



**Piloting of use of predictive
analytics to help DEFRA's agencies
target cross compliance
farm visits**

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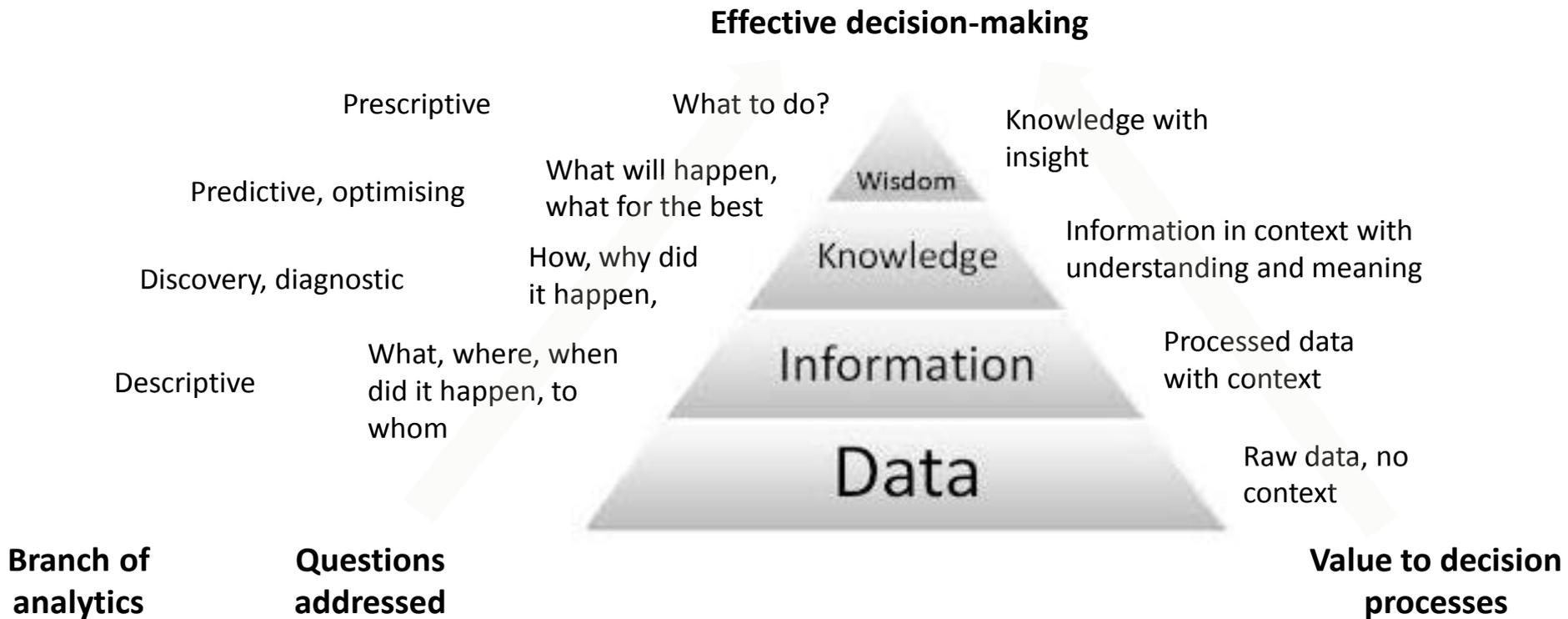
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Data Analytics at HSE

“Quantitative and qualitative techniques and processes for generating information and knowledge from raw data sources to inform organisational decisions”

