

Machine Learning

Big Idea #3

Classifier



A **classifier's** job is to sort things into categories



Spam Filters:
Spam, or
not-spam?



Loan Applications:
Low risk, Mid-risk,
High-risk

The screenshot shows a Facebook news feed for a user named Ofra Lior. The feed includes a post from Wix advertising website creation services. Other posts visible include one from Hamon VD about Natural Relief Slippers, and another from onlineshoppingnow.com about improving websites.

Ad or movie recommender:
Sports fan? Romantic?
Horror fan? History buff?

Training a Classifier



A **classifier's** job is to sort things into categories

How it Works:

Our Role:

We choose the categories & provide examples of each one.

Algorithms:

We let the machine learning algorithm figure out how to classify the examples the way we wanted them classified. Then we can test it on new data.

One machine learning method that can be used to do the classification is called a **decision tree**.



Decision tree - a collection of nested if-then statements that classify data.

Machine Learning

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to

- automatically learn
- improve its performance on a task
- without being explicitly told how to do that task

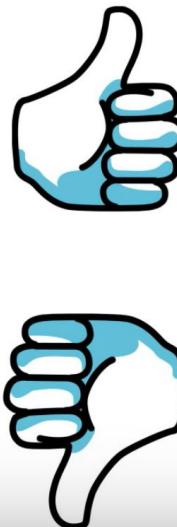
Machine learning focuses on the development of computer programs that can access data and use it learn for themselves.

Machine learning algorithms

- There are many different machine learning algorithms.
- Some algorithms construct representations using trees or graphs. For example, there are algorithms that learn decision trees.
- Some algorithms work purely by statistics making small changes to numbers to improve the performance of the model.
 - Neural network learning algorithms fall into this category.
 - The numbers in a neural network are called “weights” and “activations”.
- Many recent advances in AI have come about because computers became powerful enough to train really large neural networks using lots of data.

Characteristics used in classifying musical preferences

SUPPOSE PAUL IS LISTENING TO SONGS...

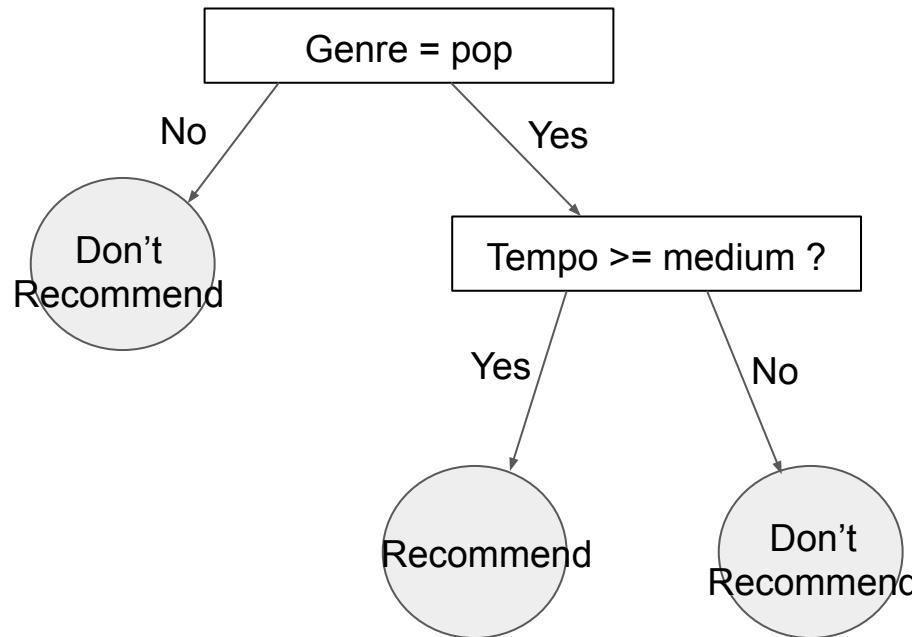


- TEMPO
- GENRE
- INTENSITY
- GENDER OF VOICE



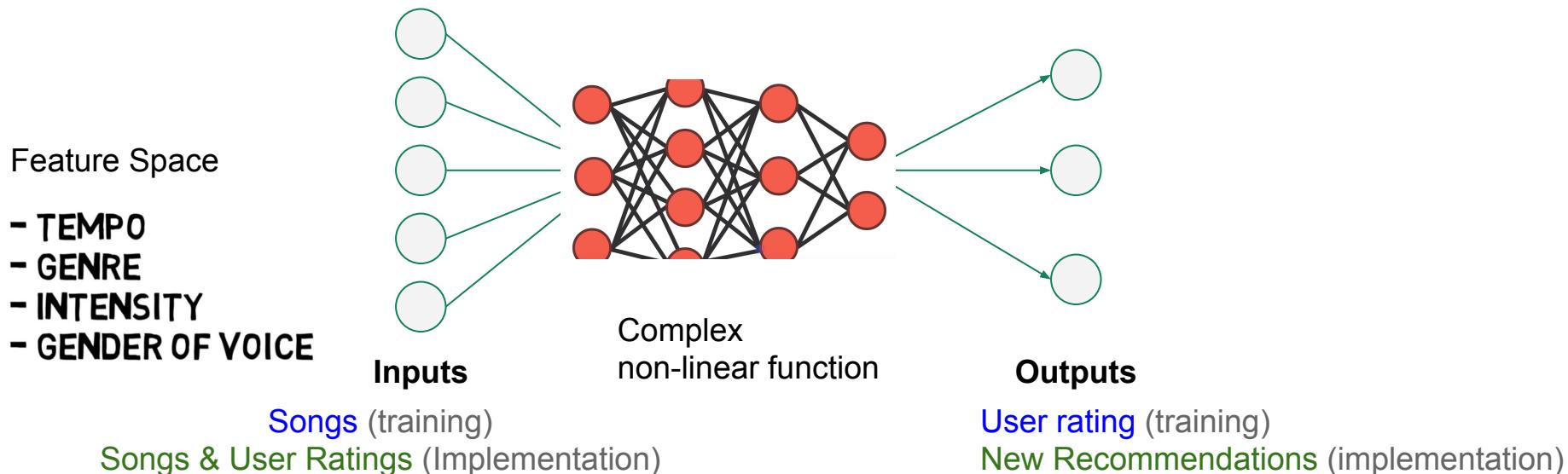
[How Machine Learning Works: An Explanation](#)

Decision tree classifier: musical preferences



How Neural Networks work

The machine learning algorithms used in neural networks are **functions** that map (transform) inputs to outputs.



