Father Christmas' Naughty or nice detector

Presented by
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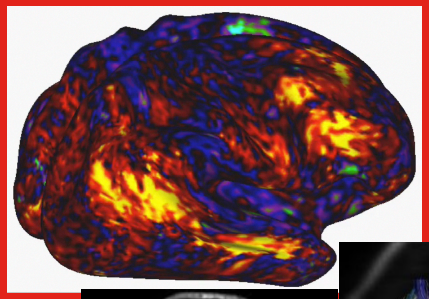
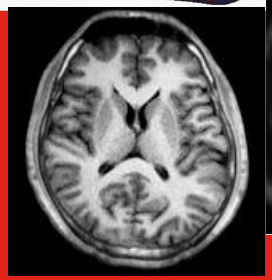
As we all know Father Christmas is a great fan of technology....

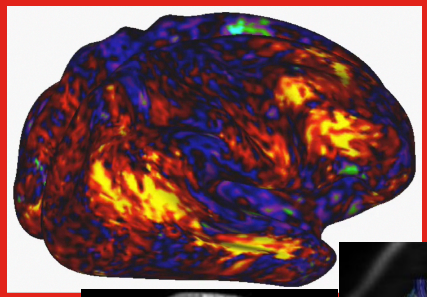
So when he heard about the work of King's College London's Biomedical Imaging department

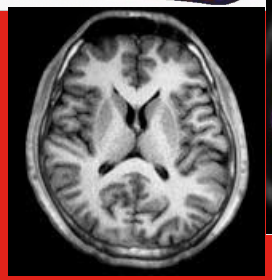




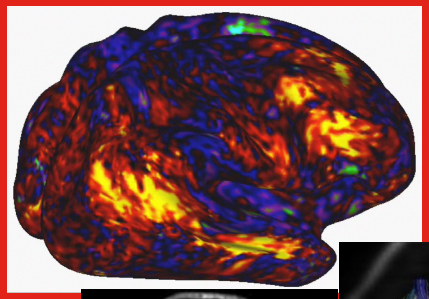
RISK OF AUTISM

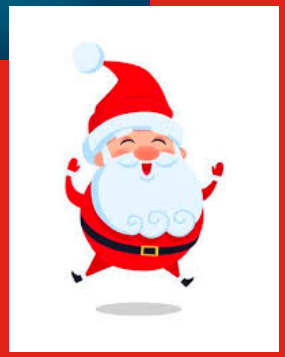
He had an idea.....





What if we could build an automated naughty/nice detector using brain imaging and machine learning!





