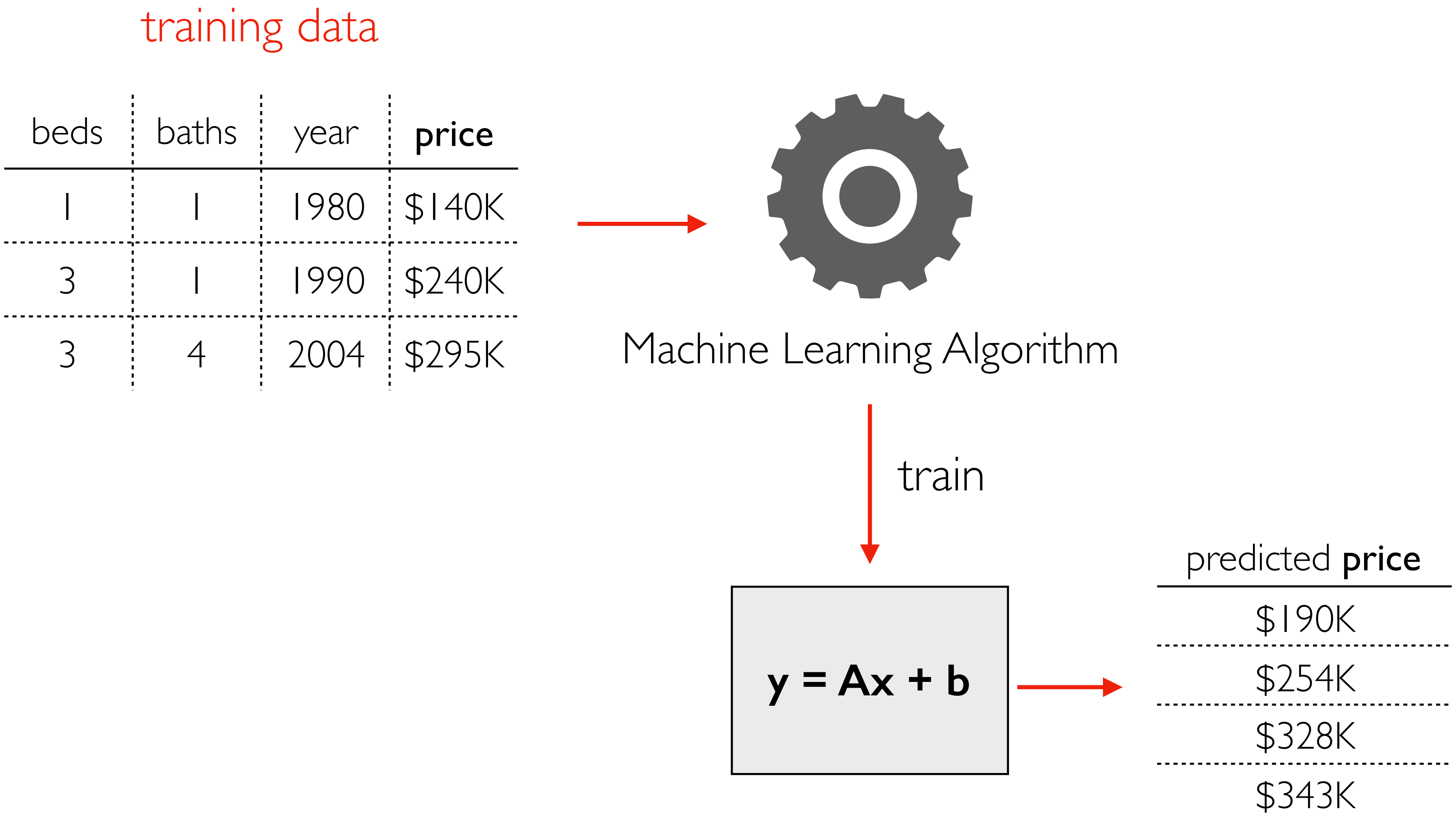
Calculus



training data

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Machine Learning Algorithm

train

y = Ax + b

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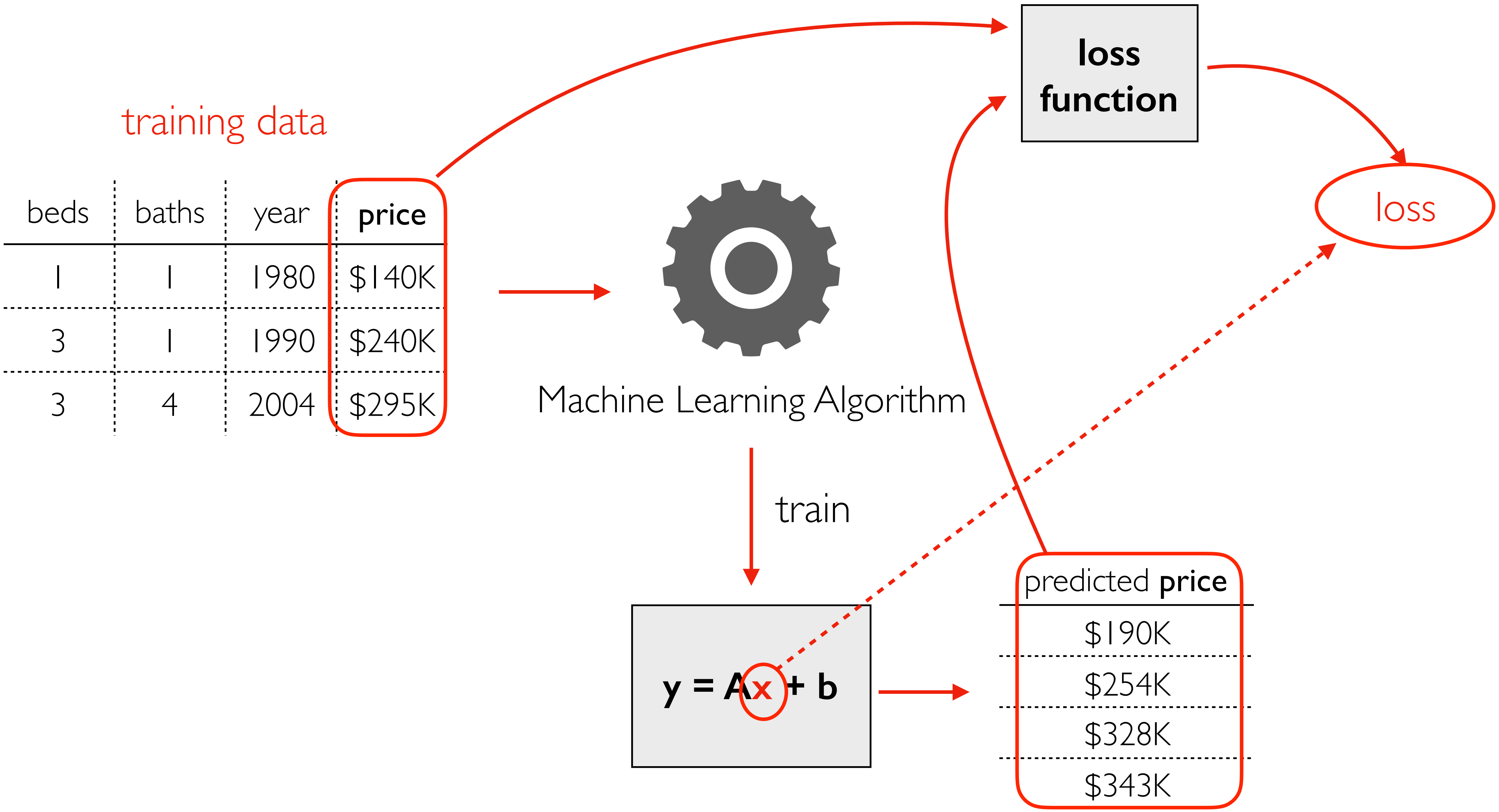
Calculus



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how we we optimize **x** to minimize **loss**?
Important concepts: derivative, gradient

Parallelism

Parallelism

- doing multiple things at the same time
- requires multiple cores

GPUs (graphics processing units)

- graphics involves many of the same operation
- better to have many weaker cores working at once than fewer faster cores
- modern GPUs may have 1000s of cores (in contrast to 10s for CPUs)

Scientific Computing

- GPUs can greatly speed up key ML operations
  - multiplying matricies
  - computing gradients
- We'll learn `pytorch` for this...

