One prediction that should come true: The agenda

A4: The evolution of predictive underwriting

Drawing on our knowledge and experience of predictive underwriting developments in the UK and international markets, we will summarise:

- what techniques are involved in predicting underwriting outcomes
- why predictive underwriting can help individualise the underwriting process for our customers
- how approaches to predicting underwriting outcomes have evolved over time
- which approaches work best for different types of insurer
- what lessons can be learned from our market, other markets and other industries.

Those attending the session will leave with a knowledge of predictive underwriting and ideas on how it could be applied to their business.

Speakers: Jonathan Hughes and Rachel Wood, Munich Re

Level: No prior knowledge required

Product Development Actuaries at Munich Re

UK & Irish Life business

Experience of UK predictive underwriting implementations

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Fundamental result of a predictive underwriting exercise

A non-technical summary of modelling approaches

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Different ways to use a predictive underwriting model

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A simple approach from 10 years ago

A more recent example

The next stage of evolution

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Recap pros and cons

Suggest optimal circumstances for each approach

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What we thought would be hard

(and what actually was)

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Let's check the room's prior knowledge…

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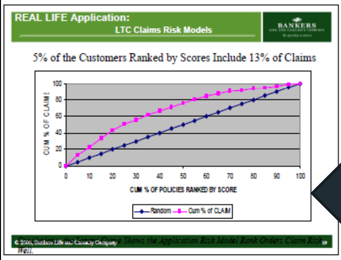
What techniques are involved in predicting underwriting outcomes

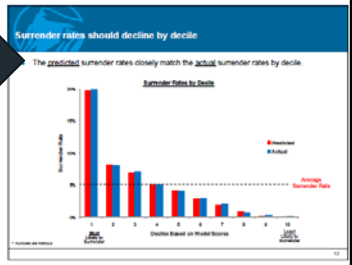
Fundamental result of a predictive underwriting exercise

A non-technical summary of modelling approaches

We have all seen predictive modelling in other industries, but **its use is increasing in ours**

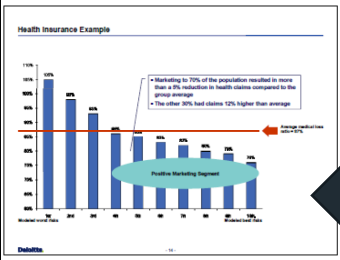


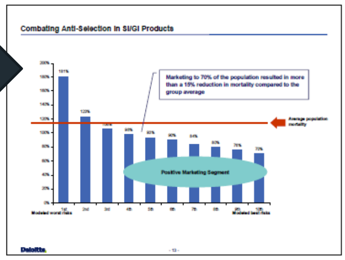
Protection lapse segmentation



LTC claims segmentation

Simplified issue underwriting segmentation

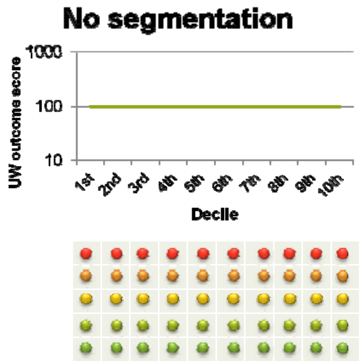




Health insurance claims segmentation

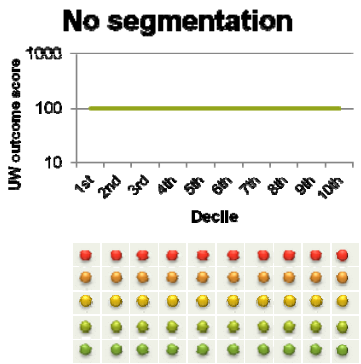
Source: Society of Actuaries seminar

"Predictive underwriting" simply applies these techniques to the underwriting process



The colours represent the true UW outcome for each life in this distributor's customer base

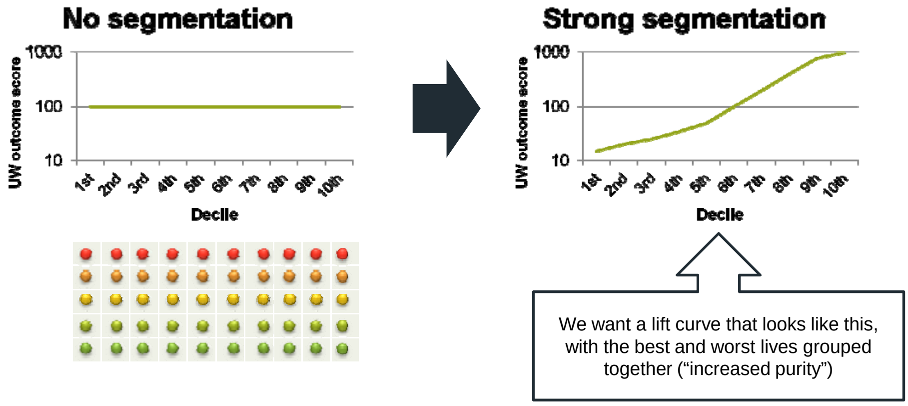
"Predictive underwriting" simply applies these techniques to the underwriting process



With no predictive modelling, each decile represents the same risk – and hence needs the same (full) UW process ("perfect impurity")

The colours represent the true UW outcome for each life in this distributor's customer base

"Predictive underwriting" simply applies these techniques to the underwriting process