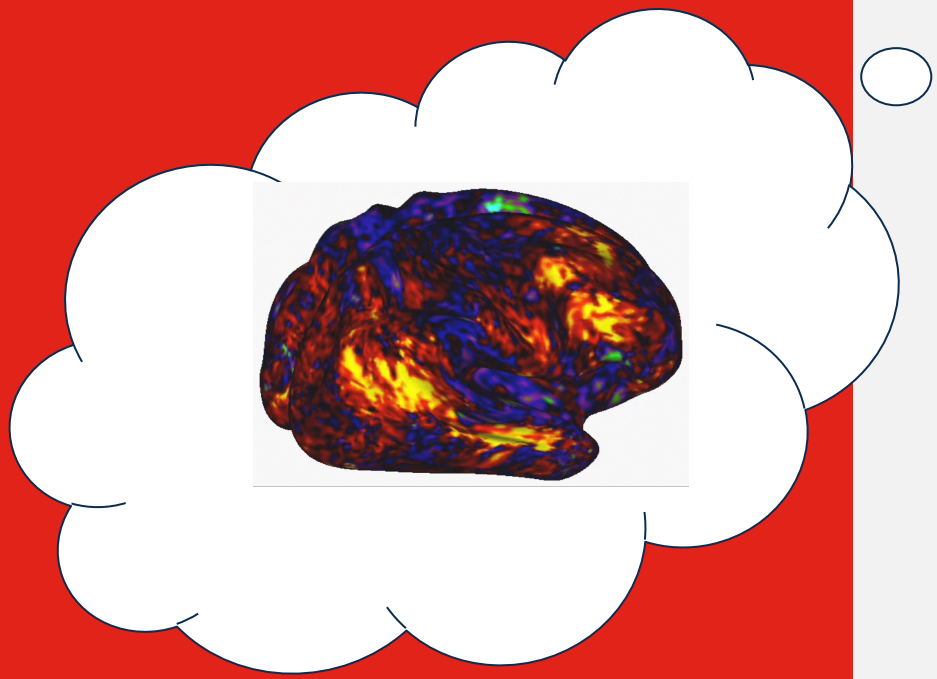
Naughty

Nice

Nice

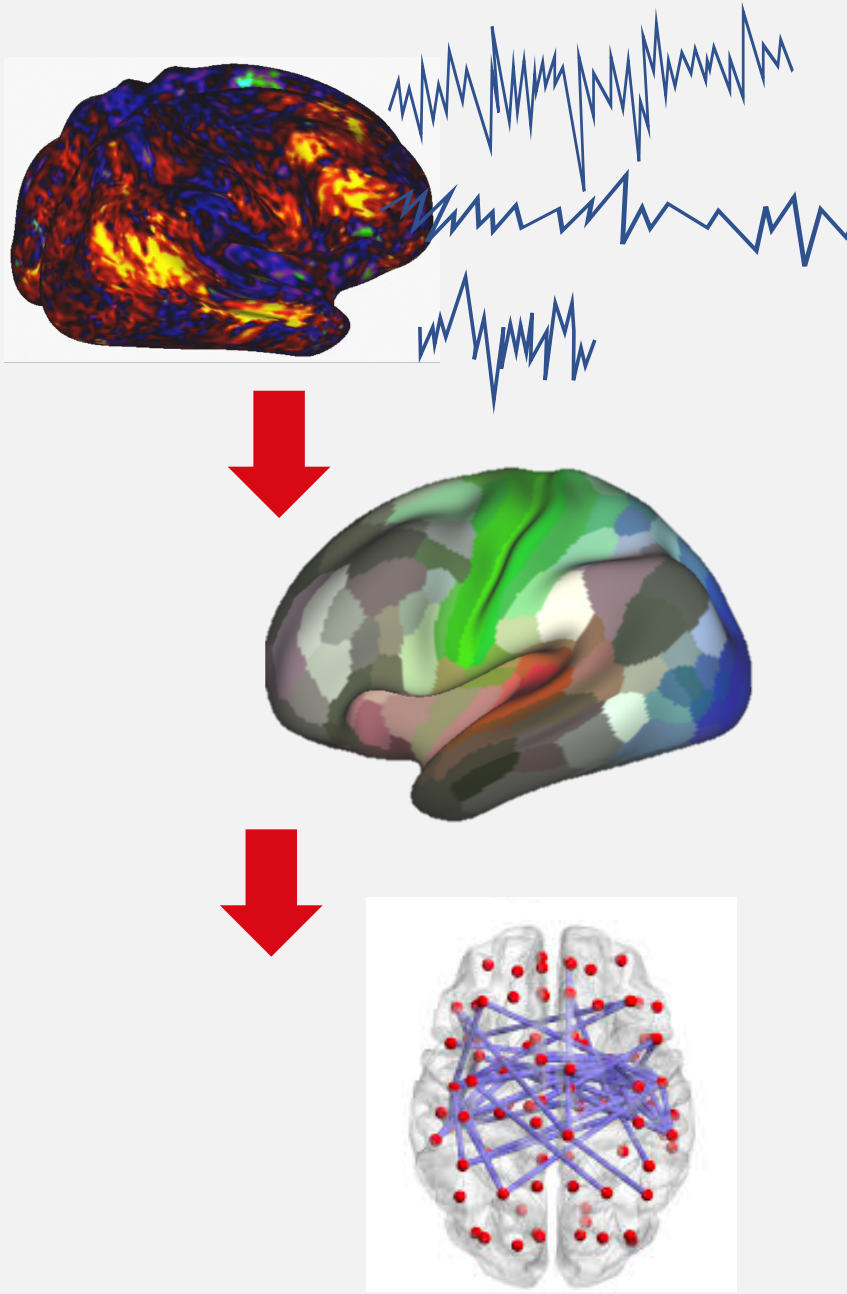
Naughty

So, he sent out his elves to scan the brains of *all* (2.2 billion) children



That's a lot of complex data!!