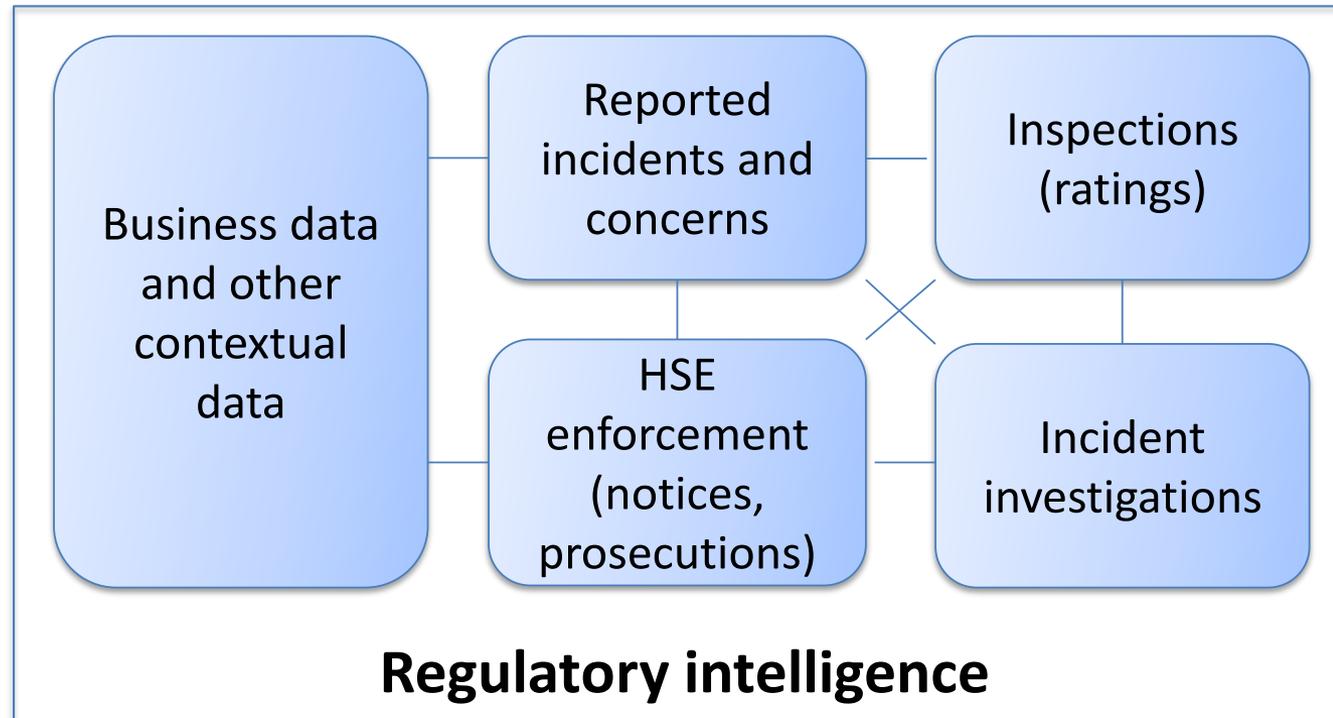




e.g. Where should regulators inspect?

- Risk based
- Target poor performers
- Minimise business burden

Data driven decision-making



Can past performance be used as an indicator of future regulatory outcomes?



