Online Appendix for:

Disentangling Suboptimal Updating: Structure, Sequencing, and Complexity

Marina Agranov

Pellumb Reshidi

September 12, 2024

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1 Instructions

1.1 Common Instructions

The instructions shown in this subsection were seen by participants regardless of their treatment. These initial instructions aimed to familiarize participants with the mechanism through which they submitted their posteriors.

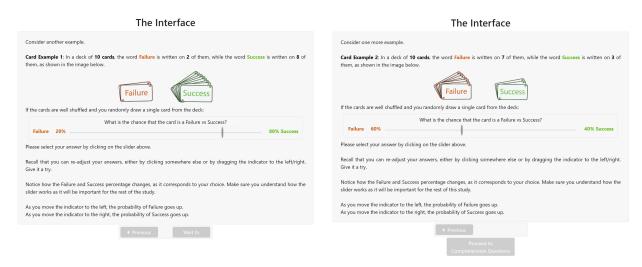
The Interface The Interface In this experiment, you will evaluate the chances that certain events happen. To explain how it works consider the following In this experiment, you will evaluate the chances that certain events happen. To explain how it works consider the following Suppose we flip a fair coin (50% chance to land on either side), which has the word Failure written on one side and the word Suppose we flip a fair coin (50% chance to land on either side), which has the word Failure written on one side and the word Failure Failure Success Consider the following trivial question Consider the following trivial question: What is the chance that the coin lands on Failure vs. Success? In the experiment, you will provide an answer to this type of question by using a slider like the one you see above. Please go ahead and click anywhere on the slider to select a point Your choice represents the % chance that the coin lands on Failure (left) and the % chance that the coin lands on Success Your choice represents the % chance that the coin lands on Failure (left) and the % chance that the coin lands on Success (right). These two percentages add up to 100. After you click somewhere on the slider, you can re-adjust your answer, by clicking somewhere else, by using the left/right arrows on your keyboard, or by dragging the indicator to the left/right. Give it a try. Notice how the Failure and Success percentage changes as you move the slider. After you click somewhere on the slider, you can re-adjust your answer, by clicking somewhere else, by using the left/right arrows on your keyboard, or by dragging the indicator to the left/right. Give it a try. Notice how the Failure and Success percentage changes as you move the slider. Setting the slider exactly at the middle means that both are equally likely (50%,50%). As you move the indicator to the left, the probability of Failure goes up, and the probability of Success goes down. As you move the indicator to the right, the opposite happens. Setting the slider exactly at the middle means that both are equally likely (50%,50%). As you move the indicator to the left, the probability of Failure goes up, and the probability of Success goes down. As you move the indicator to the right, the opposite

Figure 1: Initial Instructions I

Figure 1 shows the initial page presented to the participants. To ensure that participants spend time internalizing the information, the *Next* button was made available only after a countdown of 30 seconds.¹ On this, and every other page, there is initially no indicator on the slider via which participants submit their probabilities. We made this decision to prevent participants from being anchored. The indicator and accompanying probabilities show up only after participants click somewhere on the slider. Compare the left (before clicking) and right (after clicking) screenshots in Figure 1.

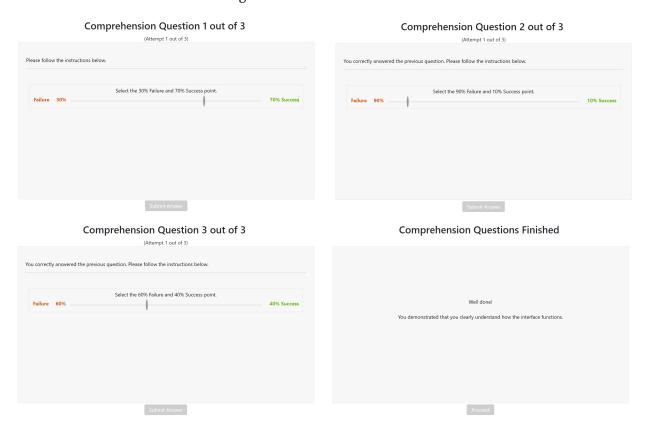
¹Compare buttons on the bottom of the left and right screenshots shown in Figure 1. The left screenshot is taken 3 seconds after the page was loaded, whereas the right screenshot is taken after at least 30 seconds.