- Each spatial location returns a timeseries of brain activity
- Common practice to simplify by modelling brain activity as coming from fixed regions
- To build a (macroscale) brain network model

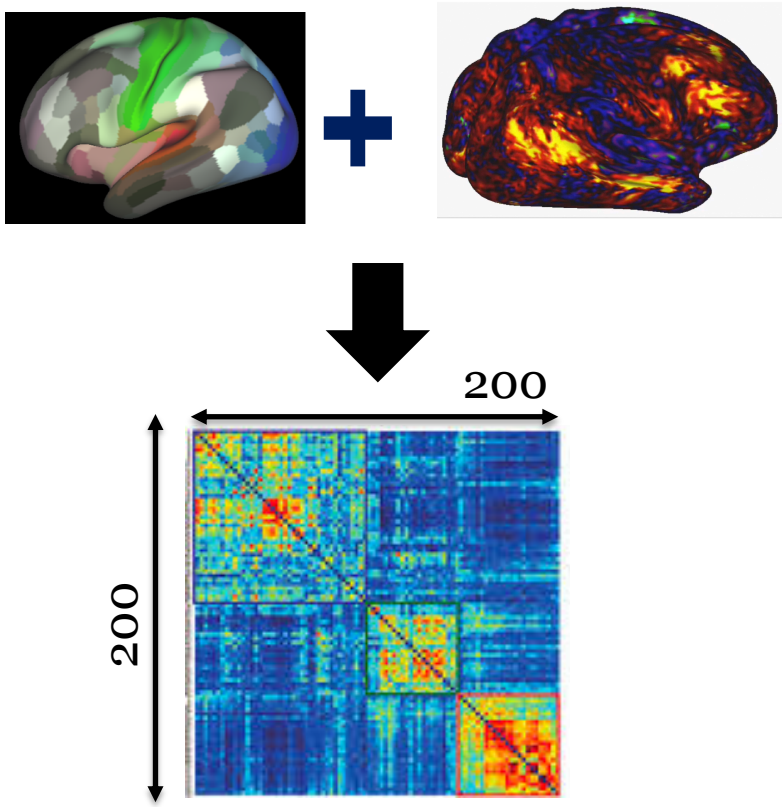


We're now ready to build our predictive model

In the following steps

1. Create our data matrix

- Let's say we have 200 regions
- Then our estimated brain network is a 200x200 matrix
- We have 2.2 billion of these

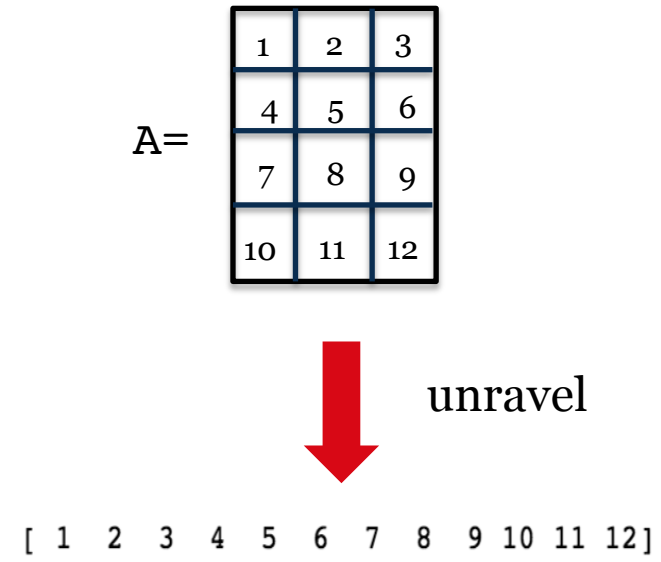


We're now ready to build our predictive model

In the following steps

1. Create our data matrix

- We need one data matrix **X** where each row represents all data from one subject
- So we unravel each connectivity matrix into a single row
  - length N(N+1)/2 = (200*201)/2= 20100

