

Technical Working Party on Testing Methods and Techniques

TWM/1/7

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COMBINED-OVER-YEAR UNIFORMITY (COYU) CRITERION: EXTRAPOLATION

Document prepared by experts from the United Kingdom

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INTRODUCTION

1. This document describes the issue of extrapolation in relation to COYU. It makes proposals about how this issue can be managed. These proposals are open for discussion by experts.
2. In UPOV document TWC/31/15 corr., the issue of extrapolation was raised in connection with COYU. This issue is relevant to both old and improved methods of COYU, but was only identified during the development of the improved method.
3. In the context of COYU, extrapolation is where a candidate variety has a mean score outside the range of scores expressed by the reference varieties in a particular year. Figure 1 shows an example.

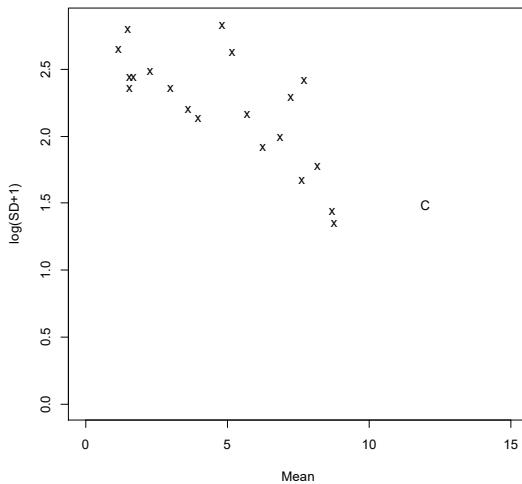


Figure 1: Example of extrapolation. For a single year/cycle, a measure of variability (log of the standard deviation of within-plot scores) is plotted against the mean score (read document TGP/8 for more details on COYU). The reference varieties are represented by 'x' and the candidate by 'c'. The candidate has a larger mean than any of the reference varieties. Whilst a trend can be seen in the reference varieties, can we extend this out to the candidate?

4. Extrapolation is a problem both in principle and technically. The General Introduction to the Examination of Distinctness, Uniformity and Stability and the Development of Harmonized Descriptions of New Varieties of Plants (TG/1/3) says in relation to uniformity:

“6.4.2.2.1 For measured characteristics, the acceptable level of variation for the variety should not significantly exceed the level of variation found in comparable varieties¹ already known.”

If the level of expression of the candidate variety is very different from the set of “comparable” varieties, it might be questioned whether these varieties are actually comparable.

5. Extrapolation is particularly important as in COYU we adjust for the relationship between variability between plants and the mean. Such as relationship occurs in many characteristics. Within the range of the reference varieties, the relationship can be based on the evidence provided by these varieties. Outside the range, the relationship is speculative. Indeed, the old and new methods of COYU give substantially different “guesses” as to the relationship (see below).
6. Previously, cases of extrapolation were not routinely flagged. For the new method, we have suggested that cases of extrapolation should be flagged and given special attention by DUS experts. In such cases, the verdicts indicated by COYU, old or new, should not be automatically accepted. Indeed, decisions for the two methods may be quite different from each other when there is extrapolation.

HOW NEW AND OLD COYU METHODS PERFORM WITH EXTRAPOLATION

7. The old and new COYU methods differ in the statistical model used to relate variability to the mean scores. The old method uses moving averages, and the new method uses splines.
8. This has the following repercussions when there is a case of extrapolation:
- Outside the range of the reference varieties, the line is horizontal for moving averages (following the trend of the outer varieties), and linear but not necessarily horizontal for splines. This is illustrated in Figure 2.
 - Relative to the fitted line, the uncertainty used to produce the COYU threshold is undetermined, and presumed constant for COYU with moving averages outside the range of the reference varieties, but increases using the new COYU the further away from the reference varieties. This is illustrated in Figure 3.