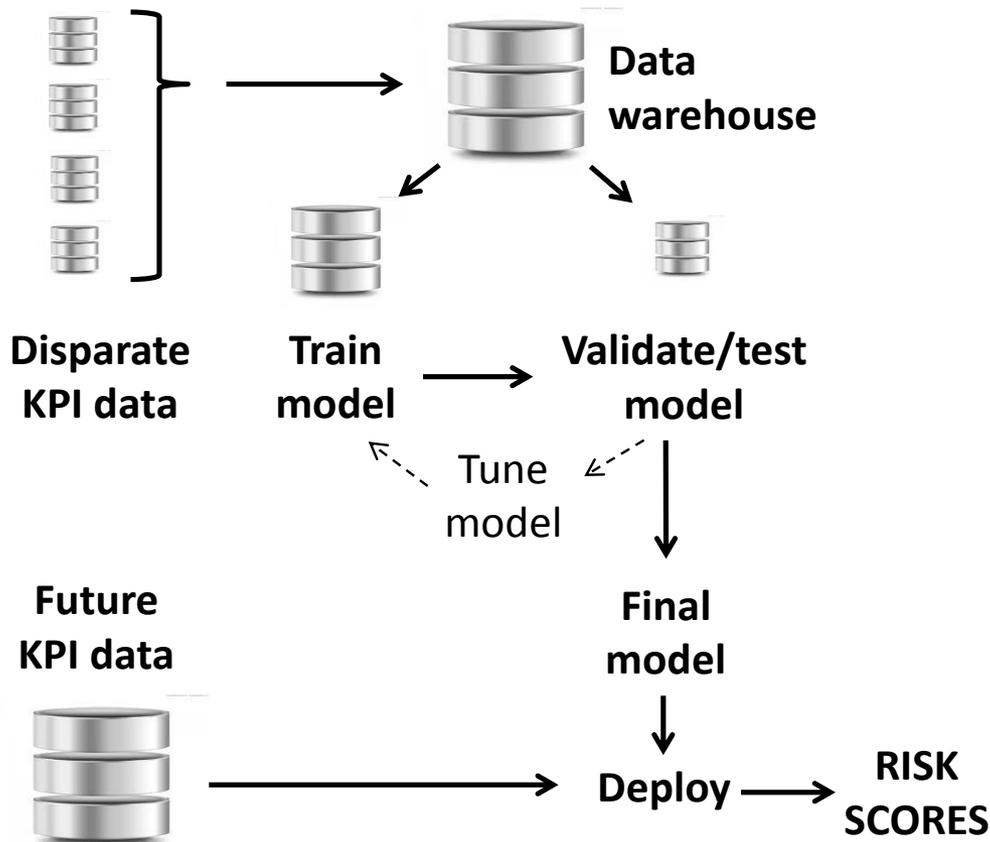
Research Question

- Can we improve targeting of DEFRA agency risk-based cross compliance farm inspection activity using predictive analytic techniques?
 - *By improve, we mean more material breaches of rules detected with fewer inspections*
- Algorithm trained to predict inspection outcomes using 2016 inspection outcome data and a range of potential predictor data
 - *Trained model then used to predict outcomes of 2017 inspections*
 - *Actual outcomes of 2017 inspections used to test model accuracy*



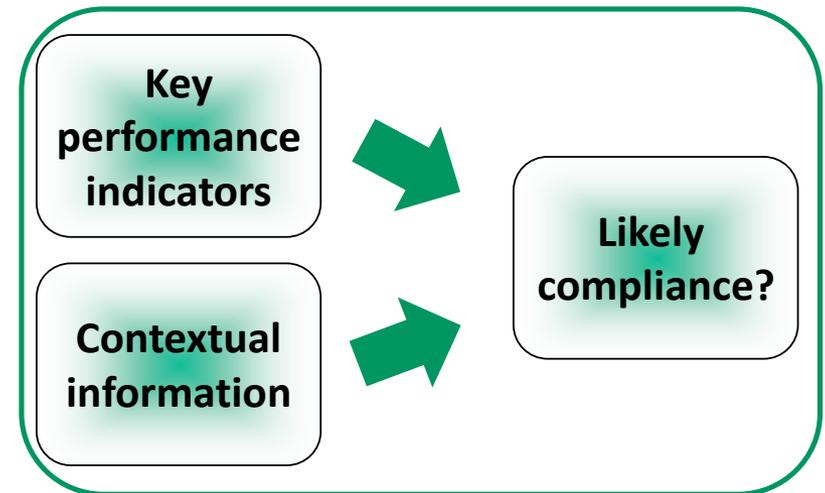
High level overview of analytic approach