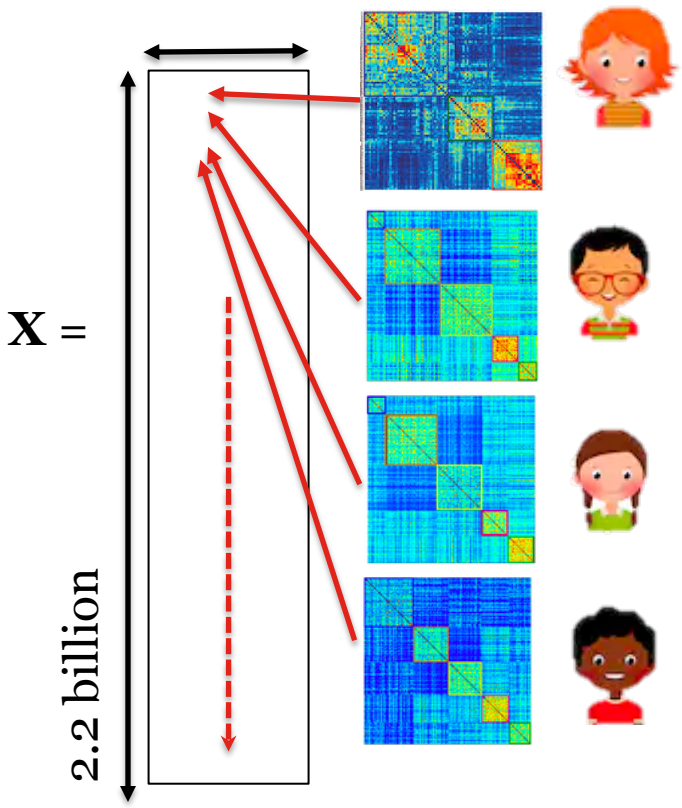


We're now ready to build our predictive model

In the following steps

1. Create our data matrix

- We need one data matrix **X** where each row represents all data from one subject
- So we unravel each connectivity matrix into a single row
- And combine all rows from all children to create **X**



We're now ready to build our predictive model

In the following steps

2. Get our labels

- In the first instance, we need Santa to tell us which children are naughty and which are nice using traditional methods
- We call these true labels and store them in **y**

0 = naughty
1 = nice

y

$$\begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \\ 1 \\ 1 \\ 1 \\ 0 \\ 1 \\ 1 \\ \vdots \\ 0 \\ 1 \\ 1 \\ 1 \end{bmatrix}$$