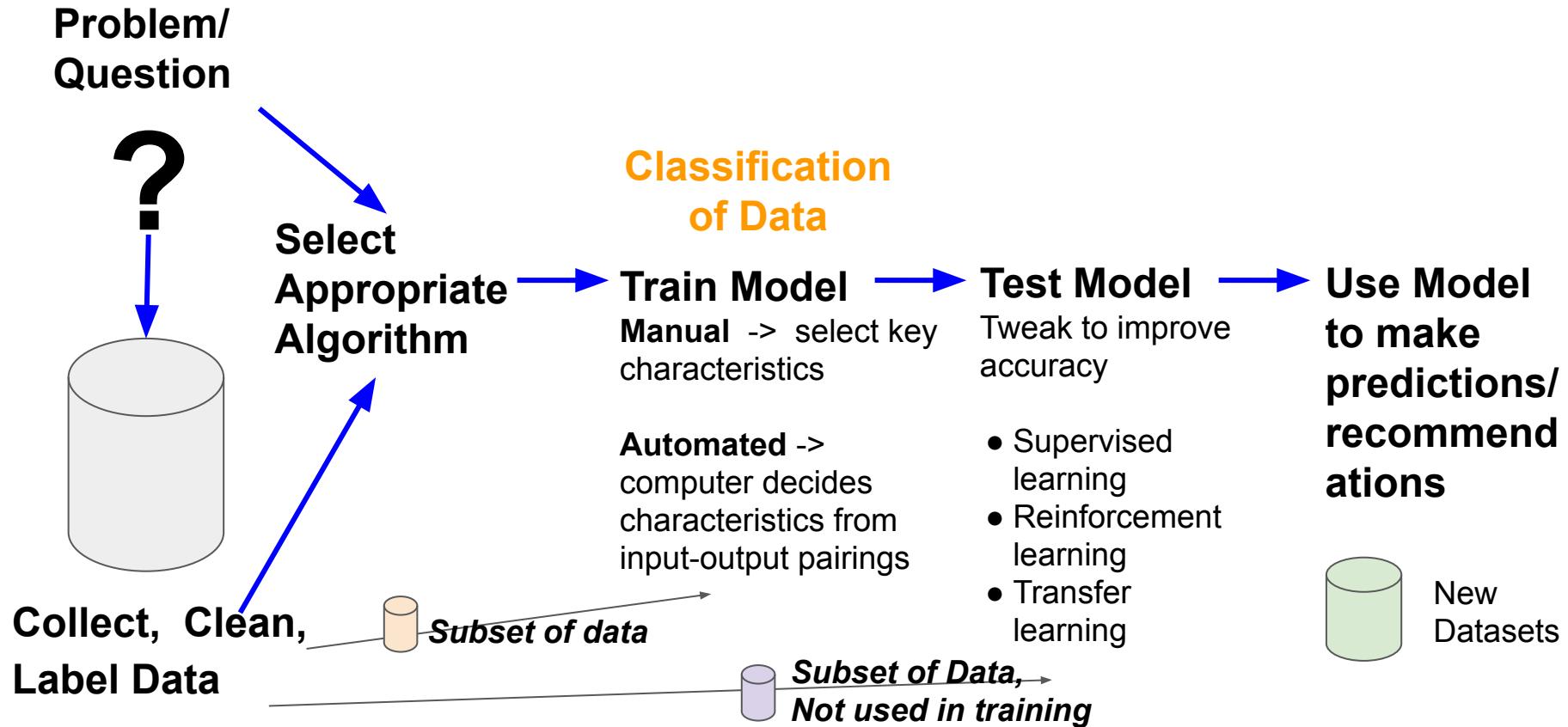
Learning is a process that adjusts the mapping to produce better results.

What do we mean by “machine learning”?

Machine learning algorithms may improve their performance on a task by:

- Accumulating experience as a “teacher”
corrects its mistakes. **(Supervised Learning)**
- Finding statistical structure in the data
it is presented with. **(Unsupervised Learning)**
- Trying to maximize a reward signal. **(Reinforcement Learning)**
- Using models trained from other data to
solve a new problem **(Transfer Learning)**

Machine Learning Process



Machine Learning for Kids

School Library Example

[Link to Supplemental Slides](#)



Machine Learning for Kids

<https://machinelearningforkids.co.uk>

Machine learning projects

These projects are downloadable step-by-step guides, with explanations and colour screenshots for students to follow.

Each project is a stand-alone activity, written to last for a single lesson, and will guide children to create a game or interactive project that demonstrates a real-world use of artificial intelligence and machine learning.

Suggestions for new worksheets, suggestions of improvements to any of the worksheets, or contributions of new project worksheets, are all very welcome.

All project types

All difficulties

All make types

Smart Classroom

Create a smart assistant in Scratch that lets you control virtual devices.

Teach a computer to recognise the meaning of your commands



Difficulty: Beginner

Recognising: text

Tags: digital assistants, supervised learning

[Download](#)

Make me happy

Create a character in Scratch that smiles if you say nice things to it and cries if you say mean things to it.

Teach a computer to recognise compliments and insults



Difficulty: Beginner

Recognising: text

Tags: sentiment analysis, supervised learning

[Download](#)

Snap!

Make a card game in Scratch that learns to recognise pictures of your card.

Teach a computer to recognise what icons look like



Difficulty: Beginner

Recognising: images

Tags: image classification, supervised learning

[Download](#)

Chameleon

Make a chameleon in Scratch that changes colour to match its background

Teach a computer to recognise colours



Difficulty: Beginner

Recognising: images

Tags: image classification, supervised learning

[Download](#)

Titanic

Create a Python program that can predict who survived the sinking of the Titanic.

Teach a computer to predict outcomes



Difficulty: Beginner

Recognising: numbers

Tags: predictive model, supervised learning

[Download](#)

Mailman Max

Make a postal sorting office in Scratch that can recognise handwritten postcodes on envelopes.

