Supplement for Improving Comprehension of Measurements Using Concrete Re-expression Strategies

# Comparing Reunitizations to Existing Automated Solutions

The Dictionary of Numbers[[1]](#footnote-1) (DN), The Measure of Things[[2]](#footnote-2) (MT), and Wolfram's Alpha[[3]](#footnote-3) (WA) can present reunitizations as text for some measures. DN and MT represent automated reunitization algorithms that rely on hand-curated databases, both of which took their creators (independent designers) considerable time and effort, even years, to build [2,3].

We compare our reunitization tool against these tools for a set of 60 input measurements (15 measurements for each of the four measures), spanning 8 orders of magnitude and the halfway points between them from 0.001 to 10,000.

We examined the first three results returned by each tool, considering a total of 180 reunitizations per tool. We assessed coverage (e.g., how many input measurements a tool was able to generate re-expressions, how many unique objects these re-expressions use), the familiarity of the objects used in re-expressions, and the magnitude of the multipliers used in the re-expressions. We summarize the results of this analysis below. The complete results from our reunitization tool can be found in the file **strategy\_results.xlsx**. The complete results from DN, MT, and WA, can be found in the file **DN\_MT\_WA\_comparison.xlsx**.

### Coverage

DN returns a single result for only 6 out of the 60 inputs (6/180, 6/180 unique objects). MT returns three results for all 60 inputs (180/180; 96/180 unique objects). WA returns three results for 41 of the 60 inputs, two results for 7 of the 60 inputs, one result for 9 of the 60 inputs, and 0 results for 3 of the 60 inputs (146/180; 77/180 unique objects).

In contrast, our reunitization tool returns three results for 60 inputs (180/180; 84/180 unique objects). Only MT also returns as many re-expressions. MT results include slightly more unique objects than our results (12 more unique objects) across the set of inputs.

### Familiarity

Three of the six objects returned by DN to re-express the input measurement are of questionable familiarity (*Mass equivalent of the energy that is called 1 megaton of TNT equivalent; weight of an adult elephant; length of longest blue whale measured, the largest animal*).

Many of the objects used in re-expressions returned by MT and WA are also of questionable familiarity. MT presents, for example, multiples of the weights of a *Blue Whale’s tongue*, *a Tyrannasaurus Rex*, *a reindeer*, *a cubic meter of snow*, *a human brain*, *hippopotamus*, and *an elephant*.

WA presents, for example, *volume of one mole of ideal gas at STP*, *height of Burj Khalafa*, *length of the Hindenburg Zeppelin*, *amoeba proteus bacterium length*, *length of Noah's Ark, average ground level of the Maldives above sea level, height of Nelson's column (including statue), highest measured ocean wave during a tsunami.*

Our tool occasionally returns a multiple of a synset that some users may not find familiar (e.g., *a light-emitting diode*, or *LED* may seem unfamiliar to some users). Overall, however, our tool clearly outperforms all three other tools for object familiarity by using mostly common everyday objects.

### Multiplier Magnitude

DN only returns reunitizations where the multiplier is 1 (6/6 results). MT returns 79/180 (44%) reunitizations with multipliers less than 1, 4/180 (2%) reunitizations with multipliers over 10, and the remaining 97/180 (54%) reunitizations with multipliers between 1 and 10. WA returns 87/146 (60%) reunitizations with multipliers less than 1, 2/146 (1.4%) reunitizations with multipliers over 10, and the remaining 57/180 (32%) reunitizations with multipliers between 1 and 10.

Our tool outperforms all three other tools for returning reunitizations with multipliers in a range that is known to be easily understood by people based on number sense research. Our tool returns 35/180 (19%) reunitizations with multipliers less than 1, 10/180 (5.6%) reunitizations with multipliers over 10, and the remaining 135/180 (75%) reunitizations with multipliers between 1 and 10.

# REFERENCES

1. Glen Chiachieri (creator of *The Dictionary of Numbers*). Personal communication. (2014).
2. Jonathon Clase (creator of *The Measure of Things*). Personal communication. (2017).

1. https://www.dictionaryofnumbers.com/ [↑](#footnote-ref-1)
2. http://www.bluebulbprojects.com/measureofthings/ [↑](#footnote-ref-2)
3. https://www.wolframalpha.com/ [↑](#footnote-ref-3)