Figure 2: Initial Instructions II



Instructions continue by giving participants two more examples and reminding them how the mechanism works; see Figure 2. After these examples, participants are invited to start a simple comprehension test to ensure they know how to use the slider properly, see Figure 3.

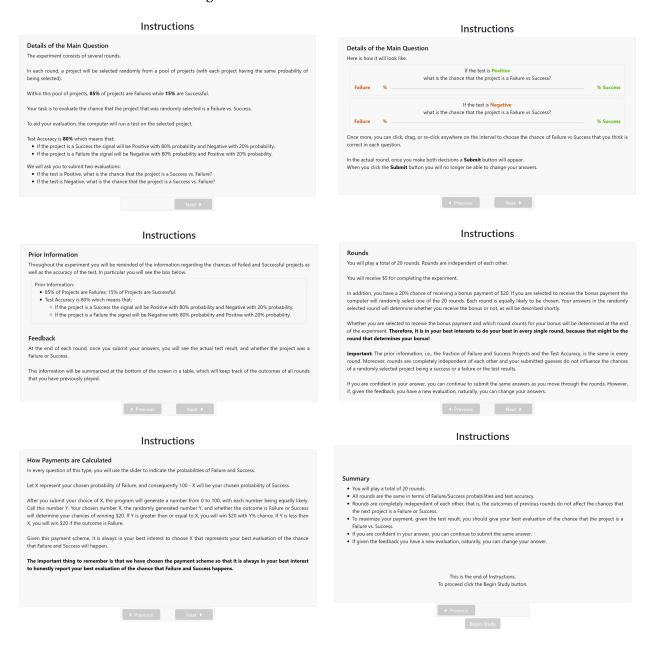
Figure 3: Initial Instructions II



If participants submitted wrong answers more than twice, they were not allowed to continue the study. Successful participants continued with treatment-specific instructions.

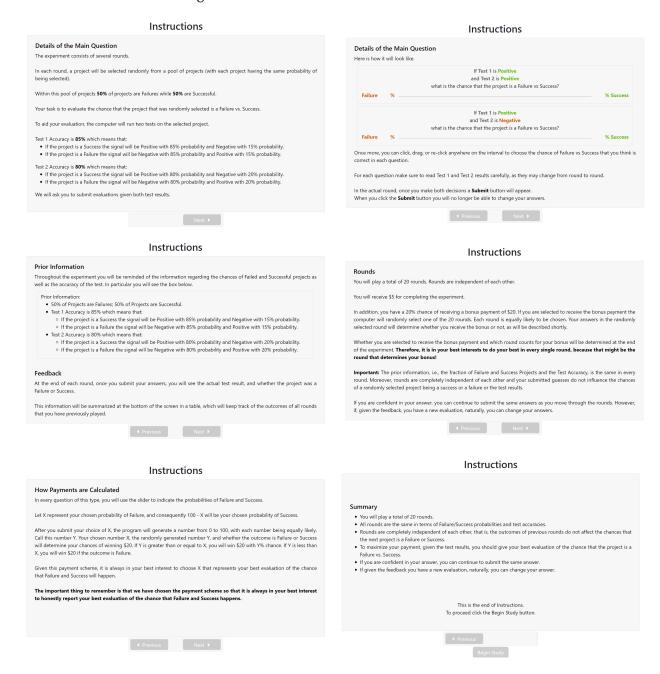
1.2 Baseline Treatment Instructions

Figure 4: Baseline Treatment Instructions



1.3 Simultaneous Treatment Instructions

Figure 5: Simultaneous Treatment Instructions



1.4 Sequential Treatment Instructions

If you are confident in your answer, you can continue to submit the same answers as you move through the rounds. However,

◆ Previous Next ▶

if, given the feedback, you have a new evaluation, naturally, you can change your answ