Teach a computer to recognise handwriting



Car or cup

Train the computer to be able to sort photos into groups.

Teach a computer to recognise pictures of objects



Face Lock

Make a phone in Scratch that unlocks if it recognises your face.

Teach a computer to recognise faces



Journey to school

Train the computer to be able to predict how you travel to school in the morning.

Teach a computer to make predictions



Shy Panda

Make a dancing panda that gets shy and stops dancing if it sees you looking.

Teach a computer to recognise pictures





Machine Learning for Kids

- 1 Collect examples of things you want to be able to recognise
- 2 Use the examples to train a computer to be able to recognise them
- 3 Make a game in Scratch that uses the computer's ability to recognise them



Image



SCRATCH



Excited



number





Activity

School Library

Create a school librarian in Scratch that suggests who a reading book might be suitable for.

Teach a computer to make recommendations

Difficulty: Intermediate



Tags: predictive model, recommendations, supervised learning



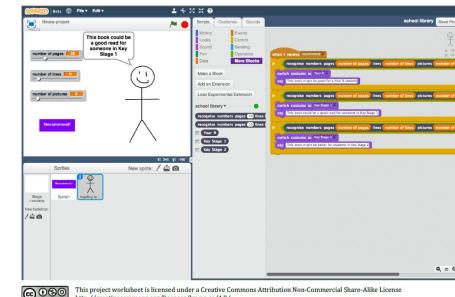
[Download](#)

School Library

In this project you will make a school librarian character that can make reading book recommendations.

If you describe a book to it, it will try to predict who that book might be suitable for.

You will teach the computer to recognise fiction books of different reading levels by giving it examples of each.



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Last updated: 1 February 2018

<https://machinelearningforkids.co.uk/#!/worksheets>

Help the Librarian

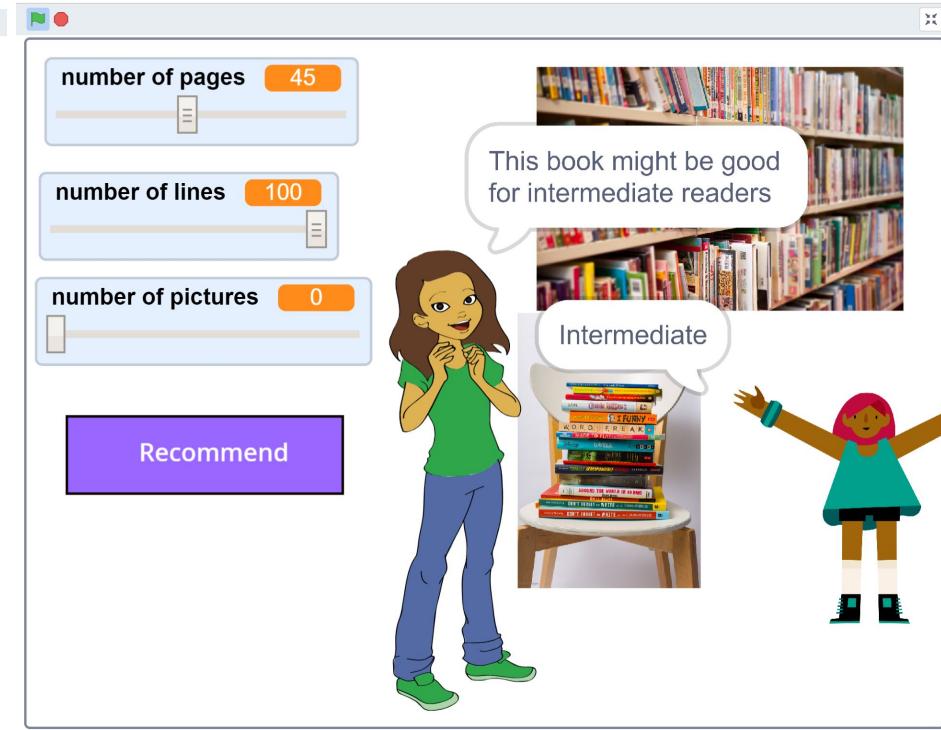
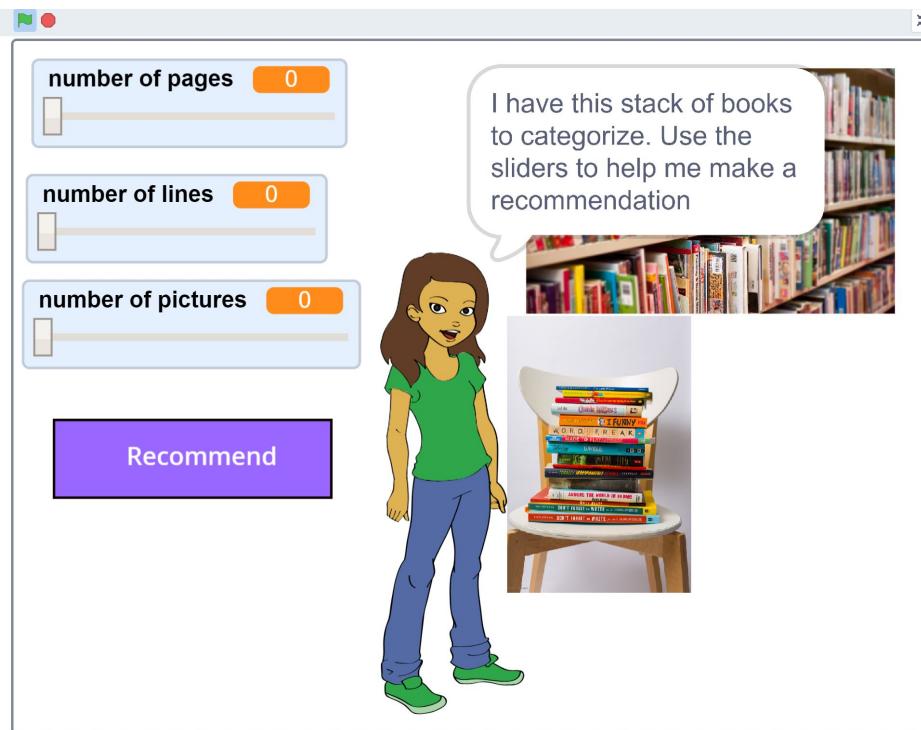
Our goal it to teach a computer to make recommendations that will help the school librarian quickly categorize new books.