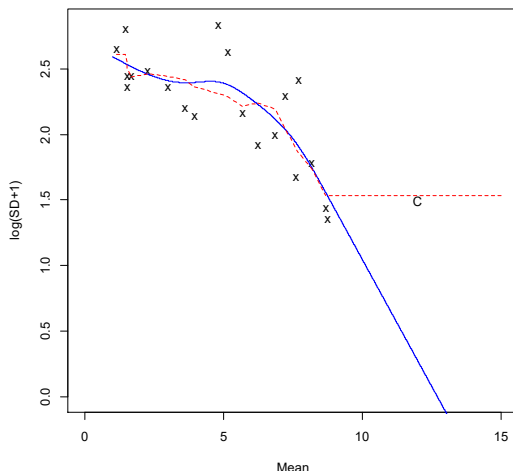


Figure 2: Example from Figure 1 showing how the moving average and spline trend extend when extrapolating outside the range of the reference varieties. The reference varieties are represented by 'x' and the candidate by 'c'. The red dashed line is for the moving average method, and the blue line is for the spline.

¹ Comparable varieties are known varieties believed to be of a similar type or nature to the new variety in question. This terminology is used in TG/1/3 and TGP/8/3 in preference to the term reference varieties in this context

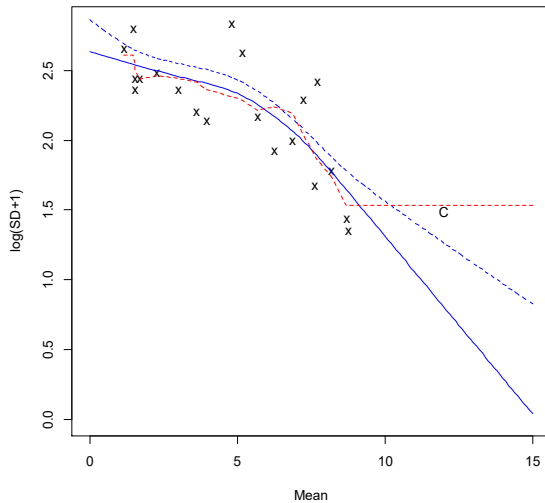


Figure 3: Example continued from Figure 2. Here, a blue dashed line represents one standard error for prediction above the spline trend line. Note, this standard error is not used directly, but enters into the COYUs calculations through an amalgamation with the other years/cycles. It does show though the steep increase in the uncertainty due to extrapolation

9. Figure 2 shows how the two COYU methods may lead to different conclusions. The candidate is under the moving average trend line for the moving average but considerably above it for the spline. It is arguable that the COYU with splines treats cases with extrapolation more sensibly. The line fitted seems a better guess for what might happen, and the increasing uncertainty better reflects the reality.

DEFINING EXTRAPOLATION

10. How should we define extrapolation in practice? A strict definition where the candidate score is outside the range of the reference varieties, even by a minuscule amount, could lead to a very high number of cases for the expert to consider. In an earlier study reported at the TWC (https://www.upov.int/edocs/mdocs/upov/en/twc_35/twc_35_6.pdf, see annex, page 9), levels of strict extrapolation varied by crop, for example being relatively high for the perennial ryegrass (13%) and low for oilseed rape (1-2%).
11. In document TWC/35/6, two methods were proposed for indicating the degree of extrapolation (paragraph 19). Following this document, the second of the two methods (19b) was adopted in draft guidance and in the software code developed.
12. The extrapolation index measures the inflation of the COYU criterion for the candidate variety in question, compared to the closest reference variety.
13. In more detail, for each year/cycle, the extrapolation index is the ratio of the square roots of the spline prediction errors and the closest variety. It has a value of 1 for when there is strictly no extrapolation, and greater than 1 when the candidate is outside the range of the reference varieties. The value increases the greater the degree of extrapolation. In the developed software, the maximum index over the years/cycles is given as the overall extrapolation index for the candidate.
14. Figure 4 shows how the extrapolation index increases outside of the reference varieties. The index increases more slowly when there are more reference varieties. This reflects the greater certainty in the estimated trend.