Figure 6: Sequential Treatment Instructions

Instructions Details of the Main Question Instructions Details of the Main Question In each round, a project will be selected randomly from a pool of projects (with each project having the same probability of Test 1 is Positiv what is the chance that the project is a Failure vs Success? Your task is to evaluate the chance that the project that was randomly selected is a Failure vs. Success. Once more, you can click, drag, or re-click anywhere on the interval to choose the chance of Failure vs Success that you think is correct in each question. To aid your evaluation, the computer will run two tests on the selected project. Test 1 Accuracy is 85% which means that: • If the project is a Success the signal will be Positive with 85% probability and Negative with 15% probability • If the project is a Failure the signal will be Negative with 85% probability and Positive with 15% probability. Make sure to read Test 1 results carefully, as they may change from round to round. In the actual round, once you make both decisions a Submit button will appear Test 2 Accuracy is 80% which means that: When you click the **Submit** button you will no longer be able to change your answers If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability. We will ask you to submit an evaluation after receiving Test 1 results. Afterwards we will ask you to submit two more evaluations: Given the result of Test 1, if Test 2 is Positive, what is the chance that the project is a Success vs. Failure? Given the result of Test 1, if Test 2 is Negative, what is the chance that the project is a Success vs. Failure ◆ Previous Next ▶ Instructions Details of the Main Question Instructions After receiving the result of Test 1 and submitting your evaluation, you will be asked for two more evaluations. For each possible Test 2 result (Positive and Negative), you will select a point that indicates the chance that the randomly selected project is a Ducess vs. Fallure given the test result. Prior Information Throughout the experiment you will be reminded of the information regarding the chances of Failed and Successful projects as well as the accuracy of the test. In particular you will see the box below. You will also be reminded of the result of Test 1. See below 50% of Projects are Failures; 50% of Projects are Successful. Test 1 is Positive. . Test 1 Accuracy is 85% which means that Test 1 Accuracy is 85% which means that: If the project is a Success the signal will be Positive with 85% probability and Negative with 15% probability. If the project is a Failure the signal will be Negative with 85% probability and Positive with 15% probability. Test 2 Accuracy is 80% which means that: If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability. If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability. If Test 2 is Positive what is the chance that the project is a Failure vs Success? If Test 2 is Negative what is the chance that the project is a Failure vs Success? Feedback At the end of each round, once you submit your answers, you will see the actual test result, and whether the project was a Once more, you can click, drag, or re-click anywhere on the interval to choose the chance of Failure vs Success that you think is Make sure to read Test 1 and Test 2 results carefully, as they may change from round to round. ◆ Previous Next ▶ When you click the Submit button you will no longer be able to change your answers Instructions Instructions Rounds How Payments are Calculated You will play a total of 20 rounds, Rounds are independent of each other. In every question of this type, you will use the slider to indicate the probabilities of Failure and Success You will receive \$5 for completing the experiment Let X represent your chosen probability of Failure, and consequently 100 - X will be your chosen probability of Success In addition, you have a 20% chance of receiving a bonus payment of \$20. If you are selected to receive the bonus payment the computer will randomly select one of the 20 rounds. Each round is equally likely to be chosen. Your answers in the randomly selected round will determine whether you receive the bonus or not, as will be described shortly. After you submit your choice of X, the program will generate a number from 0 to 100, with each number being equally likely. Call this number Y. Your chosen number X, the randomly generated number Y, and whether the outcome is Failure or Success will determine your chances of winning \$20. If Y is greater than or equal to X, you will win \$20 with Y% chance. If Y is less than X, you will win \$20 if the outcome is Failure. Whether you are selected to receive the bonus payment and which round counts for your bonus will be determined at the end of the experiment. Therefore, it is in your best interests to do your best in every single round, because that might be the round that determines your bonus! Given this payment scheme, it is always in your best interest to choose X that represents your best evaluation of the chance that Failure and Success will happen. Important: The prior information, i.e., the fraction of Failure and Success Projects and the Test Accuracy, is the same in every round. Moreover, rounds are completely independent of each other and your submitted guesses do not influence the chances of a randomly selected project being a success or a failure or the test results. The important thing to remember is that we have chosen the payment scheme so that it is always in your best interest to honestly report your best evaluation of the chance that Failure and Success happens.