Learning Objectives:

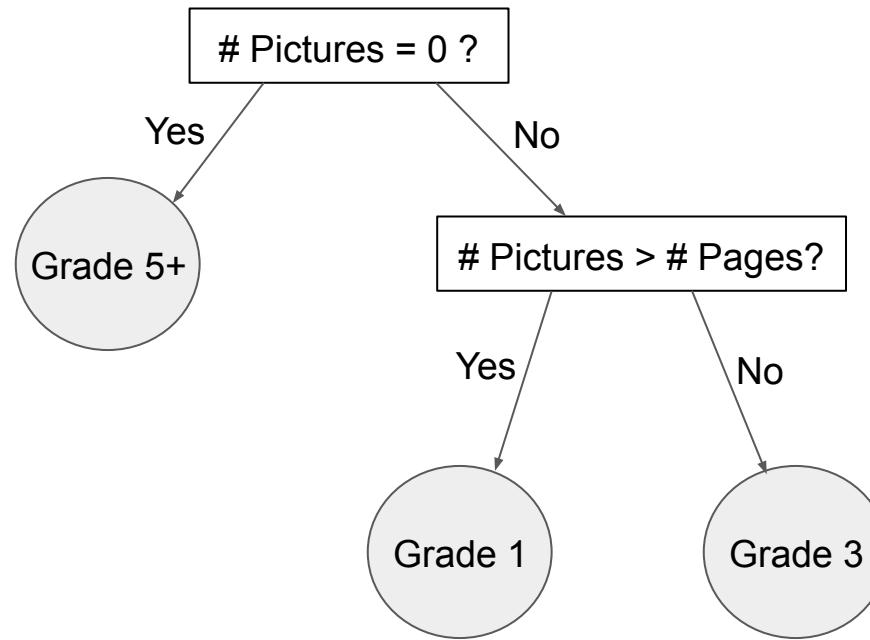
- Create a classifier to categorize books
- Train a predictive model based on attributes of books to make recommendations.
- Use model in a Scratch project



Sample Scratch Program



Decision tree classifier: book reading level



We won't see the decision tree. But if we did it might look like this.



Getting Started: Login to Machine Learning for Kids

Navigate

<https://machinelearningforkids.co.uk/>

Login

User Names: **ai4k12_01 ... ai4k12_20**

Password: **card+price+chance**

The screenshot shows the homepage of the Machine Learning for Kids website. At the top is a navigation bar with the logo, About, Projects, Worksheets, News, Help, Log Out, and Language options. Below the navigation is a search bar containing the text "School Library". The main content area features three large, rounded rectangular boxes. The first box on the left is titled "Train" and contains the sub-instruction "Collect examples of what you want the computer to recognise" and a blue "Train" button. The second box on the right is titled "Learn & Test" and contains the sub-instruction "Use the examples to train the computer to recognise numbers" and a blue "Learn & Test" button. The third box at the bottom is titled "Make" and contains the sub-instruction "Use the machine learning model you've trained to make a game or app, in Scratch or in Python" and a blue "Make" button.



Project Setup

Project Template:

You can create project templates that your students can use individually as well as whole class projects that allow your class to train one classifier using crowdsourcing.

1. **Values** or properties of the data you are storing. *Kind of like variables*
2. These are properties of a book we are going to track

pages – the number of pages in a book

lines – the number of lines on a page

pictures – the number of pictures in the book

School Library



Recognising *

numbers

Values = important characteristics

Value 1 *	Type of value *
pages	number
Value 2 *	Type of value *
lines	number
Value 3 *	Type of value *
pictures	number

Give this field a name to describe the value

ADD ANOTHER VALUE

CREATE CANCEL

Train

Collect examples of what you want
the computer to recognise

Train

Categories for Training Data



About Teacher Projects Worksheets News Help Log Out

Recognising **numbers** as **beginner, Intermediate or advanced**

< Back to project

beginner

Intermediate

advanced

+ Add new
label

+ Add example

+ Add example

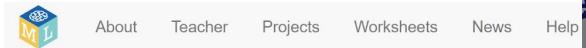
+ Add example

Train

Collect examples of what you want
the computer to recognise

Train

Add Training Data Examples



Recognising **numbers**

< Back to project

beginner

Picture books with 1 word or 1 word per page

+ Add example

Add example

Enter an example of 'beginner'

Pages

|

You have to include values for all fields in an example

Lines

pictures

Add at least 6 examples for each category

ADD CANCEL

te or advanced

+ Add new label

advanced

Chapter books with Hundreds of page, multiple paragraphs per page

+ Add example

Train

Collect examples of what you want
the computer to recognise

Train

Adding Training Data



About Teacher Projects Worksheets News Help Log Out

Recognising **numbers** as **beginner, Intermediate or advanced**

[Back to project](#)

+ Add new label

beginner

pages 10 lines 10 pictures 10	pages 5 lines 5 pictures 10	pages 10 lines 0 pictures 10
pages 8 lines 4 pictures 4	pages 20 lines 40 pictures 10	pages 40 lines 16 pictures 8

Picture books with 1 word or 1 word per page

+ Add example

6

Intermediate

pages 20 lines 40 pictures 10	pages 50 lines 100 pictures 0	pages 80 lines 120 pictures 8
pages 30 lines 75 pictures 5	pages 60 lines 240 pictures 0	pages 70 lines 350 pictures 0

Multiple sentences - paragraphs - simple chapter books

+ Add example

6

advanced

pages 150 lines 1200 pictures 0	pages 300 lines 6000 pictures 0	pages 180 lines 1980 pictures 18
pages 140 lines 2100 pictures 0	pages 200 lines 3000 pictures 0	pages 250 lines 3300 pictures 0

Chapter books with Hundreds of page, multiple paragraphs per page

+ Add example

6

Learn & Test

Use the examples to train the computer to recognise numbers

Learn & Test



About Teacher Projects Worksheets News Help Log Out

Machine learning models

< Back to project

What have you done?

Your class has collected examples of numbers for a computer to use to recognise when numbers are beginner, Intermediate or advanced.