We're now ready to build our predictive model

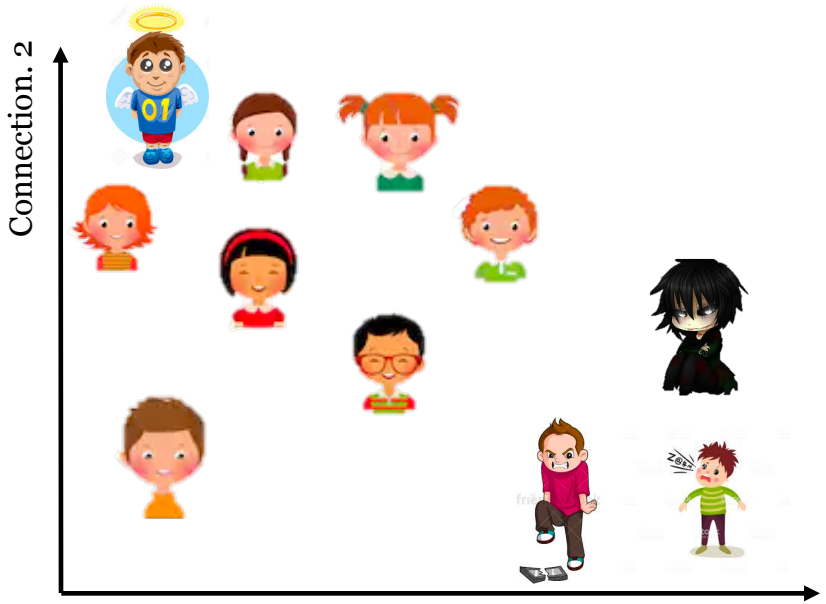
In the following steps

3. Machine learning

Teaching machines to see patterns in data

e.g. classification

- For simplicity we show only 2 dimensions - *strengths for just 2 connections*



We're now ready to build our predictive model

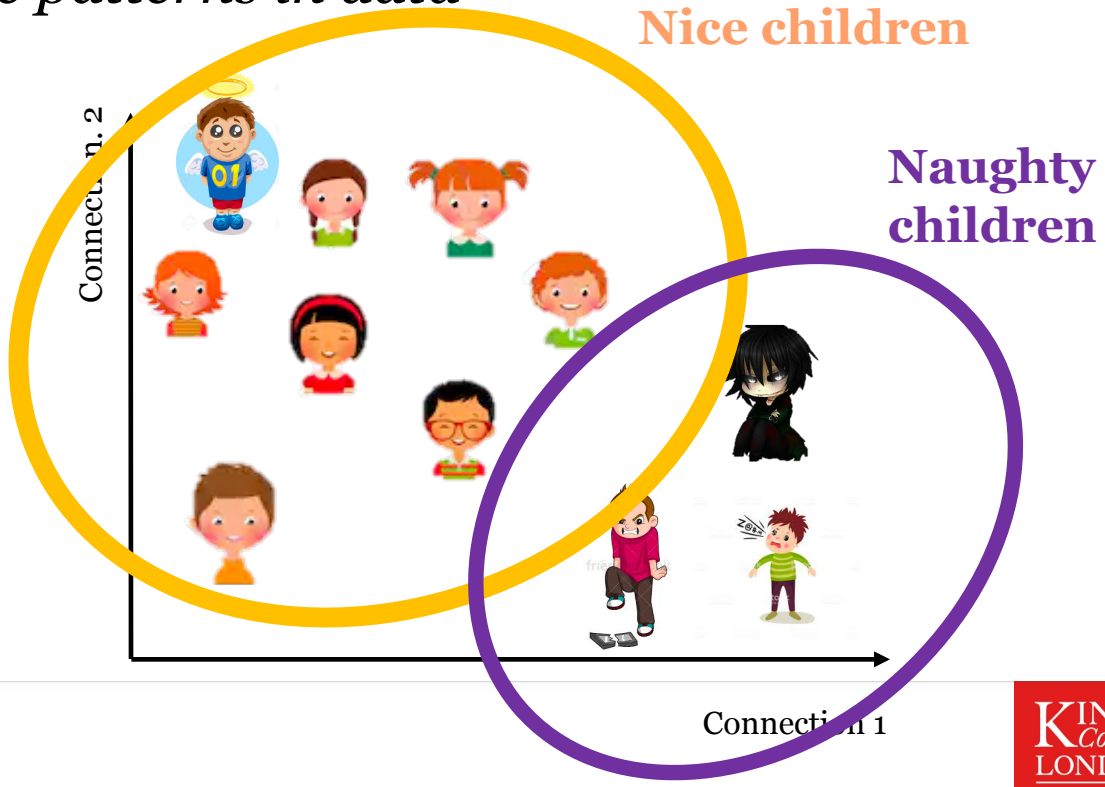
In the following steps

3. Machine learning

Teaching machines to see patterns in data

e.g. classification

- We compare values for all children
- We observe that all nice children have lower values of connection 1 and higher values of connection 2