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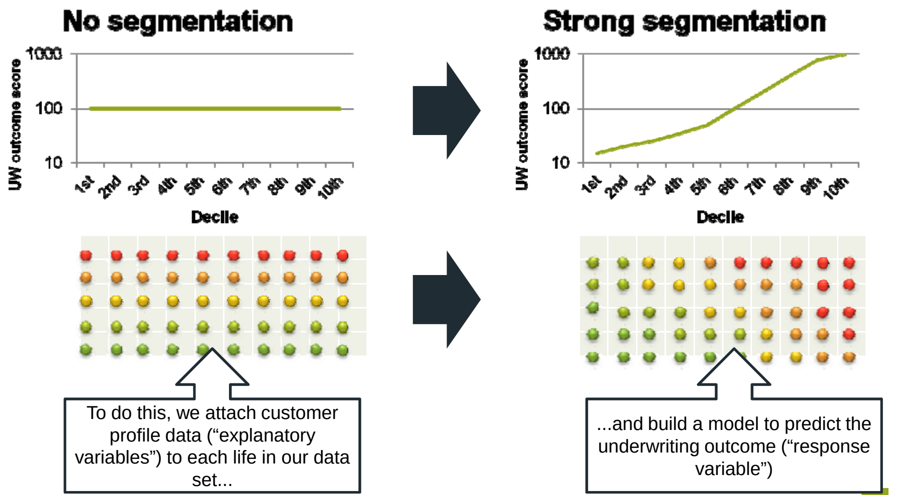
"Predictive underwriting" simply applies these techniques to the underwriting process



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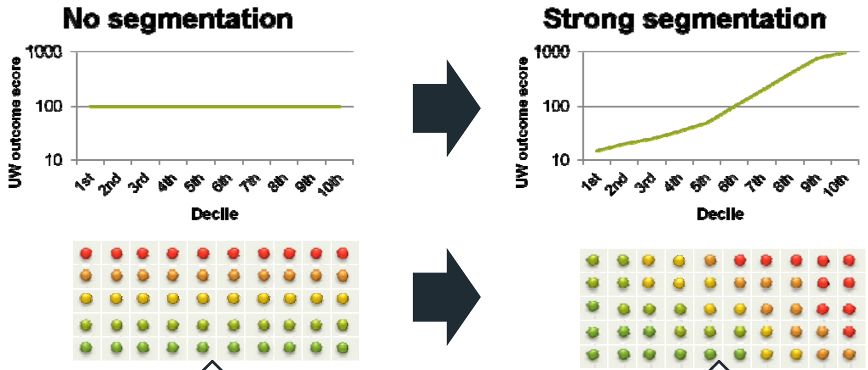
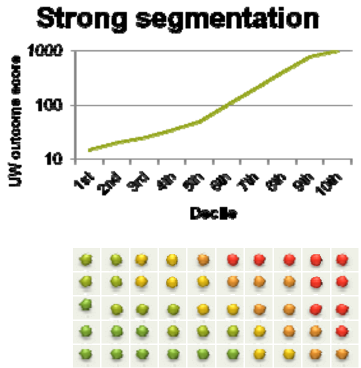


By grouping "people like this" with similar lives…

…we hope to get "outcomes like this" grouping together too

"Predictive underwriting" simply applies these techniques to the underwriting process

With a steep enough lift curve, we can be confident in offering each segment a radically different proposition



The **modelling itself is quite straightforward** (you don't even need actuaries…)

What (the three data sets)	How (the many techniques)	Who (the bodies)
Analyse the training data to identify the powerful predictive factors → Use the test data to check the degree of segmentation → Check for over-fitting with a final test against the validation data	Cluster analysis; CART; Neural networks; MARS; GLMs	▪ Insurers, reinsurers and data mining firms all have strengths in some of these techniques ▪ Each has its own strengths and weaknesses; a combination of approaches is usually best ▪ The key constraint is not skills but time: **who has the bandwidth and focus to do this properly?**

Cluster analysis

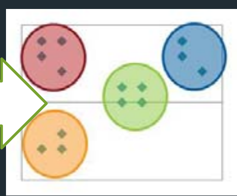
What it is

Each life is assigned a series of characteristics from both the customer profile data and outcome data.

The lives are grouped by numerical methods to minimise the characteristic variance within each group and maximise it between the groups.

There are many different methods to do this.

A two-dimensional 4-cluster analysis



Strengths

✓ Commonly used in many industries. Direct marketing agencies in particular will be familiar with these techniques

✓Commercial software is available (although these should be relatively easy to self-build anyway)

✓A good way to spot common characteristics between groups of lives and interrogate the drivers behind the outcomes

Weaknesses

×Not a predictive model by itself

×Although two dimensions are easy to understand and check "by eye", more dimensions become quite complex to sense check (although techniques such as principal factor analysis can help here)

×Some care is needed to normalise each characteristic (otherwise a factor with a large nominal scale can swamp the others)

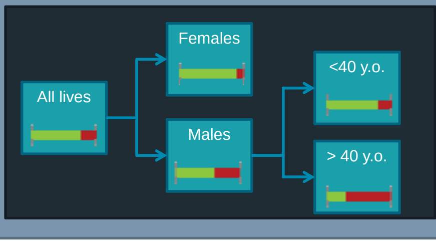
CART
(Classification and regression trees)

What it is

The aim is to maximise the “purity” of each segment.

Start by finding the one “cut” you can make to the data that yields the most increase in purity (e.g. split by gender).

Then look at each segment in turn and keep cutting (e.g. split into under and over 40s).



Strengths

✓ Simpler than MARS (equivalent to using a step function instead of “hockey sticks”)

✓Like MARS, cross-validation is part of the process, ensuring you don’t “over cut”

✓ Easy to understand (although the maths determining when to stop cutting is a bit trickier)

✓Gives clear decision rules for segmentation

Weaknesses

× Does not always yield the optimal split (although adjustments to the approach can be made to improve this)

×Less flexible than MARS

×Although good for data exploration, it does not yield by itself a predictive model

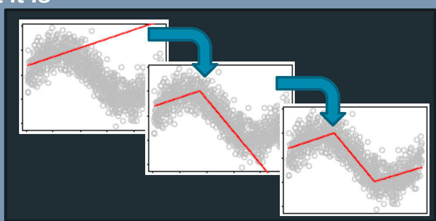
MARS
(Multivariate adaptive regression splines)

What it is

MARS is a linear collection of “hockey stick” functions plus their interactions.