They've collected:

- 6 examples of beginner,
- 6 examples of Intermediate,
- 6 examples of advanced

What's next?

Ready to start the computer's training?

Click the button below to start training a machine learning model using the examples your class have collected so far

(Or ask your class to go back to the [Train](#) page if you want them to collect more examples first.)

Info from training computer:

Train new machine learning model

Learn & Test

Use the examples to train the computer to recognise numbers

Learn & Test

Training a machine learning model

The computer will learn from patterns in the examples you've given it.

These will be used to be able to make predictions for new books.

Patterns in Training Data



About Teacher Projects Worksheets News Help Log Out

Language

Recognising **numbers** as **beginner, Intermediate or advanced**

: Back to project

1:1:1, 1:1 Pages:lines,
1/2 -1 picture:page

beginner

pages 10
lines 10
pictures 10

pages 5
lines 5
pictures 10

pages 10
lines 0
pictures 10

pages 8
lines 4
pictures 4

pages 20
lines 40
pictures 10

pages 40
lines 16
pictures 8

0-40 Pages

+ Add example

6

2x lines: pages
4- 10 lines/page

Intermediate

pages 20
lines 40
pictures 10

pages 50
lines 100
pictures 0

pages 80
lines 120
pictures 8

pages 30
lines 75
pictures 5

pages 60
lines 240
pictures 0

pages 70
lines 350
pictures 0

20 - 80 Pages

+ Add example

6

8- 20 lines/page

advanced

pages 150
lines 1200
pictures 0

pages 300
lines 6000
pictures 0

pages 180
lines 1980
pictures 18

pages 140
lines 2100
pictures 0

pages 200
lines 3000
pictures 0

pages 250
lines 3300
pictures 0

>100 Pages

+ Add example

6

Learn & Test

Use the examples to train the computer to recognise numbers

Learn & Test

Activity: Testing Our Model

Try putting in some numbers to see how it is recognised based on your training.

pages

lines

pictures

|

Test

However, I noticed that my classifier isn't quite right

Try putting in some numbers to see how it is recognised

pages	20
lines	240
pictures	20

Test

12 lines per page

Recognised as **beginner**
with 50% confidence

Try putting in some numbers to see how it is recognised

pages	50
lines	1000
pictures	0

Test

20 lines per page

Recognised as **Intermediate**
with 100% confidence

However, I noticed that my classifier isn't quite right

Try putting in some numbers to see how it is

pages 20

lines 240

pictures 20

Test

12 lines per page

Recognised as **beginner**
with 50% confidence

Try putting in some numbers to see how it is recognised

pages 50

lines 1000

pictures 0

Test

20 lines per page

Recognised as **Intermediate**
with 100% confidence

However, I noticed that my classifier isn't quite right

Try putting in some numbers to see how it is ↴

pages	100
lines	100
pictures	100

Test

1 lines per page

Recognised as **Intermediate**
with 100% confidence

Try putting in some numbers to see how it is ↴

pages	500
lines	500
pictures	500

Test

1 lines per page

Recognised as **advanced**
with 100% confidence

However, I noticed that my classifier isn't quite right

Try putting in some numbers to see how it is ↴

pages	100
lines	100
pictures	100

Test

1 lines per page

Recognised as **Intermediate**
with 100% confidence

Try putting in some numbers to see how it is ↴

pages	500
lines	500
pictures	500

Test

1 lines per page

Recognised as **advanced**
with 100% confidence

Patterns in Training Data: Model's current focus

Train

Collect examples of what you want
the computer to recognise

Train

Language



About Teacher Projects Worksheets News Help Log Out

Recognising **numbers** as **beginner, Intermediate or advanced**

: Back to project

1:1:1, 1:1 Pages:lines,
1/2 -1 picture:page

beginner

pages 10 lines 10 pictures 10	pages 5 lines 5 pictures 10	pages 10 lines 0 pictures 10
pages 8 lines 4 pictures 4	pages 20 lines 40 pictures 10	pages 40 lines 16 pictures 8

0-40 Pages

+ Add example

6

2x lines: pages, 4- 10
lines/page

Intermediate

pages 20 lines 40 pictures 10	pages 50 lines 100 pictures 0	pages 80 lines 120 pictures 8
pages 30 lines 75 pictures 5	pages 60 lines 240 pictures 0	pages 70 lines 350 pictures 0

20 - 80 Pages

+ Add example

6

8- 20 lines/page

advanced

pages 150 lines 1200 pictures 0	pages 300 lines 6000 pictures 0	pages 180 lines 1980 pictures 18
pages 140 lines 2100 pictures 0	pages 200 lines 3000 pictures 0	pages 250 lines 3300 pictures 0

>100 Pages

+ Add example

6

Train

Collect examples of what you want
the computer to recognise

Train

Language

Other Patterns in Training Data

About Teacher Projects Worksheets News Help Log Out

Recognising **numbers** as **beginner, Intermediate or advanced**

: Back to project

1:1:1, $\frac{1}{2}$ -1 pictures:page,
.5 - 2 lines/page

beginner

pages 10
lines 10
pictures 10

pages 5
lines 5
pictures 10

pages 10
lines 0
pictures 10

pages 8
lines 4
pictures 4

pages 20
lines 40
pictures 10

pages 40
lines 16
pictures 8

2.5 - 7 lines/page

Intermediate

pages 20
lines 40
pictures 10

pages 50
lines 100
pictures 0

pages 80
lines 120
pictures 8

pages 30
lines 75
pictures 5

pages 60
lines 240
pictures 0

pages 70
lines 350
pictures 0

8- 20 lines/page

advanced

pages 150
lines 1200
pictures 0

pages 300
lines 6000
pictures 0

pages 180
lines 1980
pictures 18

pages 140
lines 2100
pictures 0

pages 200
lines 3000
pictures 0

pages 250
lines 3300
pictures 0

+ Add example

+ Add example

+ Add example

6

6

6

Supervised Learning

When we are monitoring the model, e.g., how the computer is learning and categorizing books, and adjusting the model with different types of training data, this is considered a supervised learning algorithm.

Train

Collect examples of what you want
the computer to recognise

Train

Activity: Improving the Model

Let's add some additional books to the training set to help the classifier better categorize the books.