Previous Next ▶

2 Interface

2.1 Baseline Treatment Interface

We present various screenshots of the interface presented to participants in the baseline treatments at different stages of the study. We highlight important features below.

Probability Evaluation (Round 1) Probability Evaluation (Round 1) 85% of Projects are Failures; 15% of Projects are Successful.
 Test Accuracy is 80% which means that: 85% of Projects are Failures; 15% of Projects are Successfu . Test Accuracy is 80% which means that If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability.

If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability. of If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability of If the project is a Success the signal will be Negative with 80% probability and Positive with 20% probability. If the test is **Positive** what is the chance that the project is a Failure vs Success? If the test is **Negative** what is the chance that the project is a Failure vs Success? Probability Evaluation (Round 1) Probability Evaluation (Round 1) 85% of Projects are Failures; 15% of Projects are Successful.
 Test Accuracy is 80% which means that:
 If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability.
 If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability. 85% of Projects are Failures; 15% of Projects are Successful.
 Test Accuracy is 80% which means that:
 If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability.
 If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability. If the test is Positive
what is the chance that the project is a Failure vs Success? The Test was Negative. 72% Success what is the chance that the project is a Failure vs Success? Next Round Probability Evaluation (Round 2) Probability Evaluation (Round 17) Prior Information: Prior Information: **B8% of Projects are Failures; 15% of Projects are Successful.

* Test Accuracy is 80% which means that:

* If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability.

* If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability. no minimaturi.

- 85% of Projects are Failures; 15% of Projects are Successful.

- Test Accuracy is 80% which means that:

- If the project is a Success the signal will be Positive with 80% probability and Negative with 20% probability.

- If the project is a Failure the signal will be Negative with 80% probability and Positive with 20% probability. what is the chance that the project is a Failure vs Success? what is the chance that the project is a Failure vs Success? Failure 22% If the test is **Negative**what is the chance that the project is a Failure vs Success? If the test is **Negative** what is the chance that the project is a Failure vs Success? Failure 97% Submit Evaluation

Figure 7: Baseline Treatment Interface

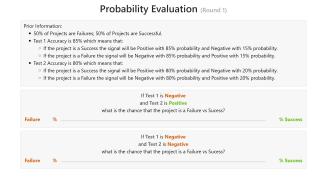
• As clarified in the instructions, throughout the experiment, at the top, participants see information regarding the prior probability of successful/failed projects as well as the signal

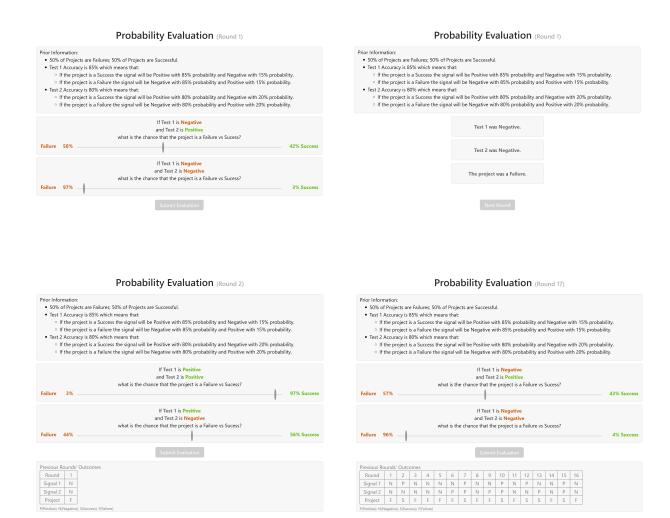
accuracy.

- As clarified in the instructions, when asked "If the test is Positive/Negative, what is the chance that the project is a Failure vs. Success?" there is initially no indicator on the slider. We made this decision to prevent participants from being anchored. Only after they click somewhere on the slider does the indicator and the accompanying probabilities show up. For a concrete example, compare the top right and middle left screenshots in Figure 7.
- After clicking the "Submit Evaluation" button, participants were informed about the particular realized value of the signal and whether the project was a Failure or Success. See the middle right screenshot above.
- The realized signals and project outcomes from previous rounds are summarized in a table at the bottom of the interface. See bottom left for an example in Round 2 and bottom right for an example in Round 17. We keep track of past outcomes to shut down possible effects that imperfect recall may have.