Practioners

Conclusion: Our focus

training data

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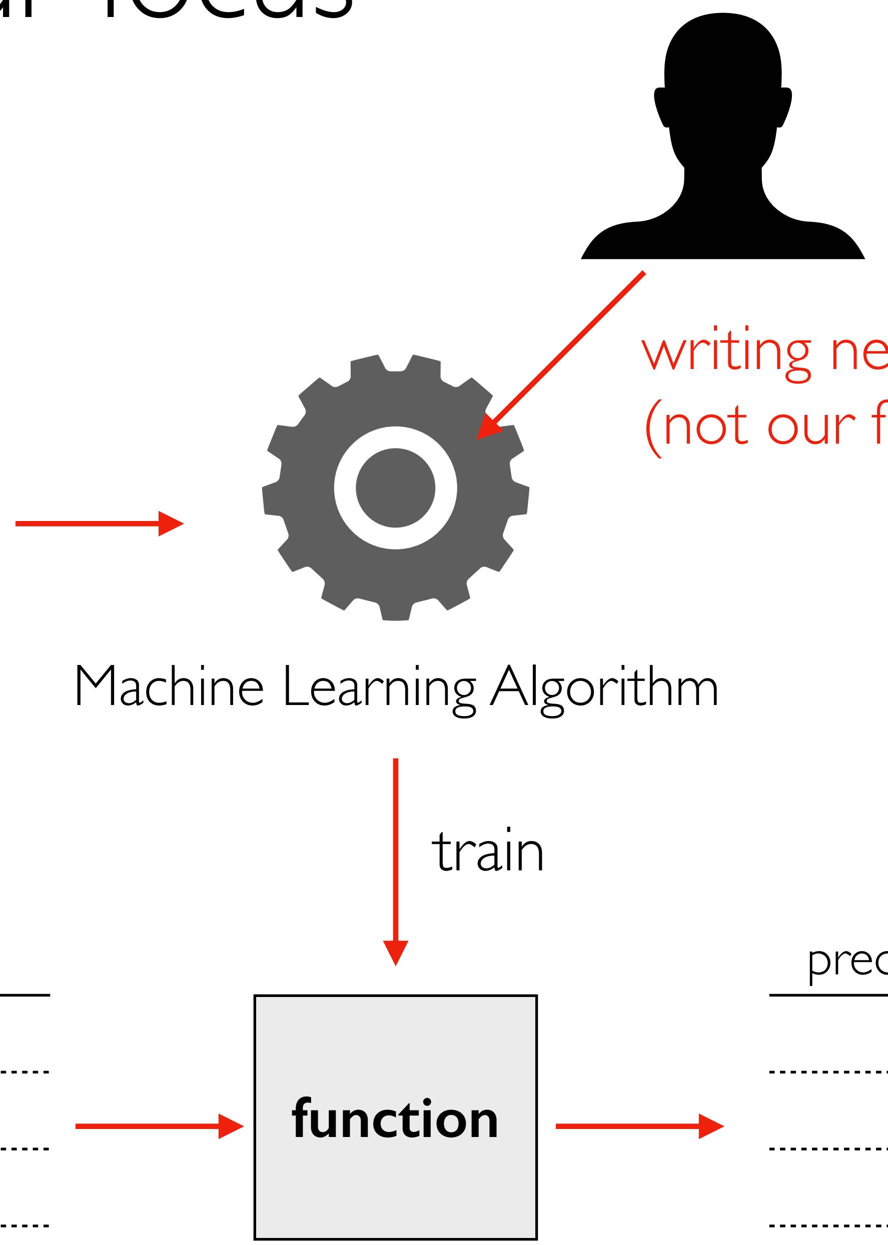

writing new algorithms (not our focus)