This means we need to focus on the other relationships we think are important.

of lines/page

.5 - 2 lines/page

Beginner

2.5 - 7 lines/page

Intermediate

8- 20 lines/page

Advanced

of pictures/ page

$\frac{1}{2}$ -1+ pictures:page

Beginner

< 1 picture per 8+ pages

Intermediate

*Chapter books with pictures at the
beginning of the chapter*

of pictures/ page / lines

Multiple pictures with high lines per page (see lines/page)

Intermediate/Advanced

Comics

Next Steps

Now let's integrate our model into an application

Make

Use the machine learning model you've trained to make a game or app, in Scratch or in Python

Make



About Projects Worksheets News Help Log Out

Make something with your machine learning model

< Back to project

Scratch

Make a project in the old version of Scratch



Scratch

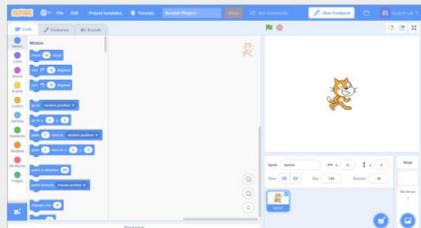


Scratch 3

Use the new version of Scratch



Scratch 3

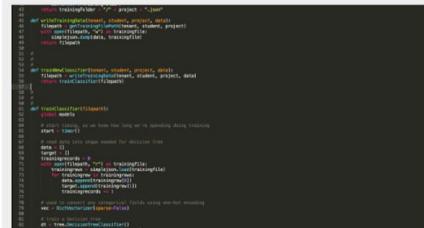


Python

Write Python code to use your machine learning model



Python

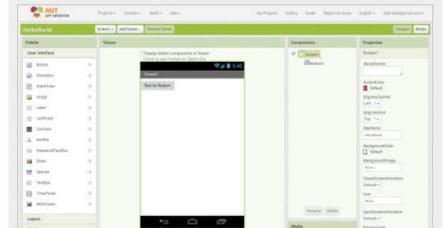


App Inventor

Make a mobile app for your phone or tablet



App Inventor



Exporting our model to Scratch

Using machine learning in Scratch 3

< Back to project

[Open in Scratch 3](#)

Your project will add these blocks to Scratch.



Put numbers in the input for this, and it will return the label that your machine learning model recognises it as.



This will return how confident your machine learning model is that it recognises the type of numbers. (As a number from 0 - 100).



These blocks represent the labels you've created in your project, so you can use their names in your scripts.

This means you can do something like this:

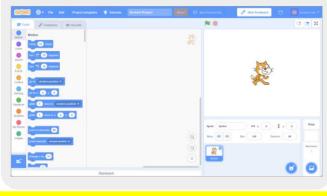


Scratch 3

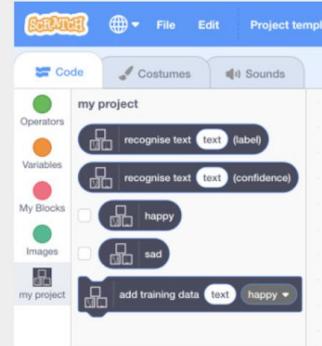
Use the new version of Scratch



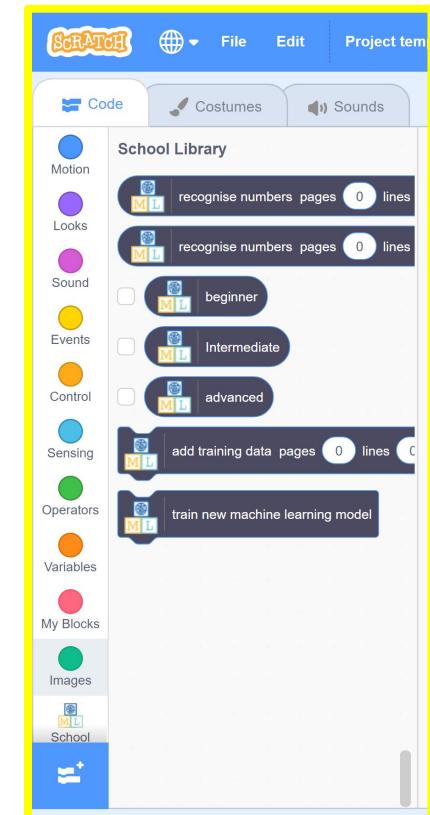
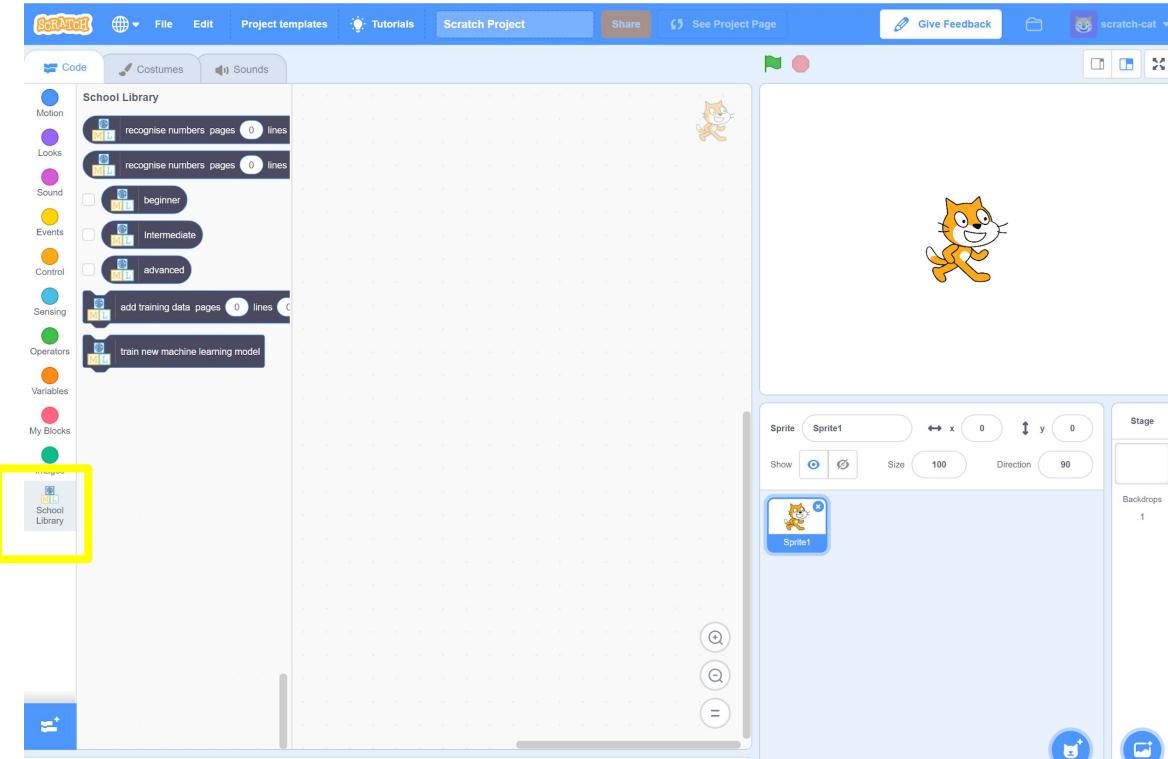
[Scratch 3](#)