PREDICTIVE ANALYTIC MODEL



PREDICTORS

for years previous



OUTCOME

for now



High level overview of analytic approach – Risk scores

Data-driven
decision-making

Risk
unacceptable –
take action

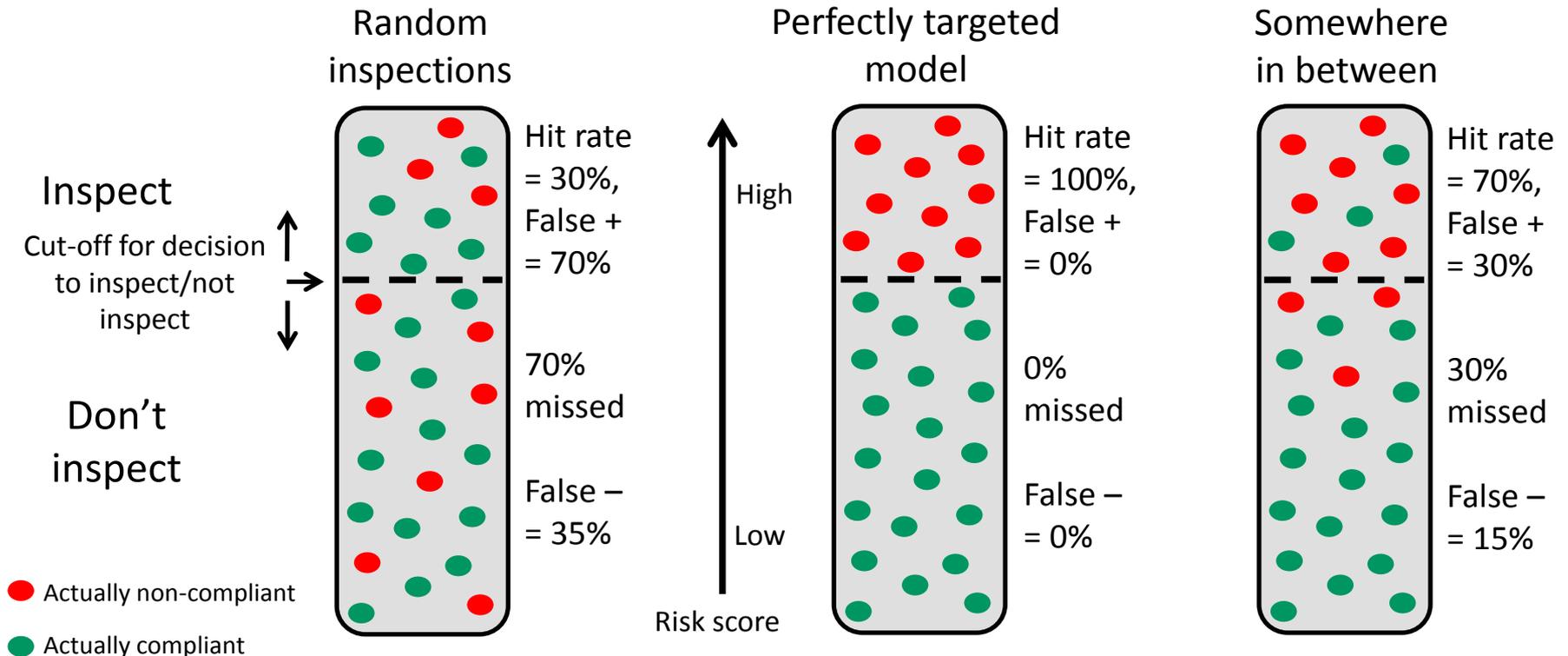
Risk acceptable
– business as
usual

Unit	Risk Score (%)	Risk factors contributing most to risk score				
		RF1	RF2	RF3	RF4	RF5
id1	95	✓	✓	✓	✓	✓
id2	85	✓	✓		✓	✓
id3	75	✓		✓		✓
id4	65			✓	✓	
id5	55	✓	✓			
id6	45		✓		✓	
id7	35	✓		✓		
id8	25		✓			✓
id9	15	✓				
id10 etc.	5			✓		



High level overview of analytic approach – The challenge

- Non-compliance prevalence in test dataset = e.g. 30%
- Can we identify those farms in our data sample that should have been inspected?



