Data Science Campus

Machine Learning for Social Surveys LCF/SLC/HFS

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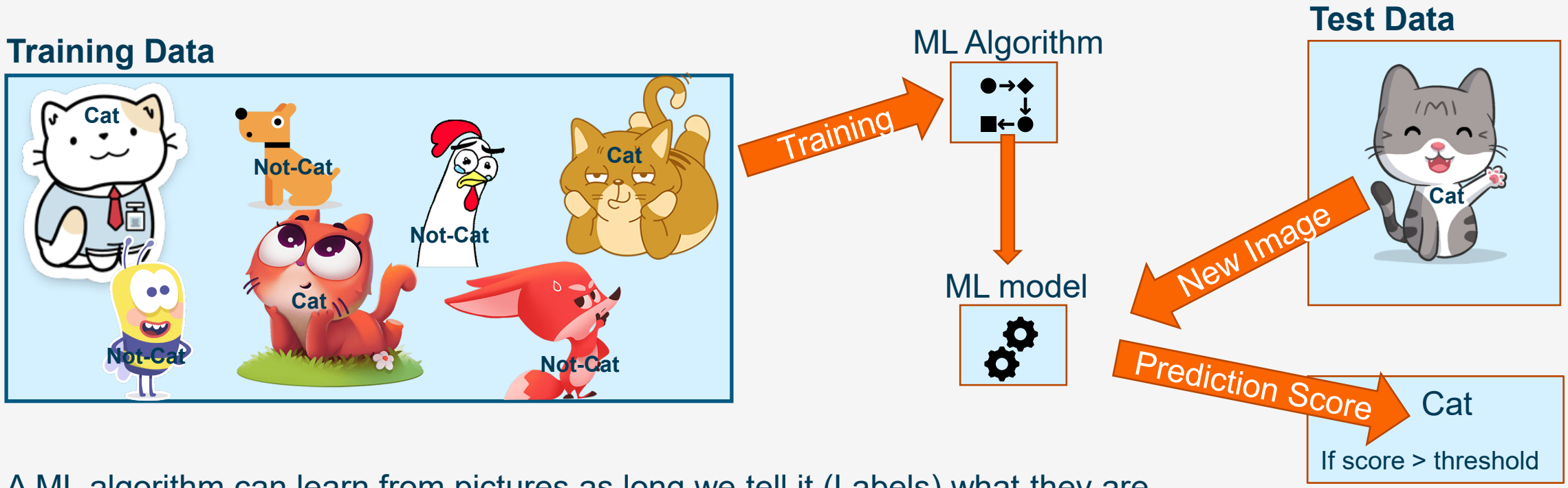
Data Science Campus

What is Machine Learning?

Machine Learning is used to identify rules and patterns in data humans can not.