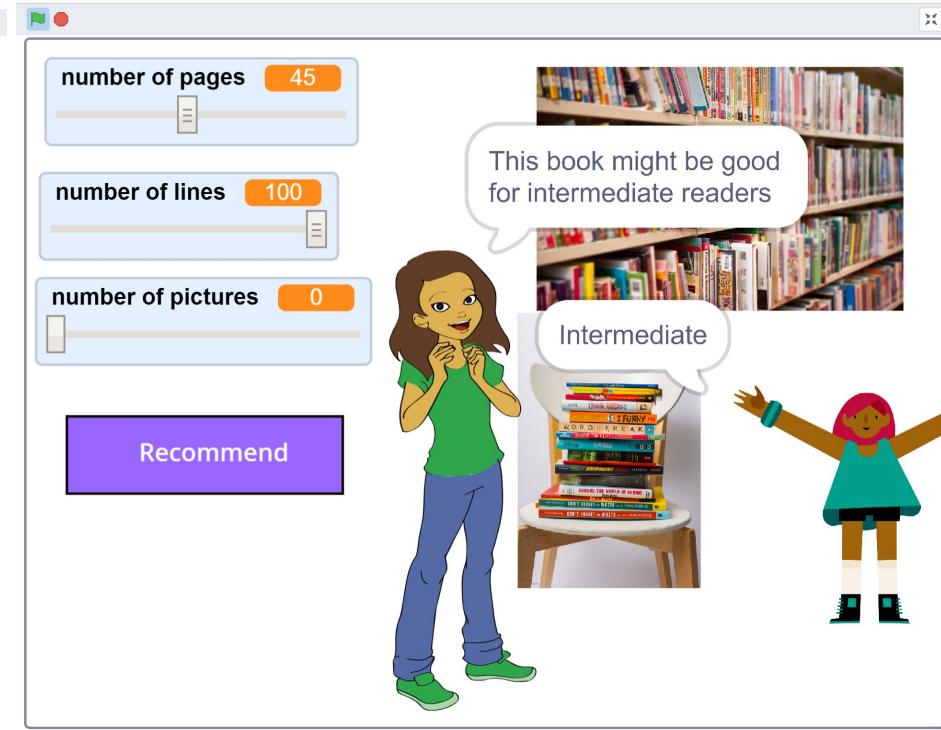
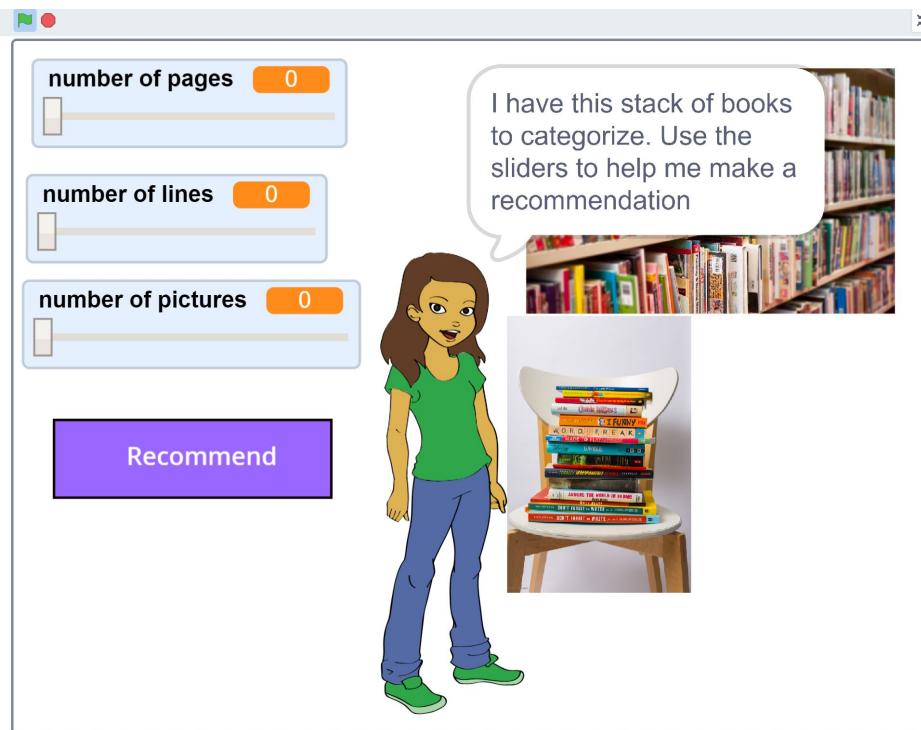
It will look something like this - except with the name of your project.



Our project in Scratch



Sample Scratch Program



Code



```
when green flag clicked
  switch costume to Abby-a
  say [I have this stack of books to categorize. Use the sliders to help me make a recommendation] for [4] seconds
  switch costume to Abby-b
when I receive [recommend]
  if [ML recognise numbers pages] = [beginner]
    switch costume to Abby-c
    say [This book might be good for beginner readers] for [4] seconds
    set [recommend] to [beginner]
  end
  if [ML recognise numbers pages] = [Intermediate]
    switch costume to Abby-c
    say [This book might be good for intermediate readers] for [4] seconds
    set [recommend] to [Intermediate]
  end
  if [ML recognise numbers pages] = [advanced]
    switch costume to Abby-c
    say [This book might be good for advanced readers] for [4] seconds
    set [recommend] to [advanced]
```

The Scratch script starts with an "when green flag clicked" hat block. It begins by switching the costume to "Abby-a". It then displays a message: "I have this stack of books to categorize. Use the sliders to help me make a recommendation" for 4 seconds. After this, it switches to costume "Abby-b".