2.2 Simultaneous Treatment Interface

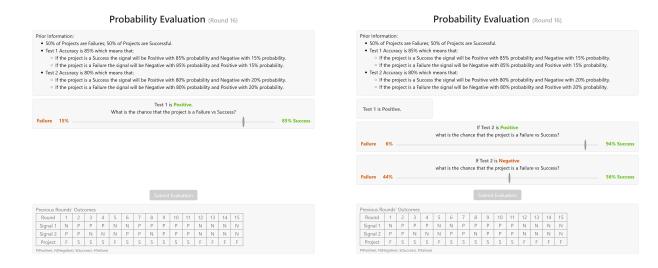






• Most of the design choices are unchanged from the Baseline treatment. However, in the simultaneous treatment, participants received both signals at the same time.

2.3 Sequential Treatment Interface



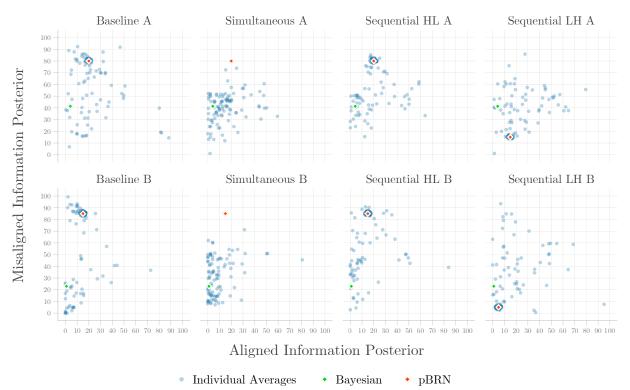
- Once more, most of the design choices are unchanged from the previous treatments. However, in the sequential treatment, participants received signals sequentially. Upon receiving the first signal, their posterior probability was elicited. Afterward, participants stated their posteriors conditional on the realized value of the second signal.
- The interface displays the outcome of the first signal when participants make choices conditional on the outcome of the second signal.

3 Related Data Analysis

3.1 Individual Level Analysis

Figure 8 displays the counterpart of Figure 9 in the main text, utilizing data from the last five rounds only.

Figure 8: Average Individual Choices: Last Five Rounds

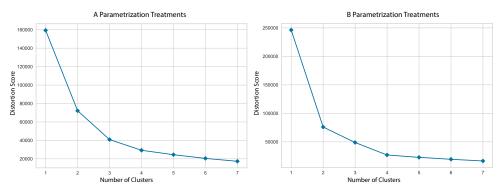


Notes: To help distinguish the large amount of data bundled on the pBRN level, we apply a jitter of 1.5 magnitude. This jittering perturbs the datapoint no further than a distance of 1.5 from the initial value. The top(bottom) row displays data across treatments under parametrization A(B).

3.2 Classifying Types

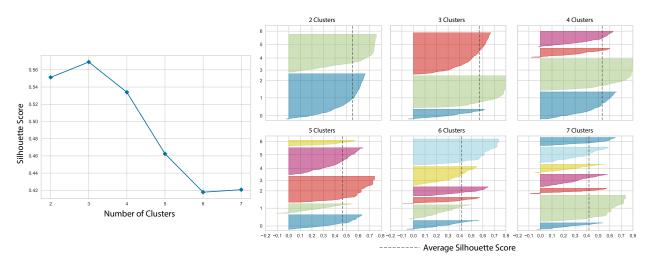
The elbow method is a way to determine the optimal number of clusters in a dataset for k-means clustering. It works by plotting the sum of squared distances between each point and the centroid of its cluster against the number of clusters used. The plot looks like an arm, and the elbow point on the arm represents the best number of clusters to use. This is because the elbow point is where adding more clusters does not significantly improve the clustering results. The elbow method helps to select an appropriate number of clusters for k-means clustering, avoiding underfitting or overfitting the data. The graphs shown in Figure 9 reveal that the elbow method recommends three clusters for parametrization A, while for parametrization B, the score is somewhat ambiguous between two, three, and four clusters. We supplement our calculations by determining the optimal number of clusters via the silhouette method.