We're now ready to build our predictive model

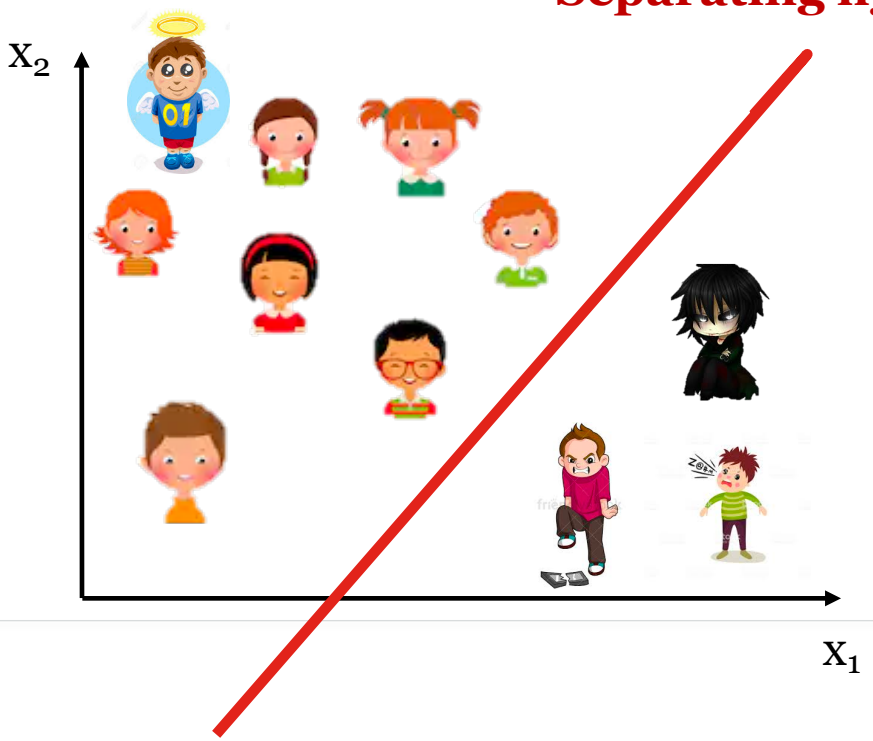
In the following steps

3. Machine learning

Teaching machines to see patterns in data

e.g. classification
(in 2 dimensions)

- So we can build a model which splits data by fitting a ***separating hyperplane***



We're now ready to build our predictive model

In the following steps

3. Machine learning

Teaching machines to see patterns in data

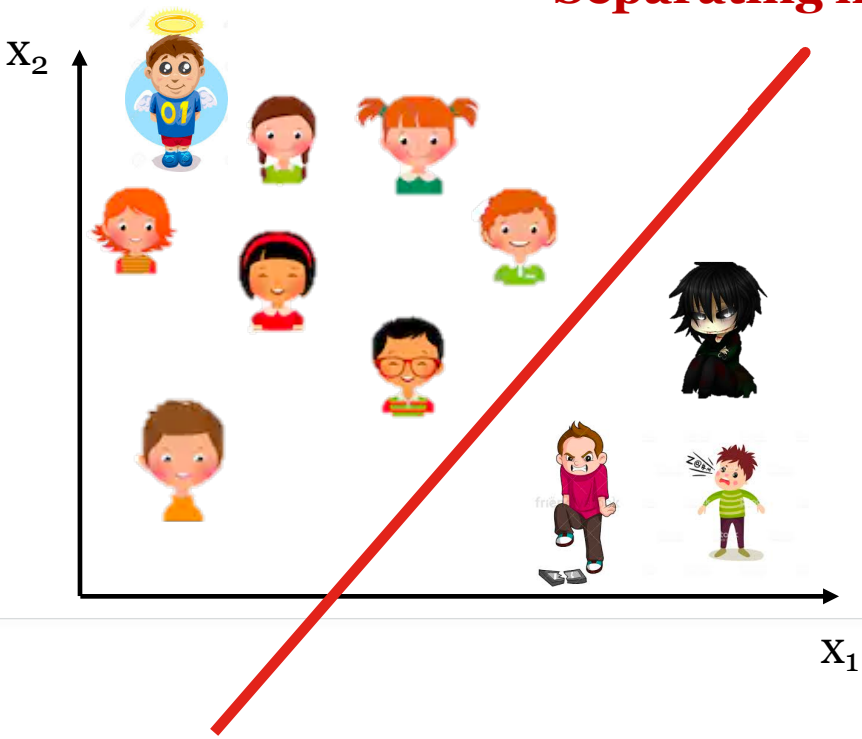
e.g. classification
(in 2 dimensions)