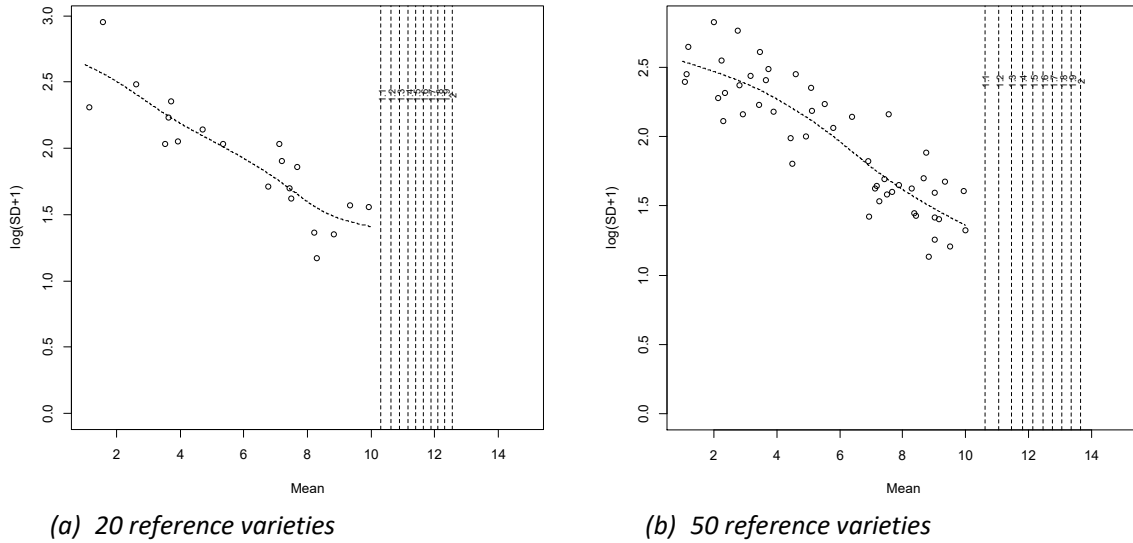


Figure 4: Two examples showing how the extrapolation index increases with distance from outer reference varieties. Vertical dashed lines indicate the extrapolation index, with values from 1.1 to 2.0. In (a), there are 20 reference varieties, and in (b) there are 50

15. We propose that a threshold is set for the extrapolation index, such that the COYU is not used if the threshold is exceeded. The choice of threshold is subjective, and needs to balance the practicalities of having too many cases with extrapolation and the need to make well-founded decisions. It would be beneficial to agree a fixed threshold for use with COYU, and this requires discussion.
16. As part of a recent United Kingdom study comparing the old and new methods of COYU, there was an analysis of how different extrapolation index thresholds would affect the number of cases identified. The study covered three years of results, in four subgroups of perennial ryegrass.
17. In the ryegrass study, there were 4640 cases in total (number of candidate variety by characteristic combinations) and 105 candidate varieties. Table 1 shows how the number of cases depends on the threshold adopted. Note that even 1% of cases would mean a considerable number of cases that need to be examine more carefully (46 in this example).

Table 1: Number of cases and candidates affected by extrapolation under varying thresholds

Extrapolation index threshold	Cases with extrapolation	Candidates with extrapolation in any characteristic
1 (= strict extrapolation)	8.4%	67%
1.1	3.8%	38%
1.2	2.3%	30%
1.3	1.5%	27%
1.4	1.0%	17%
1.5	0.9%	14%

18. Based on Figure 4, the reduction in the number of cases seen in the example, and the implications on decisions, we suggest a threshold of 1.2 as starting point for discussions in the TWM.

WHAT TO DO IN CASE OF EXTRAPOLATION?

