The purpose of scaling is to convert the raw scores (coefficients), generated at the end of the scorecard build, into a useable business tool.

Scaling is a simple process of linear transformation. It does not change the performance of the scorecard in anyway, but facilitates its presentation.

Starting point.

Score1 is the score for an individual based on the "raw" scorecard. This is typically the result of a logistic regression. It includes a constant and several characteristics.

This value gives the log odds (ln) for each individual in the sample. The logarithms are so-called "natural" logarithms (to base e = 2.7813...). A score of 0 (= ln 1) corresponds to odds of 1:1, a score of 1.4 (= ln 4) to odds of 4:1 etc.

Adding ln2 (= 0.7 roughly) to this "natural" score corresponds to doubling the odds.

Example for a 2 characteristics scorecard:

Constant: 2.5

Accommodation type “owner” co-efficient: +3.0

Time with main banking provider “< 2 years” co-efficient: -0.3

Score1 = 2.5 + 3.0 - 0.3 = 5.2

Step 1: correction for biased sample

Frequently, a scorecard estimation is not based on a random sample of the entire population. "Bads" are over-sampled. So, the first step is to correct for the bias introduced by the sampling. The odds observed on the sample should be corrected to allow for this sampling bias.

Thus Score2 = Score1 + ln(sampling fraction of bads) - ln(sampling fraction of goods).

For example, if 100% of Bads and 10% of Goods were included in the sample then:

Score2 = Score1+ ln(1) - ln(0.1) = Score1 + ln(10)

This corresponds to multiplying every individual's odds by 10, to correct for the sample bias.

Calculation:

Example: Score2 = Score1 (= 5.2) + ln(10) (= 2.3) = 7.5

Score2 is still on the log-odds scale, but now corresponds to the estimated "real" risk at the population level, not that observed on the (biased) sample. A score of 7.5 gives a log-odds of 7.5 or odds of exp(7.5) = 1808:1. This gives a probability of default of 0.055%.

Step 2: scale up to standard slope

Business convention is to adopt a standard scale to express scores. The most common scale is given by Points to Double Odds (PDO) = 20

In Score2, adding ln 2 (= 0.693… i.e. approx. 0.7) to an individual's score doubles their odds. For Score3, adding 20 should do the same thing. This is achieved by:

Score3 = Score2 x PDO / ln 2.

Example: Score2 = 7.5; PDO = 20

Score3 = 7.5 x 20 / 0.693 = 216

Step 3: centre the score to make a chosen score = odds of 1:1

A score of 0 still corresponds to 1:1 odds. It is convenient to apply an offset, so ensure that all scores are positive. This is done by simply adding a constant to each individual's score.

For instance, suppose it is desired that a score of 160 corresponds to 1:1 odds in the final score. Then,

Score4 = Score3 + 1:1 score

216 + 160 = 376

Final Score-Odds Line

These steps generate scores which can be interpreted by a pre-determined score-odds line. In the example given, this has PDO = 20 and odds of 1:1 at a score of 160. This facilitates monitoring: score-odds lines should always match this standard.

Example:

Score		Odds
160	=	1/1
180	=	2/1
200	=	4/1
220	=	8/1

Choice of 1:1 Score

This stage is to produce scores which have common meaning throughout the organisation. This could be a ubiquitous 1:1 score - e.g. all scorecards are scaled to give odds of 1:1 at a score of 500 and 20 points to double the odds. A given score has the same meaning regardless of scorecard type.

Alternatively, this can be varied depending on the type of scorecard.

Examples:

Score		Odds	Scorecard type
100	=	4/1	Mailing / response scores
200	=	4/1	Application scores
400	=	4/1	Collections scores
600	=	4/1	Behaviour scores

Scaling scorecard coefficients

The process described up to now converts each individual's score to the pre-determined standard. It is also necessary to put the scorecard itself (the coefficients) on this standard.

This ensures that the scaled scorecard will give the scaled scores as described above. Once again, it involves a linear transformation of the "raw" scorecard coefficients:

- Multiply each coefficient by PDO/ln 2
- Add a the conventional 1:1 score as a constant offset to each individual's score.

This results in the "correct" scores, but some attributes will get negative score coefficient and every score includes a constant which is difficult to explain in a business context. Therefore, a convention has arisen of distributing the constant over the different scorecard characteristics to make all coefficients positive and to give the same minimum score on each characteristic. This process makes no difference whatsoever to the scores for the individuals, but results in a scorecard which matches a business convention. It facilitates the communication and use of the scorecard in a business environment.

Integer Coefficients.

The final scorecard coefficients will not be integers. To get to whole numbers, round all attribute scores to integer values.

Rounding slightly reduces the discriminant power of the scorecard and so the integer values can be adjusted to improve discrimination. To ensure this does not lead to any imbalance in the scorecard the Marginal Chi squared should be used to test for misalignment. Calculate delta scores to show if further adjustments are needed.