In essence, you start by drawing a straight line. Where it diverges from the data, you add a new line.

Overfit the data, then prune it back until you have the best fit.



Strengths

✓ Like CART, cross-validation is a part of the modelling process, ensuring you don’t add too many “knots”

✓Provides a finer segmentation than, say, decision tree approaches

✓Generally faster to build and implement than, say, neural nets

Weaknesses

× Simple MARS models can actually be equivalent to GLMs

×Actuaries are generally less familiar with these techniques => harder to build and maintain an analytical capability

Neural networks

What it is

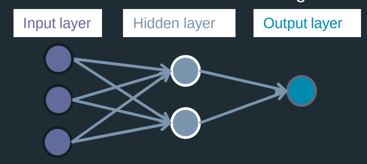
A neural network models Y as a non-linear function of X.

The "input layer" represents X_1, X_2, etc.

The "output layer" represents Y.

The connections between each node transform the incoming signal.

In essence, the model is specified by the layer architecture and associated weights:



Strengths

✓ Very flexible: can be designed to mimic pretty much any non-linear function

✓ Better than decision trees for continuous variables

✓ No need to assume linearity on the link function scale (unlike GLMs)

Weaknesses

× Often considered a black box (although this need not actually be the case)

× Although there is some decent software out there, it less commonly used by actuaries, who are more familiar with GLMs

× Since a logit GLM actually closely resembles a neural net in some instances, we tend to prefer GLMs

GLMs (Generalised linear models)

What it is

Choose a response variable and look at your data to quantify the impact of each potential explanatory variable on the response.

You specify a model and then solve for the coefficients to minimise the error.

The model outputs the impact each explanatory variable has on the response.

Strengths

✓Relaxes many of the linearity assumptions of classic regression – can use any member of the exponential family of distributions

✓Excels at stripping out mix of business effects to quantify the true underlying variable

✓Commonly used among actuaries, with good commercial software available => generally the technique with the lowest overhead

Weaknesses

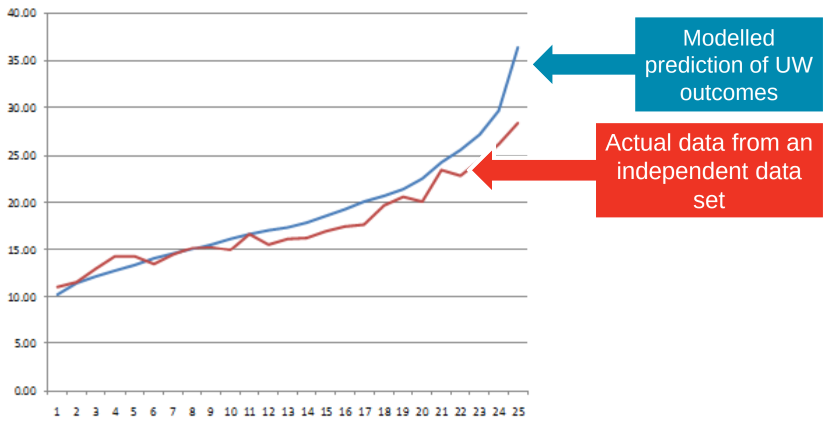
× Becomes unwieldy with large numbers of interactions between variables

×The user specifies in advance the model structure (although there are ways to test appropriateness)

×Still requires linearity in the link function, so not as flexible / universal as, say, neural nets (although GLMs can be extended with techniques such as GAMs etc)

Whichever technique is used, **the "acid test" is generally the same**

After segmentation, use "hold out" data to check the validity of the model



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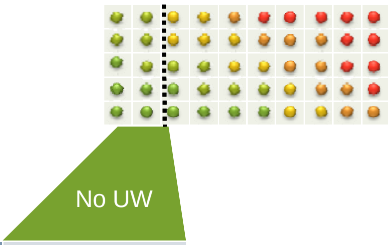
Why predictive underwriting can help individualise the underwriting process for our customers

Different ways to use a predictive underwriting model

The usual approach is to **create segments and tailor your proposition** to each one



	No UW
Marketing approach	Tightly time-bound (“flash sale”)
Underwriting process	Guaranteed acceptance
Mortality pricing	+++% for no UW - -% for good profile
Other pricing	- -% for low expenses

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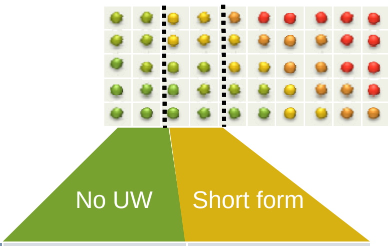
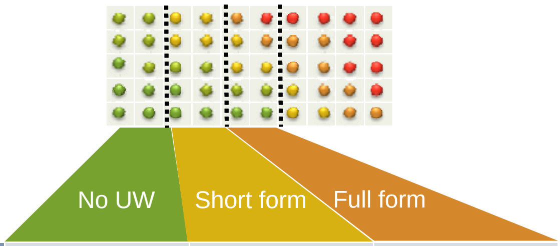


	No UW	Short form
Marketing approach	Tightly time-bound (“flash sale”)	Some time limits (“hurry before your next birthday”)
Underwriting process	Guaranteed acceptance	Very short form, questions tailored to each applicant
Mortality pricing	+++% for no UW - -% for good profile	++% for limited UW - % for good profile
Other pricing	- -% for low expenses	- -% for low expenses

The usual approach is to **create segments and tailor your proposition** to each one



Marketing approach	Tightly time-bound ("flash sale")	Some time limits ("hurry before your next birthday")	Focus on high take-up cases
Underwriting process	Guaranteed acceptance	Very short form, questions tailored to each applicant	Traditional UW form
Mortality pricing	+++% for no UW - -% for good profile	++% for limited UW - % for good profile	+% for poor profile
Other pricing	- -% for low expenses	- -% for low expenses	-% for low expenses?