19. With no extrapolation, the COYU criterion with splines gives a clear basis for uniformity. With extrapolation, the crop experts must apply judgement. The output from the software, including graphs, can help here. Here, we discuss the factors that may influence the decision, with examples.
20. The following should be considered:
 - The degree of extrapolation;
 - Is it likely that the trend seen in the reference varieties would extend to the candidate?
 - What is the situation in other cycles, is there also extrapolation?
21. The degree of extrapolation is key. If not great, perhaps it is possible to make judgements based on trends seen in the reference varieties. If very large, then the candidate could be seen as having no comparable varieties. In this case, perhaps the benefit of doubt should be given to the candidate.
22. The trend seen in the reference varieties may be expected for some characteristics. In these cases, there may be more confidence in extrapolation.
23. It is important to examine the other cycles/years. The COYU decision is made over cycles/years, and it can be tricky to combine results subjectively if there is inconsistency.
24. We now give some examples for consideration. In Figure 5, we have a case where there is little trend in the reference varieties. Candidate 1 is clearly low in variability compared to the reference varieties, and so might indicate satisfactory uniformity if the other cycles/years are similar. On the other hand, candidate 2 shows high levels of variability compared to the reference varieties, and there may be strong concerns about lack of uniformity.

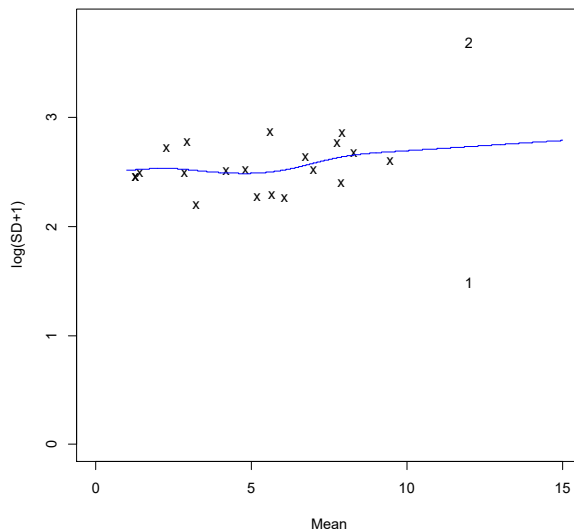


Figure 5: Example with little trend evident. The reference varieties are represented by 'x' and the candidates by '1' and '2'. The blue line is for the spline.

25. In the next example, we return to the same data as in Figure 1. Figure 6 shows the same reference variety data, but with two new candidates. Here candidate 1 is broadly in line with the trend, and arguably there would be no concerns about uniformity here. However, candidate 2 is significantly above the trend line.

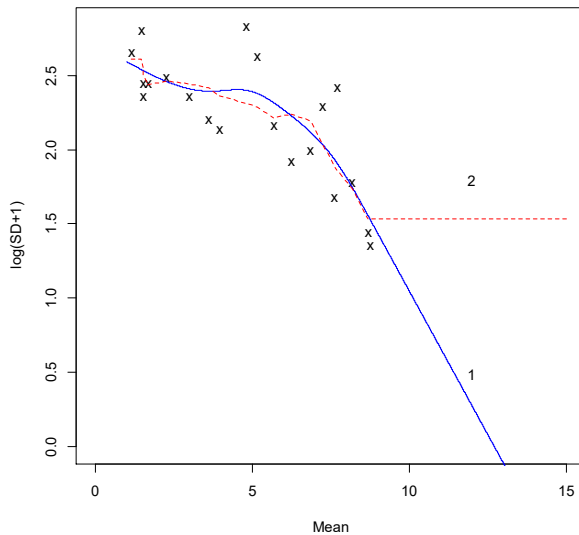


Figure 6: Example with a strong trend. The reference varieties are represented by 'x' and the candidates by '1' and '2'. The blue line is for the spline.

DISCUSSIONS NEEDED

26. Extrapolation is a newly identified issue for COYU, and there is little practical experience of managing it. Although the issue was highlighted in the development of COYU with splines, it is just as relevant to the old method. Therefore, some discussion is required on how to define it in practical terms, and on what to do when extrapolation is indicated.
27. Experts from the United Kingdom have made proposals here to start discussions within the forum of the TWM.
28. Once guidance is developed, it can be incorporated into document TGP/8, and reflected in the software.

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