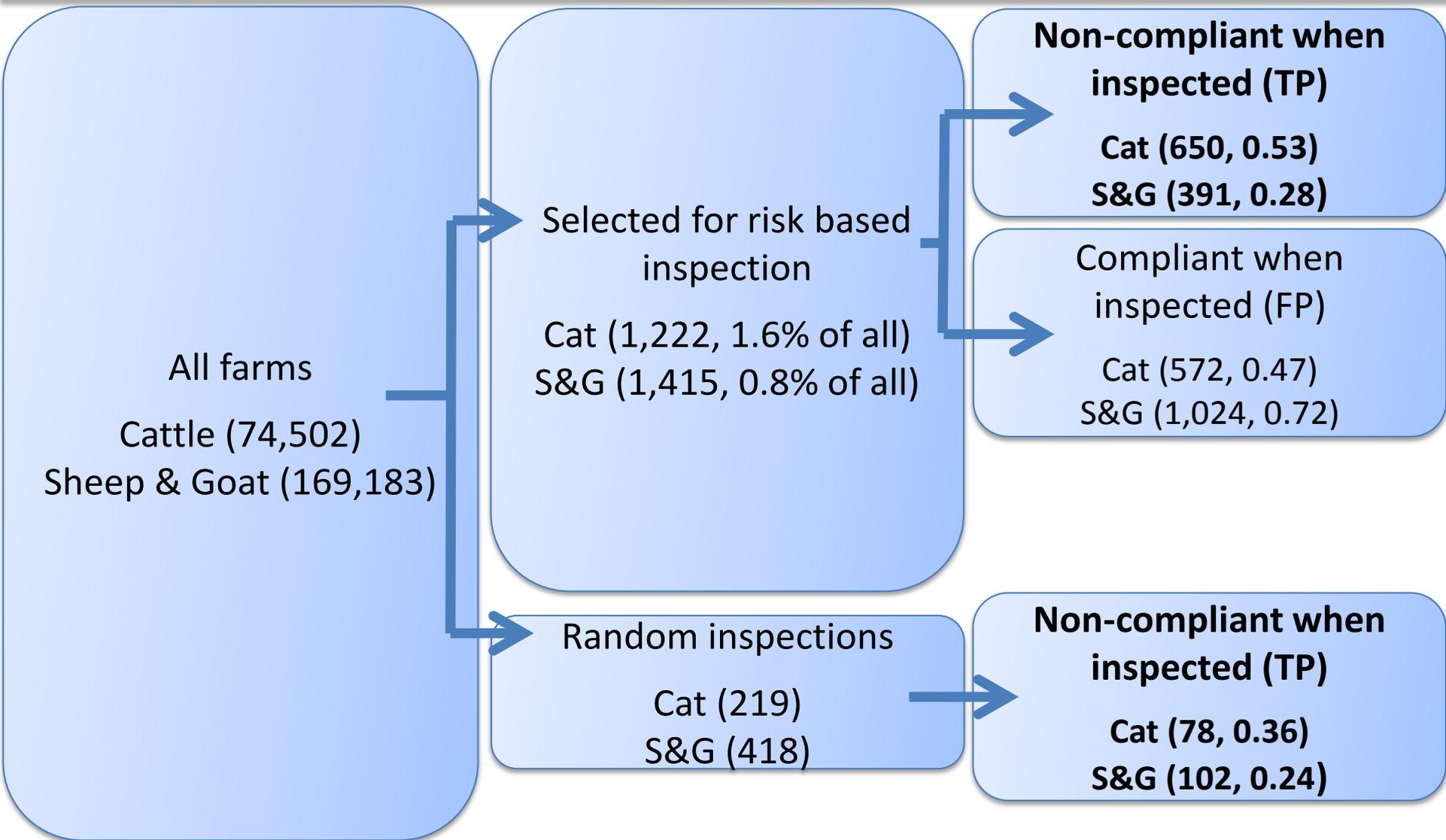


Predictor data used in model training work

- Past inspection history (last 3 years)
 - *Rural Payments Agency (XC, LE), Environment Agency, Natural England, Animal and Plant Health Agency (AW)*
- Other composite scores (last 3 years)
 - *Environment Agency OPRA scores, Animal and Plant Health Agency TB risk scores*
- Red Tractor assurance scheme membership (latest)
 - *Beef and lamb, dairy, crops, pigs, produce*
- Contextual data (latest)
 - *DEFRA agricultural census data, Natural England land class data*



Current targeting approach – Likelihood of farms flagged for inspection being non-compliant