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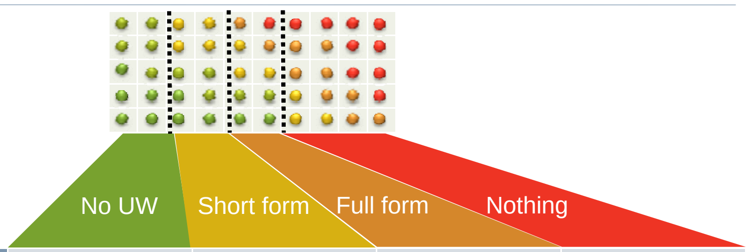
The usual approach is to **create segments and tailor your proposition** to each one



Marketing approach	Tightly time-bound ("flash sale")	Some time limits ("hurry before your next birthday")	Focus on high take-up cases	No approach
Underwriting process	Guaranteed acceptance	Very short form, questions tailored to each applicant	Traditional UW form	n/a
Mortality pricing	+++% for no UW - -% for good profile	++% for limited UW - % for good profile	+% for poor profile	n/a
Other pricing	- -% for low expenses	- -% for low expenses	-% for low expenses?	n/a

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How approaches to predicting underwriting outcomes have evolved over time

A simple approach from 10 years ago

A more recent example

The next stage of evolution

The first predictive underwriting propositions (of which we're aware) were **about 10 years ago**

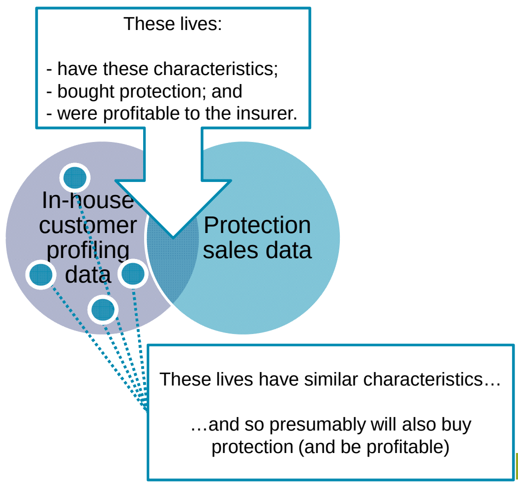
Predictive underwriting is not a new creature, but it has evolved