Example: How to recognise a cat

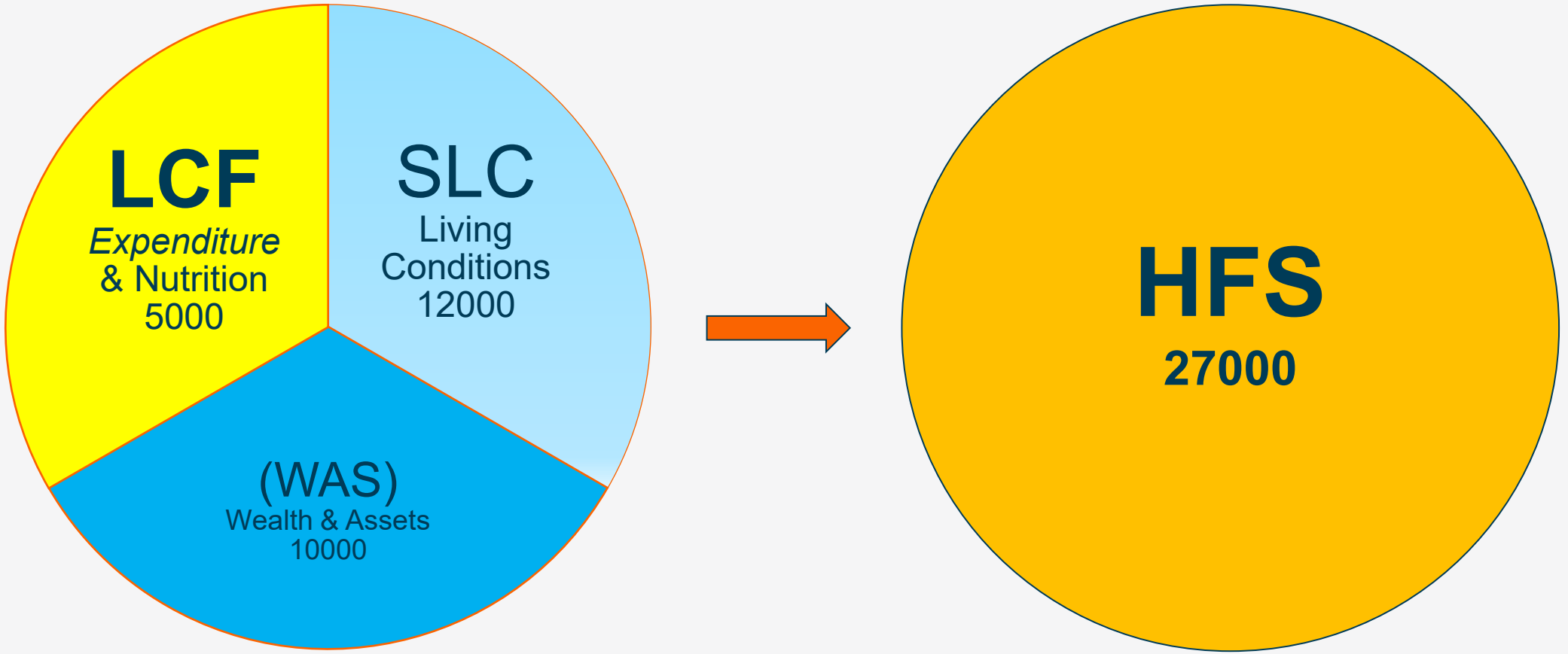
But not just one cat but all cats. What are the rules?



A ML algorithm can learn from pictures as long we tell it (Labels) what they are

ML can make an inference of the class of new pictures, it gives a score for the most likely class

The HFS and it's component Surveys



Number of co-operating Households each year

Survey Specific Editing (Currently in Production)

Editing: Identifying records that need values changed or missing values inserted

- LCF – all cases go through clerical editing

  too slow and too labour intensive → **Speed &Cost?**

  Over Editing?

- SLC – Scripted outlier detection (range of values)

- Only about 50% (?) of changes that are made with the LCF method are made with the SLC method → **Accuracy?**

- WAS – Scripted outlier detection (range of values)

  Accuracy?

ML

Editing of LCF income data with ML

LCF Editing Instructions for Income → extensive manual Editing → Ground Truth

5 most often changed Independent Variables:

- Net income (after deductions)
- Income Tax
- Gross pay (before deductions)
- National Insurance paid
- Deduction for pension

Any change of more than 10% is counted as a change → Label/Target/Dependant

Two Class Classification Problem:

- No-Change
- Change

Supervised Learning

Training data → Train the algorithm
Test data → Test the trained model

Random Forest ML algorithm

Results of 2912 LCF Test Cases – What is good enough?

Battle between Recall and Precision, they can't both be 100%

Prediction Threshold	20%	25%	30%	35%	40%	45%	50%
Recall	95.7%	94.0%	91.8%	88.9%	84.2%	81.0%	77.4%
Precision	37.0%	41.3%	47.5%	55.1%	61.8%	69.8%	77.4%
F1-Score	53.3%	57.4%	62.6%	68.0%	71.3%	75.0%	77.4%
TP	352	346	338	**327**	310	298	285
FP	600	491	374	**267**	192	129	83

Exp v62.1

327/368 = 88.9%

If prediction score > Threshold → Case belongs to the Change Class

Objective:

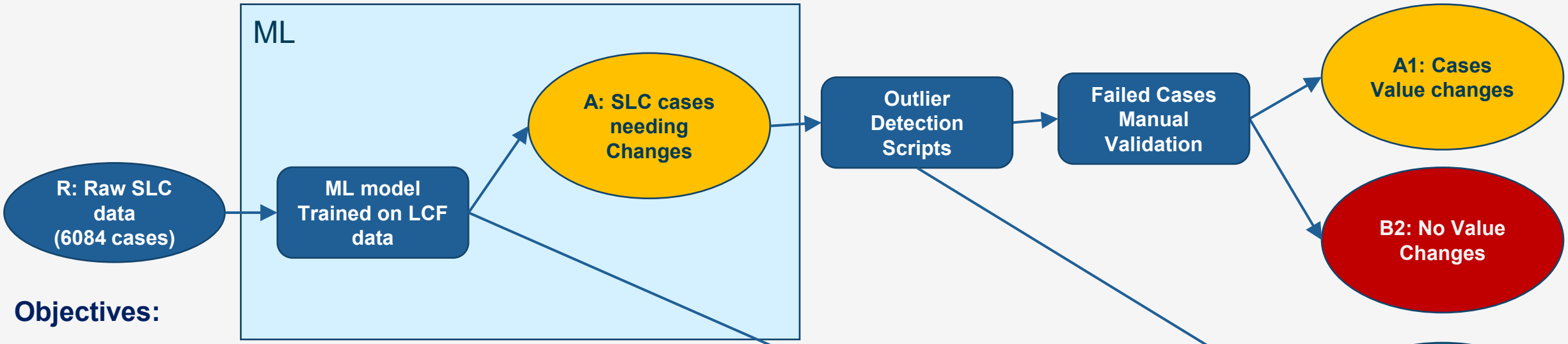
1. Find as many True Positive (TP) as possible with small number of False Positives (FP) - 88.9% ☑
2. Find all cases with large value changes > 500% - 100% ☑
3. Reduce the number of cases to be manually analysed (from 3000 to about 600) - 80% ☑

The same team could check 5 x the number of cases for inconsistent data → HFS

Then we looked at SLC survey data

- SLC also collects Income data, but uses a deterministic editing process
- No SLC Ground Truth, but we know which cases have been changed (Labels)
- Transfer Learning – Can we use the trained LCF ML model?
- Objective:
  - Reduce: number of cases flagged by the deterministic SLC process, but do not receive a value change
  - Keep all cases with Changes
  - Keep all cases with large value changes

Proposed SLC Editing Pipeline



Objectives:

- Retain the SLC Editing method
- Add ML as a filter to remove cases that:
  Are flagged by the scripts, but do not need any changes → 'Wasted Effort'
- Reducing this Burden is key to use the SLC Editing method for HFS
- Retain cases that
  - need changes
  - need large value changes
- A longer term objective is to have only one Editing process

Results of 6084 SLC Cases – What is good enough?

Battle between Recall and Precision, they can't both be 100%

SLC Prediction Results:

Prediction Threshold	20%	25%	30%	35%	40%	45%	50%
Recall	99.7%	99.7%	99.3%	98.4%	97.4%	95.2%	92.6%
Precision	34.5%	35.8%	38.7%	43.7%	52.2%	60.9%	69.4%
F1-Score	51.2%	52.7%	55.7%	60.6%	67.9%	74.4%	79.3%
TP	753	753	750	743	734	**719**	699
FP	1432	1351	1188	956	674	**462**	308
Burden cases filtered out				**76%**		**82.6%**	**85.3%**
				736 of 968		**800 of 968**	**826 of 968**

Exp v65.1

If prediction score > Threshold → Case belongs to the Change Class

Objective:

1. Find as many True Positive (TP) as possible with small number of False Positives (FP) - 95.2% ☑
2. Find all cases with large value changes >300% - 100% ☑
3. Reduce the number of cases manually checked, without receiving value changes (240 hours annually) - 82.6% ☑

The same team could check 5 x the number of cases for inconsistent data → HFS

Challenges

Results show that ML can make data Editing more efficient
Questions:

- What is good enough?
- What is it we want to achieve?
- How do we put this into production?
- How will ML fit into the data pipeline?

What about:

- Training Data
- Model/Data Drift
- Ethics?
- Explainability?

The Research and Implementation ML Workshop Part 1 will look at these in more detail

Technical ML sessions will look in more details how ML works and how to do it.

Thank you