Algorithmically we must fit

$$y = \begin{cases} 0 & \mathbf{w}.\mathbf{x} > T \\ 1 & \text{otherwise} \end{cases}$$

We must find $\mathbf{w}$

Must fit
Separating hyperplane

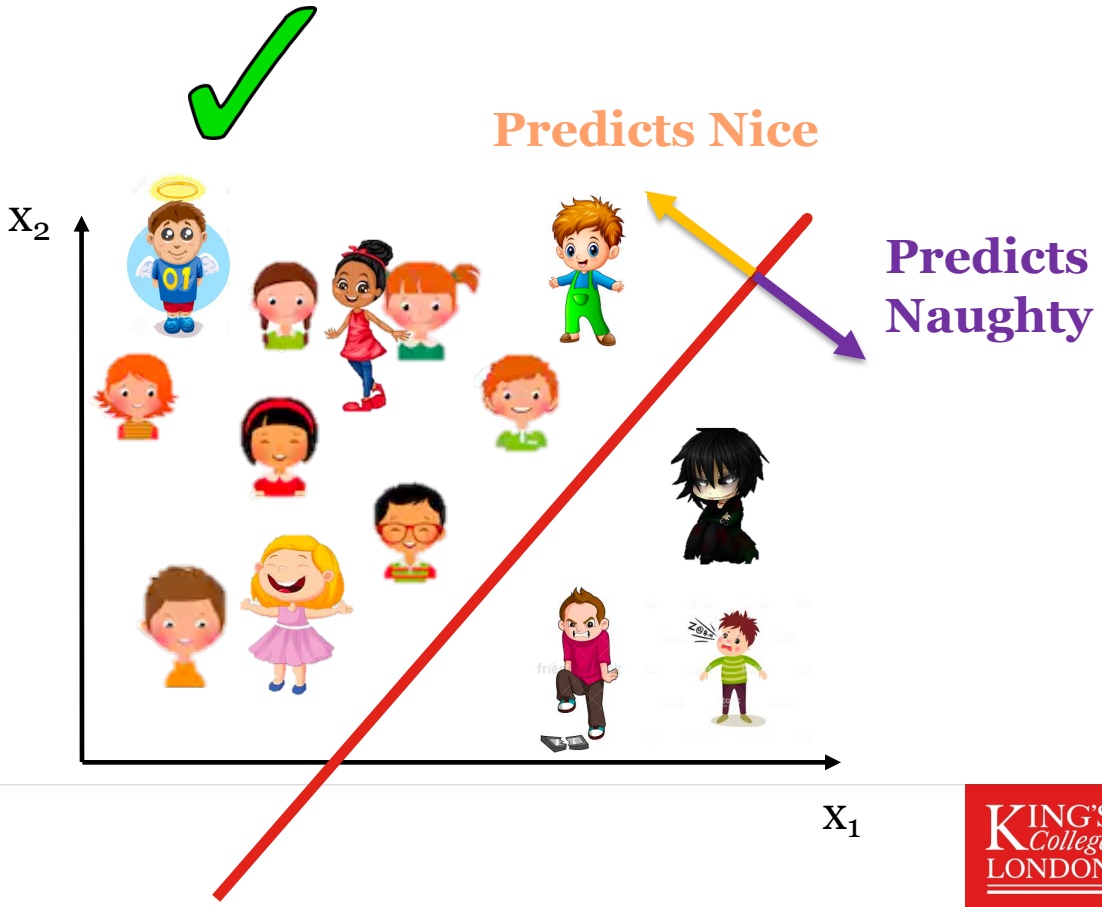


We're now ready to build our predictive model

In the following steps

4. Prediction *We can now predict the labels (naughty/nice) for new children*

- If above the line the classifier will predict nice
- If below the line the classifier will predict naughty
- First let's plot the values of new children that we know are nice