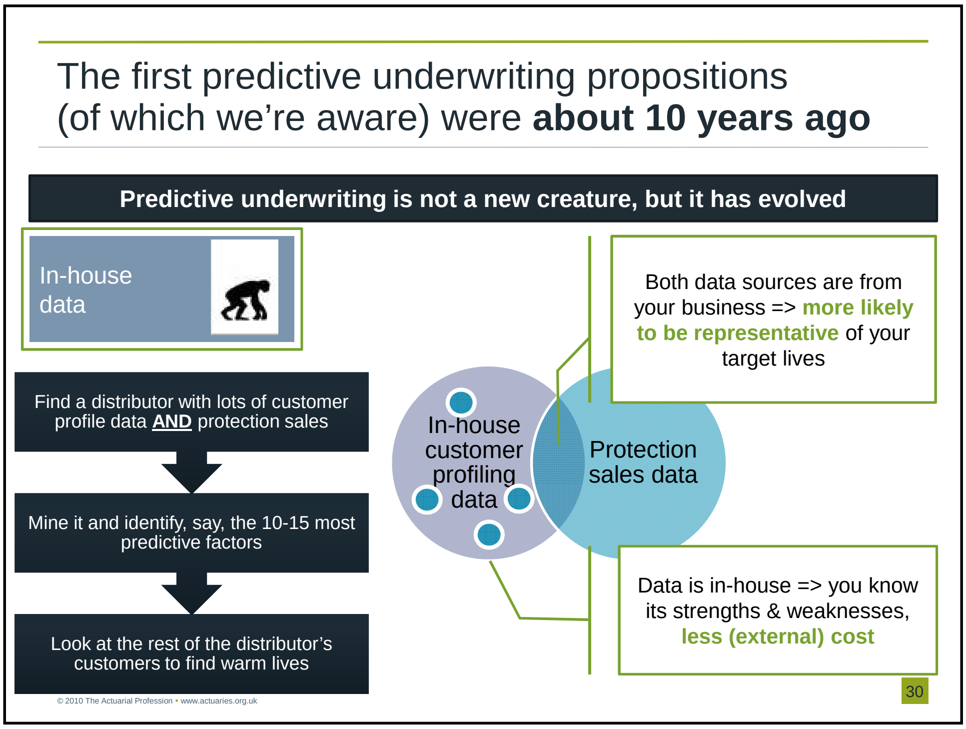
In-house data

Find a distributor with lots of customer profile data **AND** protection sales

Mine it and identify, say, the 10-15 most predictive factors

Look at the rest of the distributor's customers to find warm lives

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Predictive underwriting is not a new creature, but it has evolved
In-house
data
Find a distributor with lots of customer profile data AND protection sales
Mine it and identify, say, the 10-15 most predictive factors
Look at the rest of the distributor's customers to find warm lives
In-house customer profiling data
Protection sales data
Both data sources are from your business => more likely to be representative of your target lives
Data is in-house => you know its strengths & weaknesses, less (external) cost
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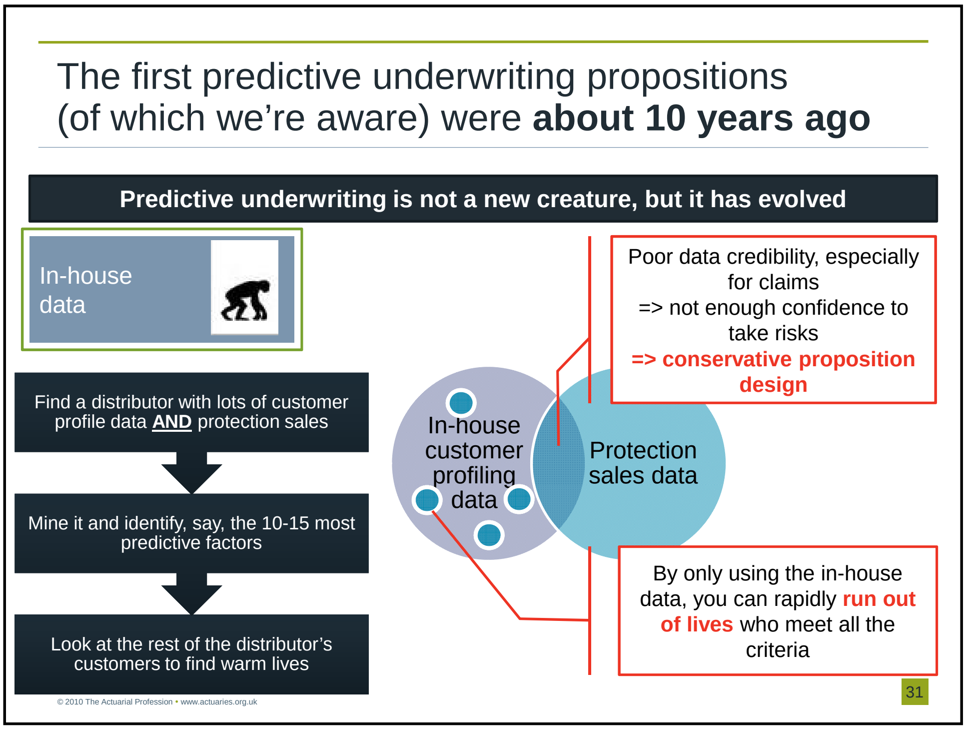
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Look at the rest of the distributor's customers to find warm lives
In-house customer profiling data
Protection sales data
Poor data credibility, especially for claims
=> not enough confidence to take risks
=> conservative proposition design
By only using the in-house data, you can rapidly run out of lives who meet all the criteria
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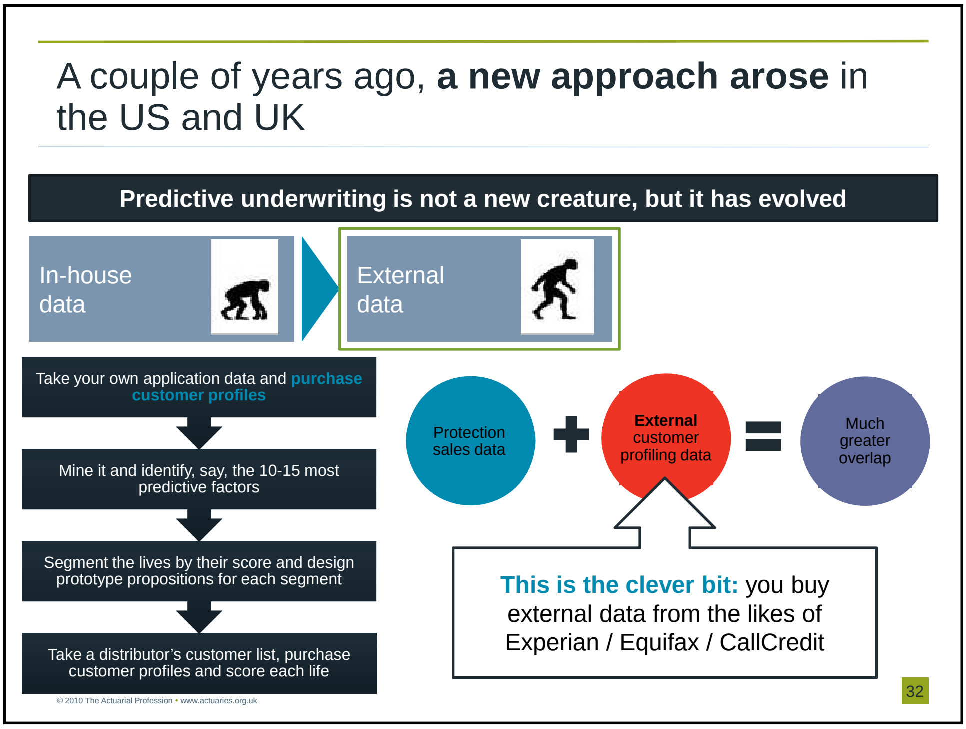
A couple of years ago, **a new approach arose** in the US and UK
Predictive underwriting is not a new creature, but it has evolved
In-house data
External data
Take your own application data and purchase customer profiles
Mine it and identify, say, the 10-15 most predictive factors
Segment the lives by their score and design prototype propositions for each segment
Take a distributor's customer list, purchase customer profiles and score each life
Protection sales data
External customer profiling data
Much greater overlap
This is the clever bit: you buy external data from the likes of Experian / Equifax / CallCredit