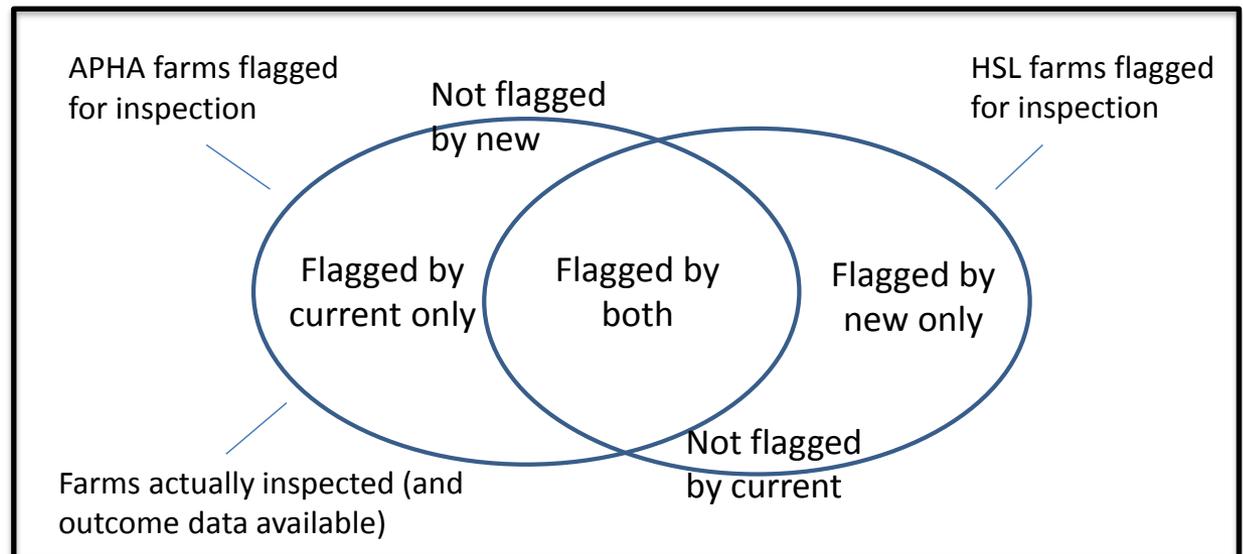
Judging model performance – Perfect world

- Typically, calculate positive predictive value, negative predictive value, sensitivity and specificity for model
 - **Positive predictive value** (likelihood of non-compliance in a farm flagged for inspection)
 - **Negative predictive value** (likelihood of compliance in a farm not flagged for inspection)
 - **Sensitivity** (likelihood that a farm flagged for inspection will actually be non-compliant)
 - **Specificity** (likelihood that a farm not flagged for inspection will actually be compliant)