Figure 9: Distortion Score Elbow for K-Means Clustering



The silhouette method is a way to evaluate the quality of clustering results in a dataset. It works by measuring how similar an observation is to its own cluster compared to other clusters. The silhouette score ranges from -1 to 1, with higher values indicating better clustering results. A score of 1 indicates that the observation is well-matched to its own cluster and poorly-matched to other clusters. A score of -1 indicates the opposite, while a score of 0 indicates that the observation is equally similar to its own cluster and other clusters. The silhouette method calculates the average silhouette score of all observations in the dataset and uses this as a measure of how well the data is clustered. The method can be used to compare different clustering methods or to select the best number of clusters to use in a k-means clustering analysis. By selecting the number of clusters that maximizes the silhouette score, the method can help improve the accuracy and reliability of the clustering results. The graphs shown in Figure 10 reveal that the silhouette score is maximized under three clusters.

Figure 10: Silhouette Scores For K-Means Clustering



We thus decide to proceed with the clustering exercise with three clusters.

4 Pilot Data

4.1 Estimated Means

We ran two pilot studies under parametrization A for the Baseline and Simultaneous treatment. In Table 1, we compare the estimated mean from Baseline A and Simultaneous A with the estimated means in their corresponding pilot treatments. The variable *Constant* captures the estimated mean in the regular session, whereas the variable *Pilot* captures the difference of the estimated mean from this value in the pilot treatment. As can be seen, regardless of the error clustering level, the difference is never statistically significant.

Baseline A Simultaneous A Ind C Ind C + Last 5 Ind C + Last 5 No C No C Ind C 63.79*** 63.79*** 60.43*** 41.65*** 40.29*** 41.65*** Constant (1.971)(2.428)(0.987)(1.295)(0.595)(0.384)Pilot0.4340.4345.911 1.001 1.001 1.483 (1.041)(3.680)(4.285)(0.667)(1.740)(2.382)N 3000 3000 750 3020 3020 755

Table 1: Estimated Means

4.2 Individual Level Analysis

In Figure 11, we plot the individual level data for Baseline A and Simultaneous A, as well as their corresponding pilot treatments.

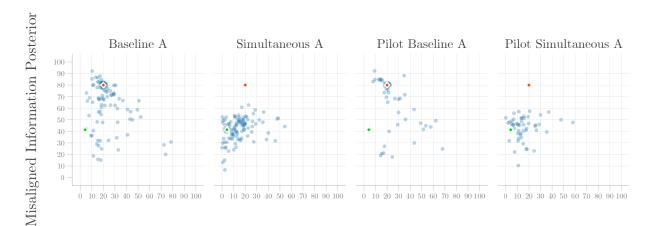


Figure 11: Average Individual Choices

Aligned Information Posterior

Individual Averages
 Bayesian
 pBRN

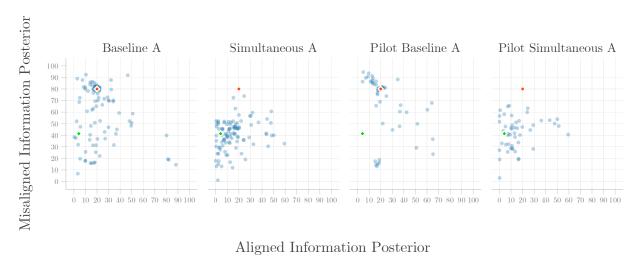
<u>Notes:</u> To help distinguish the large amount of data bundled on the pBRN level, we apply a jitter of 1.5 magnitude. This jittering perturbs the datapoint no further than a distance of 1.5 from the initial value.

Standard errors in parentheses

^{*} p < 0.10, ** p < 0.05, *** p < 0.01

In Figure 12, we do the same utilizing data from the last five rounds only.

Figure 12: Average Individual Choices: Last Five Rounds



• Individual Averages • Bayesian • pBRN

<u>Notes:</u> To help distinguish the large amount of data bundled on the pBRN level, we apply a jitter of 1.5 magnitude. This jittering perturbs the datapoint no further than a distance of 1.5 from the initial value.