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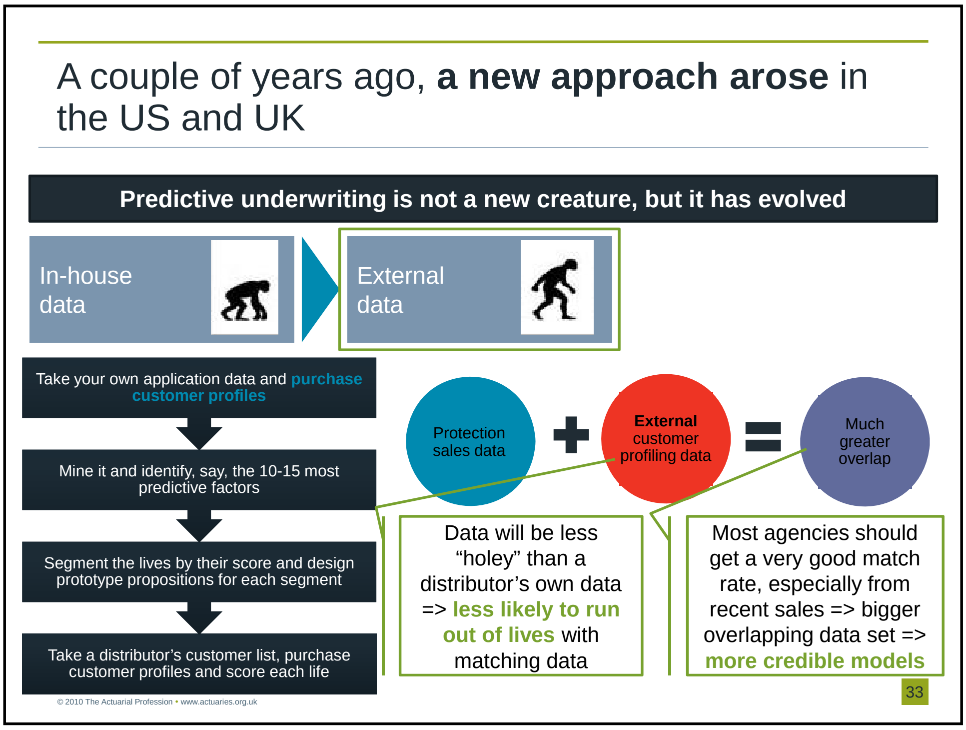
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Segment the lives by their score and design prototype propositions for each segment
Take a distributor's customer list, purchase customer profiles and score each life
Protection sales data
External customer profiling data
Much greater overlap
Data will be less "holey" than a distributor's own data => less likely to run out of lives with matching data
Most agencies should get a very good match rate, especially from recent sales => bigger overlapping data set => more credible models
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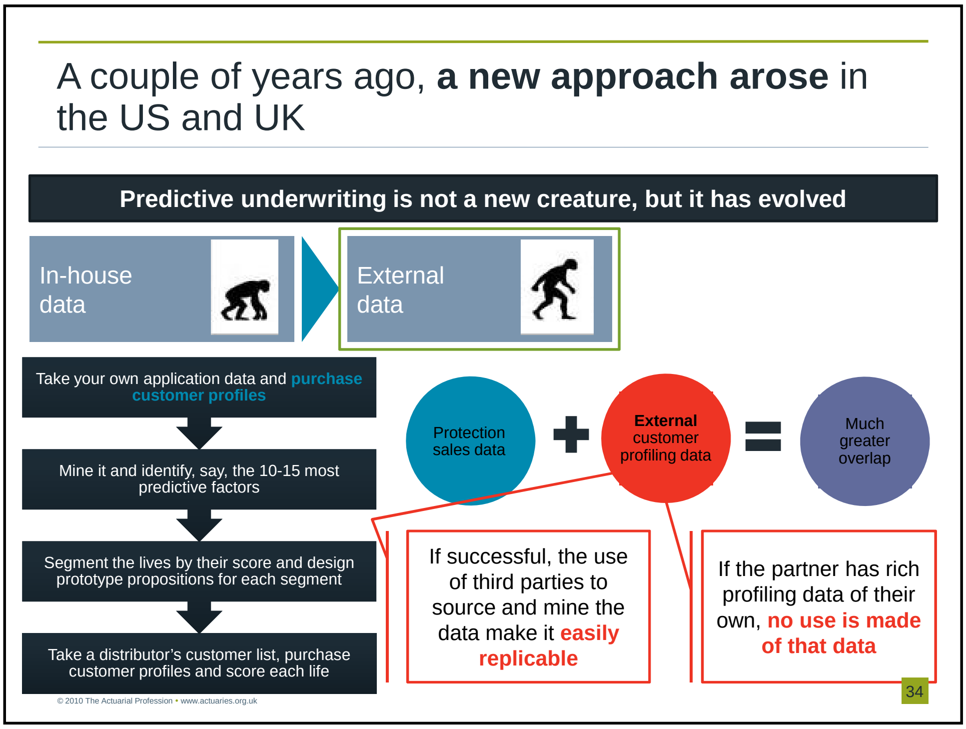
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Segment the lives by their score and design prototype propositions for each segment
Take a distributor's customer list, purchase customer profiles and score each life
Protection sales data
External customer profiling data
Much greater overlap
If successful, the use of third parties to source and mine the data make it easily replicable
If the partner has rich profiling data of their own, no use is made of that data
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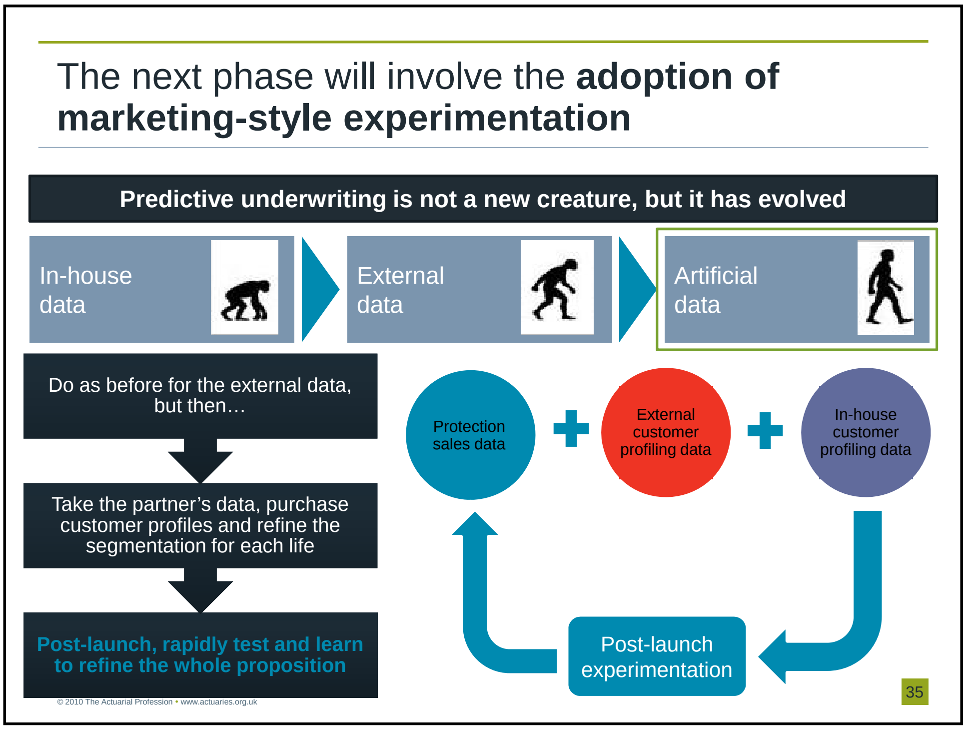
The next phase will involve the **adoption of marketing-style experimentation**
Predictive underwriting is not a new creature, but it has evolved
In-house data
External data
Artificial data
Do as before for the external data, but then…
Take the partner's data, purchase customer profiles and refine the segmentation for each life
Post-launch, rapidly test and learn to refine the whole proposition
Protection sales data
External customer profiling data
In-house customer profiling data
Post-launch experimentation
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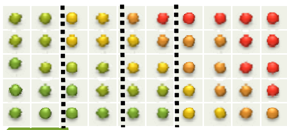
(But first let's quickly deal **with combining the external and internal data**)