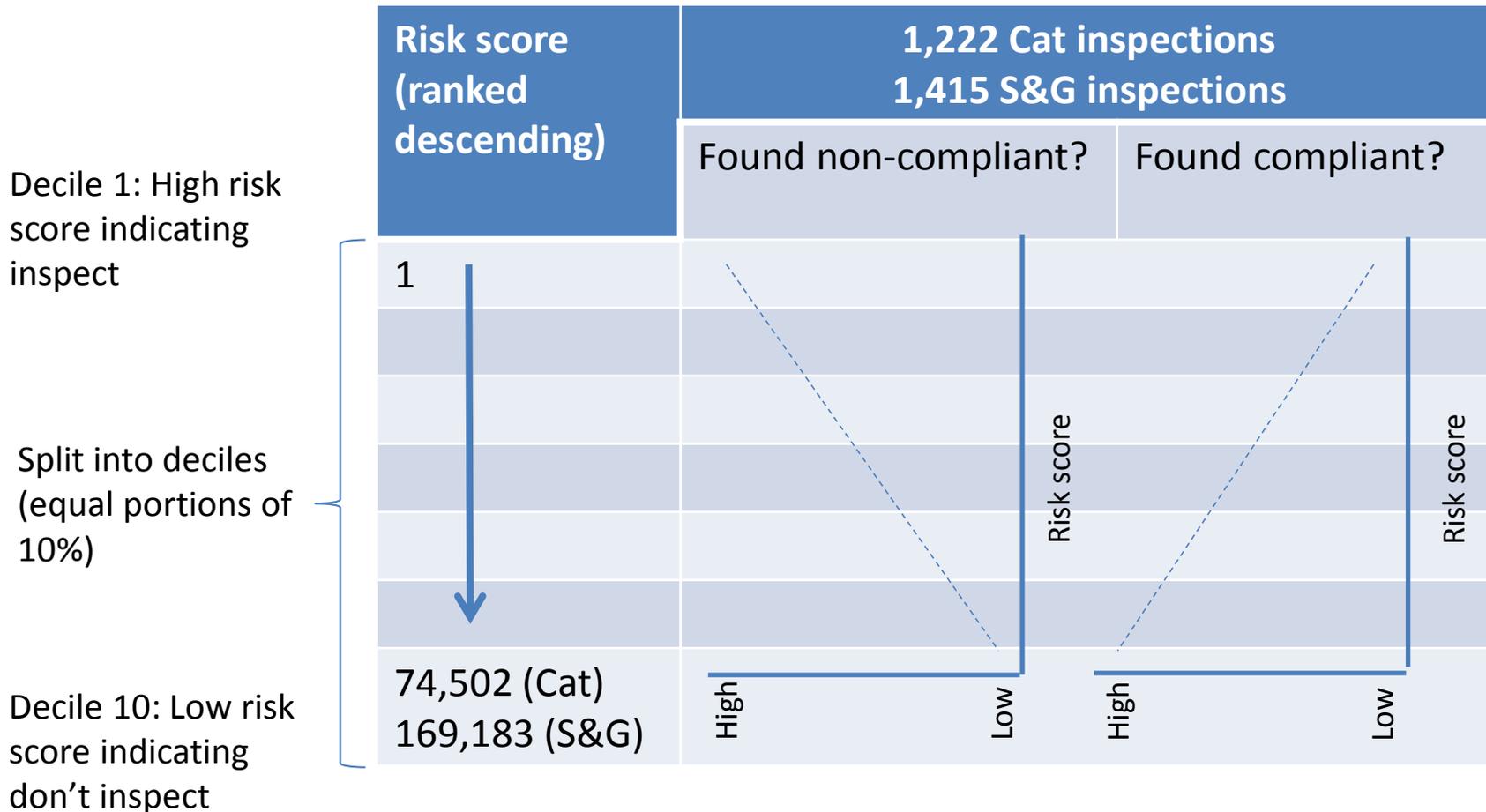
Judging model performance – In reality

- However, we only have inspection results for farms flagged for inspection by the current approach, in the last inspection round
 - *What about the farms not actually inspected in the last round that the new approach might have correctly or incorrectly flagged for a inspection?*
 - *And what about the results for the farms not flagged for inspection by both approaches?*





Judging performance of new targeting approach – Look at results across decile tables





Interpretation

➤ Cattle ID inspections

- Upper deciles seem to preferentially flag non-compliant farms and farms warranting larger financial penalties
- Lower deciles seem to preferentially flag compliant farms and farms warranting lesser financial penalties

➤ Sheep and goat inspections

- Lower deciles seem to preferentially flag compliant farms and farms warranting lesser financial penalties



Interpretation

True positive rates

- Comparison of true positive rates for random selections, current targeting and new targeting are consistent with new targeting being better than random inspections (2.1-2.2x times better) and current targeting approach (1.5-1.8x better)



Issues in interpretation

- Lots of missing predictor data with new targeting approach
 - what a difference better predictor data coverage would make on performance of new approach?
- Very small overlap in selections between current and new targeting approaches
 - Given above, extent to which performance metrics reported for new approach are generalisable to entire dataset, i.e.
 - *what about the farms that were flagged for inspection by the new approach but not the current*
 - *potentially incl. farms correctly and incorrectly flagged for insp.*
 - *what about the farms that were not flagged by either*
 - *potentially incl. farms correctly and incorrectly not flagged for insp.*



Next steps – Options

- Do nothing
- More comprehensive trial and assessment of approach (additional inspections)
- Use new approach to refine selections of current – i.e. preferentially select likely worst performers and deselect likely good performers
- Look to operationalise S&G (>0% model and or >3% model)
- Look to operationalise S&G and Cattle (>0% model and or >3% model)



Thanks for listening, any questions?