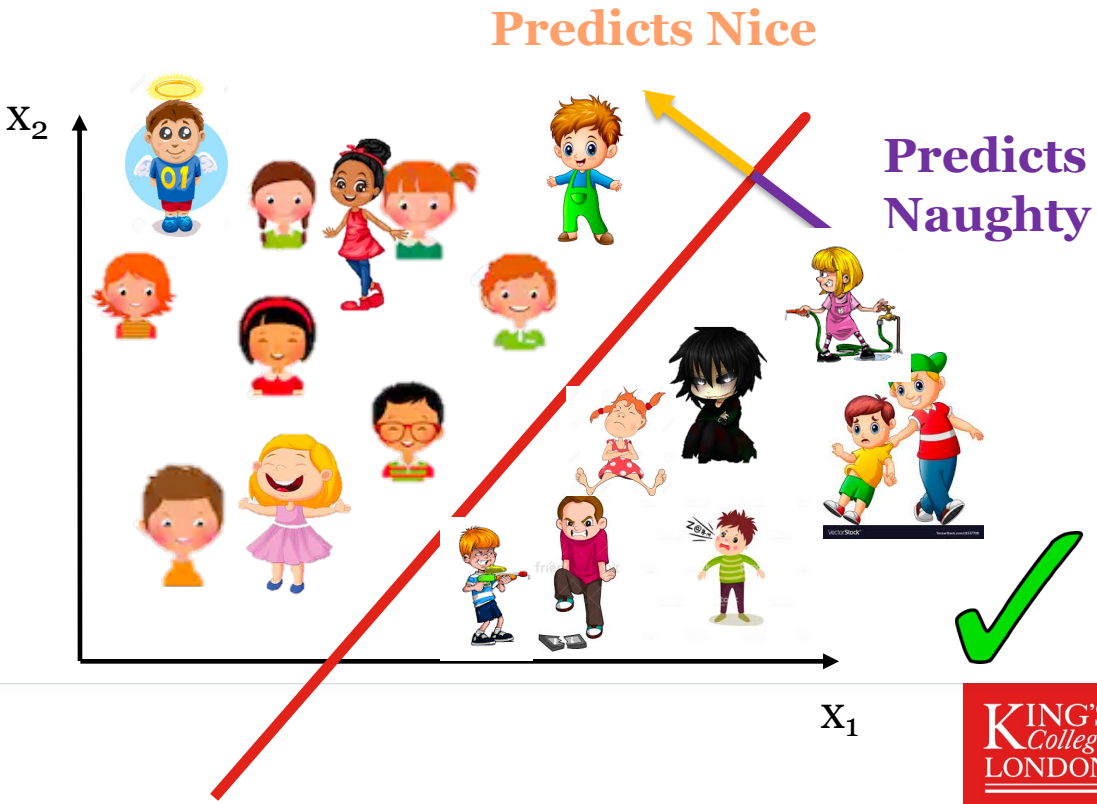
We're now ready to build our predictive model

In the following steps

4. Prediction *We can now predict the labels (naughty/nice) for new children*

- Now the naughty children

Our classifier is
100% correct!

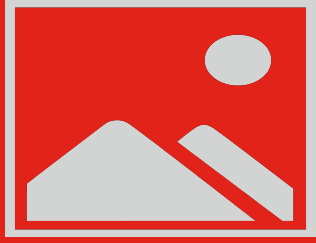


So now Father Christmas can put his feet up...

And leave the elves to do all the work

MeTrICS

centre for the developing brain



For more information:

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https://metrics-lab.github.io/

Developing Human Connectome Project