No UW

Marketing approach	Tightly time-bound ("flash sale")
Underwriting process	Guaranteed acceptance
Mortality pricing	+++% for no UW - -% for good profile
Other pricing	- -% for low expenses

Refine each segment using the partner's data

- Buys cigarettes
- No family purchases (e.g. nappies)
- High proportion of unhealthy purchases (e.g. take-aways) relative to healthy ones (e.g. fruit & veg)

Move from this segment to a fully underwritten segment

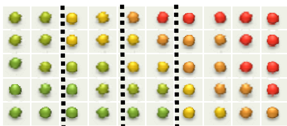
No change

- Evidence of family purchases
- Low proportion of unhealthy to healthy purchases

Reduce mortality pricing further

36

(But first let's quickly deal **with combining the external and internal data**)



No UW

Marketing approach	Tightly time-bound ("flash sale")
Underwriting process	Guaranteed acceptance
Mortality pricing	+++% for no UW - -% for good profile
Other pricing	- -% for low expenses

Refine each segment using the partner's data

- No family
- Poor credit score
- Often overdrawn
- Irregular income

Move from this segment to a fully underwritten segment

No change

- Child benefit recently increased
- Good credit score
- Good salary trajectory
- Positive direct debits (e.g. gym membership)

Reduce mortality pricing further

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The next phase will involve the **adoption of marketing-style experimentation**

Post-launch experimentation is not a trivial exercise

1 State your hypothesis of record

This involves clearly defining each and every initial cause-and-effect assumption that you make. For example:

"An application process, marketed well, that involves only two short questions will increase take-up by good risks by 150% and bad risks by 300%"

Obviously you test and research as many of these pre-launch as possible

The next phase will involve the **adoption of marketing-style experimentation**

Post-launch experimentation is not a trivial exercise

1 State your hypothesis of record

2 Design your proposition accordingly

After completing your pre-launch research, you design a proposition that fits your hypothesis of record:

Lives with a good mortality score	**Lives with a bad mortality score**
Very short application form Shortened process actively sold to potential applicants	Traditional application form No emphasis on process during marketing

The next phase will involve the **adoption of marketing-style experimentation**

Post-launch experimentation is not a trivial exercise

1. State your hypothesis of record
2. Design your proposition accordingly
3. Design experiments to test your initial assumptions

	Short UW	Full UW
Market the process	90% of good lives 0% of bad lives	N/A
Don't market the process	5% of good lives 5% of bad lives	5% of good lives 95% of bad lives

True "test and learn" is about much more than just the usual actuarial control cycle (although many of us fail to do even that…)

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Which approaches work best for different types of insurer

Recap pros and cons

Suggest optimal circumstances for each approach

Each evolutionary phase has its **strengths and weaknesses**

Predictive underwriting is not a new creature, but it has evolved

In-house data

✓ Pretty straightforward to implement

Can be done entirely in-house

✗ Lacks scalability

Can lead to conservative propositions

Works for companies which...

✓Have clean, stable, accessible customer profile data

✓Have a clearly defined, known target market

Each evolutionary phase has its **strengths and weaknesses**

Predictive underwriting is not a new creature, but it has evolved

In-house data

✓ Pretty straightforward to implement

Can be done entirely in-house

✗ Lacks scalability

Can lead to conservative propositions

External data

✓ Easily replicable across new channels

✗ Easily replicable by competitors

Only builds limited intellectual property

Works for companies which...