When the script receives the "recommend" message, it checks the value of the "ML recognise numbers pages" sensor. If the value is "beginner", it switches to costume "Abby-c", says "This book might be good for beginner readers" for 4 seconds, and sets the "recommend" variable to "beginner".

If the value is "Intermediate", it switches to costume "Abby-c", says "This book might be good for intermediate readers" for 4 seconds, and sets the "recommend" variable to "Intermediate".

If the value is "advanced", it switches to costume "Abby-c", says "This book might be good for advanced readers" for 4 seconds, and sets the "recommend" variable to "advanced".

Code

Beginner



Intermediate



Advanced



when green flag clicked
hide

when I receive recommend
hide
if recommend = beginner then
switch costume to Ballerina-d
show
say Beginner for 4 seconds
if recommend = Intermediate then
switch costume to Max-b
show
say Intermediate for 4 seconds
if recommend = advanced then
switch costume to Hannah-b
show
say Advanced for 4 seconds

What have we done so far?

You've created a Scratch game with a school librarian that uses machine learning.

Your character is using “predictive modelling” – making a prediction of who a book might be suitable for, based on the machine learning model that you've made.

You trained that machine learning model by collecting examples of books, and telling the computer what reading level each of them would be. The more examples you give it, the better it should get at recommending correctly.

You will see changes in the model based on your interaction with the Scratch program and your direct interaction with the model.



Recognising numbers as beginner, Intermediate or advanced

< Back to project

+ Add new label

beginner

pages 10 lines 10 pictures 10	pages 5 lines 5 pictures 10	pages 20 lines 40 pictures 10
pages 10 lines 0 pictures 10	pages 20 lines 10 pictures 50	pages 20 lines 10 pictures 50
pages 50 lines 400 pictures 0	pages 20 lines 10 pictures 50	pages 50 lines 400 pictures 0
pages 8 lines 4 pictures 4	pages 20 lines 10 pictures 50	pages 50 lines 400 pictures 0
pages 20 lines 10 pictures 50	pages 50 lines 400	pages 50 lines 400

+ Add example

14

Intermediate

pages 30 lines 75 pictures 5	pages 60 lines 240 pictures 0	pages 70 lines 350 pictures 0
pages 50 lines 100 pictures 0	pages 20 lines 40 pictures 10	pages 80 lines 120 pictures 8

+ Add example

6

advanced

pages 200 lines 3000 pictures 0	pages 150 lines 1200 pictures 0	pages 250 lines 3300 pictures 0
pages 300 lines 6000 pictures 0	pages 180 lines 1980 pictures 18	pages 140 lines 2100 pictures 0
pages 100 lines 20000 pictures 0	pages 100 lines 20000 pictures 0	pages 100 lines 20000 pictures 0

+ Add example

10

Project Extensions

Ideas and Extensions

Now that you've finished, why not give one of these ideas a try?

Or come up with one of your own?

Choose different numbers

Instead of number of pages, number of lines, and number of pictures, what other numbers could you use?

What other numbers or measurements could you make that you think could be used to make predictions or recommendations?

The height of the book? The thickness? The size of the letters?

Try creating a new numbers project and this time use your own ideas. Compare it with your first project – is it better or worse at making recommendations?

Help improve the predictions from Scratch



How does IBM Watson work?



Watch later

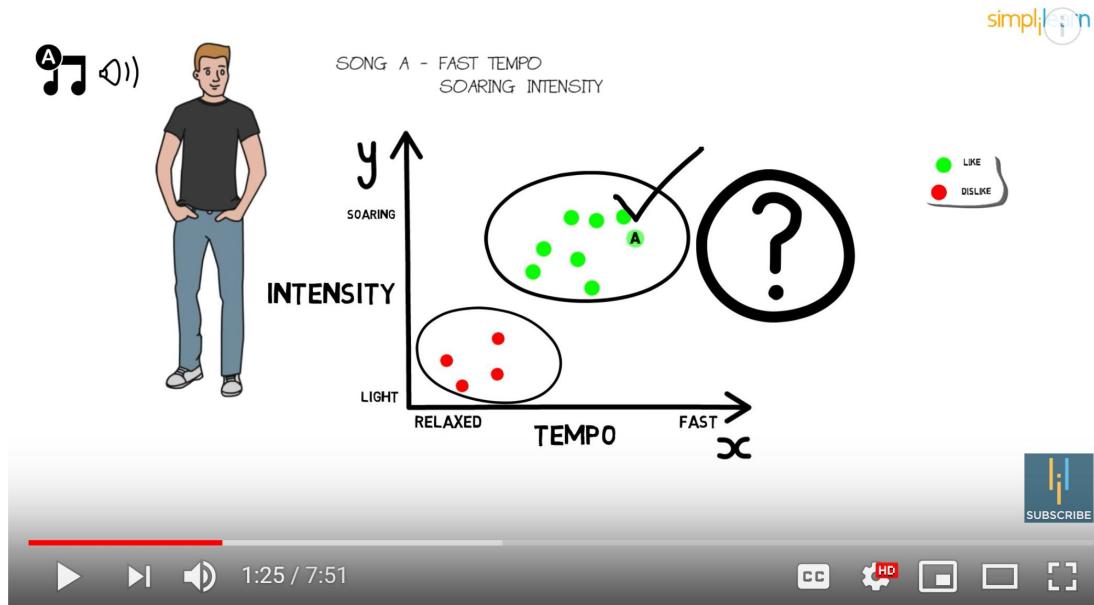
Share

How Watson Works

Play (k)

[How IBM Watson Works?](#)

How Machine Learning Works? An Explanation



#MachineLearning #MachineLearningAlgorithms #DataScience

Machine Learning Basics | What Is Machine Learning? | Introduction To Machine Learning | Simplilearn

[Link](#)