Machine Learning Algorithm

train

function

live data

beds	baths	year
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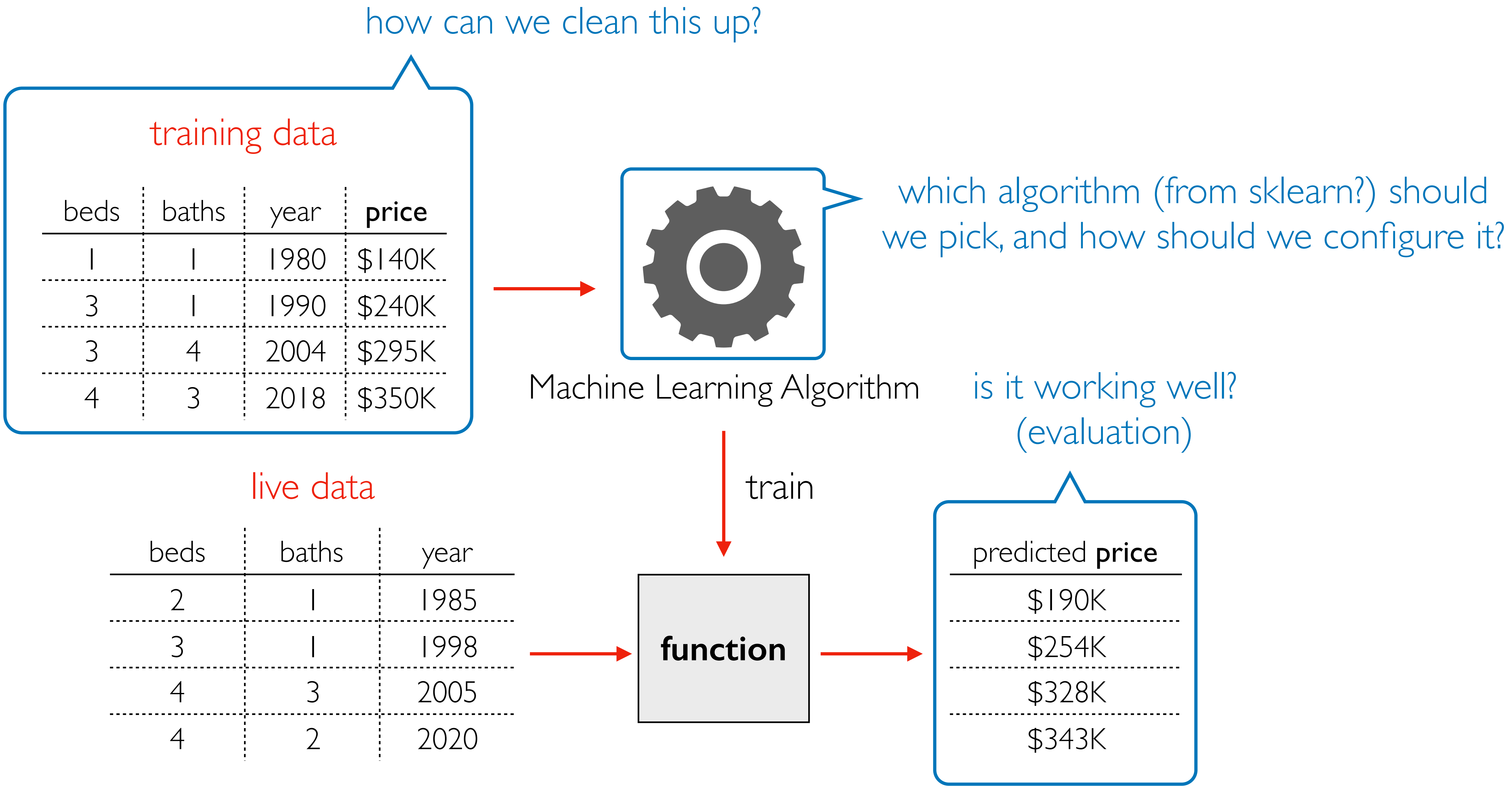
many functions are **models** that can be used to predict

Conclusion: Our focus



how can we clean this up?

training data

beds	baths	year	**price**
1	1	1980	$140K
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4	3	2018	$350K

Machine Learning Algorithm

which algorithm (from sklearn?) should we pick, and how should we configure it?

train

live data

beds	baths	year
2	1	1985
3	1	1998
4	3	2005
4	2	2020

function

is it working well? (evaluation)

predicted **price**
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many functions are **models** that can be used to predict