✓Are not in open competition for access to the target customers

✓Have speed and time-to-market as the highest priority

Each evolutionary phase has its **strengths and weaknesses**

Predictive underwriting is not a new creature, but it has evolved

In-house data	External data	Artificial data
✓ Pretty straightforward to implement Can be done entirely in-house	Works for companies which... ✓Will be in regular, open competition for access to the target lives ✓Have flexible administration that allows cheap, controlled experiments	✓ Constantly improves Robustness allows radical propositions
✗ Lacks scalability Can lead to conservative propositions		✗ Requires a larger degree of admin flexibility

Each approach can be successful and has its place

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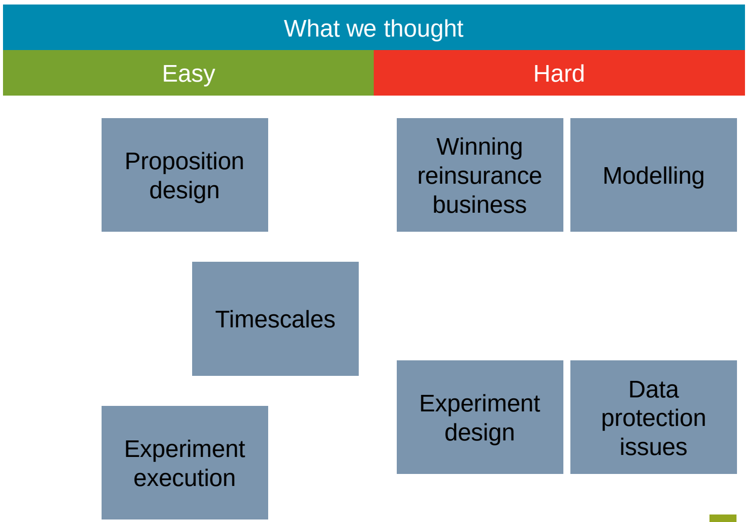
What lessons can be learned from our market, other markets and other industries

What we thought would be hard

(and what actually was)

What we thought would be hard...



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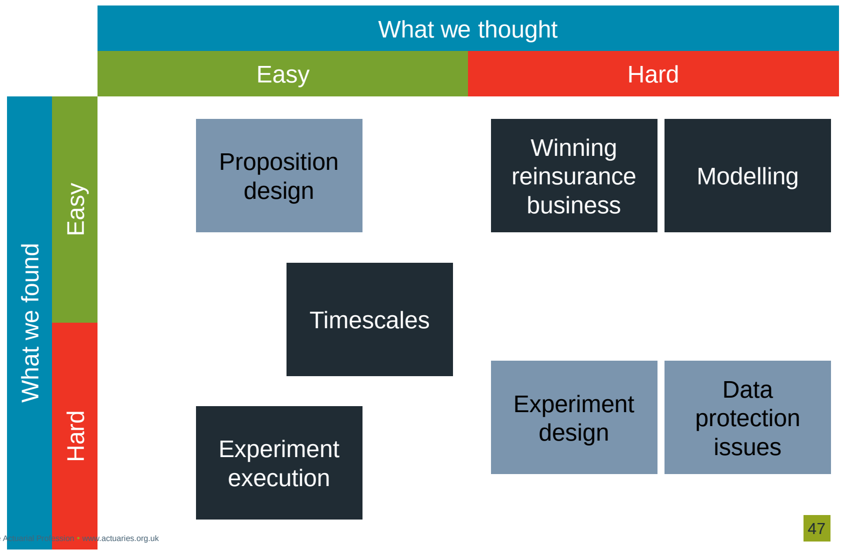
What we thought would be hard...
...and what actually was



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Those attending the session will leave with a knowledge of predictive underwriting and ideas on how it could be applied to their business

Five key parts of a predictive underwriting proposition

Final thoughts

Most predictive underwriting propositions we have seen involve **five key components**

Consider all possible **sources of data:**

-In-house
-Commercially available
-Distributor-specific

1 Understand what data you have…

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Most predictive underwriting propositions we have seen involve **five key components**

Do some **"quick n' dirty" modelling** to see what sort of segmentation you believe could be possible

2 …and how useful it is

1 Understand what data you have…

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Most predictive underwriting propositions we have seen involve **five key components**

As well as in-house or reinsurer resource, remember that there is ample **expertise commercially available**:

-Marketing firms often have this expertise
-Boutique modellers

3 Source the modelling skills

2 …and how useful it is

1 Understand what data you have…

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Most predictive underwriting propositions we have seen involve **five key components**

4 Be able to tailor an underwriting process to specific applicants

3 Source the modelling skills

2 …and how useful it is

1 Understand what data you have…

Having segmented the potential customer base, you need to be able to **design a robust process** that suits their specific characteristics (not all lives will be low risk)

Most predictive underwriting propositions we have seen involve **five key components**

5 Make your assumptions explicit (and test them)

4 Be able to tailor an underwriting process to specific applicants

3 Source the modelling skills

2 …and how useful it is

1 Understand what data you have…

Ditch those **frustrating "gut feel" arguments**: find a way to express the key assumptions you're making and just test them

Final thoughts

Predictive underwriting requires technical skill…	…but it is not a technical subject
It creates new protection risks…	…but in many ways these can be better analysed and understood than traditional business
There are numerous ways to implement it…	…and each has its place

Predictive underwriting can be a powerful tool for offering our customers a better proposition

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Questions or comments?

Expressions of individual views by members of The Actuarial Profession and its staff are encouraged.

The views expressed in this presentation are those of the presenter.

If you're feeling shy, email us:

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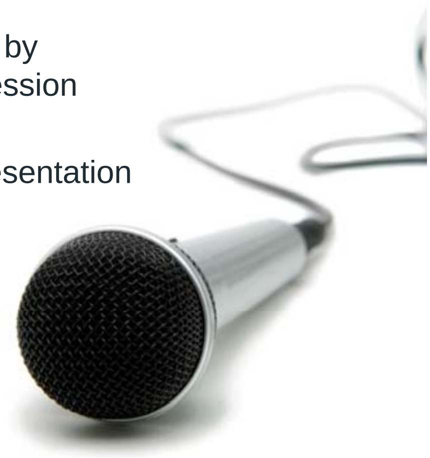

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