**ALY6050 Introduction to Enterprise Analytics**

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Module 3

Benefit-Cost Analysis of Construction Projects

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# INTRODUCTION

This study will be evaluating two potential dam construction projects for the JET Corporation. They have identified sites in North Carolina and Georgia that are currently under consideration. As part of the site evaluation process, the team at JET has identified six benefit categories

* Improved navigation
* Hydroelectric power
* Fish and wildlife
* Recreation
* Flood control
* Commercial development

Each of these metrics were scored by JET Corporation and have been provided in three estimates, a minimum, maximum, and most likely (or mode), for each site. In addition to these benefits, the team has also estimated two cost variables (the 30-year annualized capital cost and the annual operating budget) – these estimates have been provided by minimum, maximum, and mode as well. To better inform the decision-making process for JET, a benefit-cost analysis will be performed for each potential dam site. Using Monte-Carlo simulation techniques, all 8-performance metrics will be estimated in 10,000 randomly chosen scenarios. In each scenario, the total benefits and costs will be compared to calculate the benefit-cost ratio. Any resulting ration above 1.0 would be considered a favorable outcome.

## DAM SITES

For the study, the North Carolina site will be referred to as Dam #1. The following chart has been developed by JET for this study.



And Dam #2, the southwest Georgia site



For both charts, the costs are shown in millions of dollars.

# PART 1 – CREATION AND ANALYSIS OF MONTE CARLO SIMULATIONS

To begin the study, the data will be prepared to conduct a Monte-Carlo simulation for each variable with 10,000 simulations. This will be entail running the simulation for each variable and then calculating 10,000 resulting benefit-cost ratios. For the purposes of the study, each simulation is assumed to be independent of each other. Also, the simulation and calculations will be conducted in R. While nearly all work will be done in base R, the tidyverse package will be used for creating supporting visualizations. Since the variables were presented with minimum, mode, and maximum values – a triangular distribution model was chosen for these simulations.

A screenshot of a computer program

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This function utilizes random number generation in R to create 10,000 random values between 0 and 1. Each of these random numbers will represent one trial of the Monte-Carlo simulation. It utilizes the ifelse logic from R to calculate the cumulative distribution function (CDF) of a triangular distribution depending on whether the value is greater than or less than the mode. This ensures that the simulations will follow the triangular distribution. With the random numbers generated, the benefit-cost variables from each dam site can be simulated and combined.

A screenshot of a computer program

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With the sample data created, the frequency distributions can be analyzed and compared between the two dam sites. Using the standard binning technique of using the square root of the number of simulations, frequency distribution tables for each dam site are generated with 100 bins, these are available in the appendix. Additionally, histograms are produced to evaluate the shape of the distribution. For reference, the histograms also include lines for a benefit-cost ratio of 1 in red and dark blue or green lines for the mean or average benefit-cost ratio for the site.

A graph of a bar graph

AI-generated content may be incorrect.A graph of a bar chart

AI-generated content may be incorrect.Comparting the observed values of the simulation versus the theoretical, the following charts have been prepared.

|  |  |  |
| --- | --- | --- |
| **Dam # 1 Project** | **Observed** | **Theoretical** |
| **Mean of Total Benefits** | 29.44203 | 29.46667 |
| **SD of Total Benefits** | 2.29219 | 2.307476 |
| **Mean of Total Cost** | 20.77601 | 20.76667 |
| **SD of Total Cost** | 1.511466 | 1.502599 |
| **Mean of Benfit-cost Ratio** | 1.424515 | X |
| **SD of Befit-cost Ratio** | 0.1511598 | X |

|  |  |  |
| --- | --- | --- |
| **Dam # 2 Project** | **Observed** | **Theoretical** |
| **Mean of Total Benefits** | 30.73804 | 30.7 |
| **SD of Total Benefits** | 2.434149 | 2.409703 |
| **Mean of Total Cost** | 22.07021 | 22.06667 |
| **SD of Total Cost** | 1.741182 | 1.726589 |
| **Mean of Benfit-cost Ratio** | 1.401481 | X |
| **SD of Befit-cost Ratio** | 0.1573849 | X |

# PART TWO – ANALYSIS OF A PROBABILITY DISTRIBUTION

To further test the analysis conducted for the dam sites, the results of the simulations will be compered to a theoretical distribution and a Chi-Squared goodness of fit test will be conducted. For brevity, this comparison will only be done for Dam #1. The results of the simulation will be compared to a lognormal theoretical distribution. The following code performs a small modification to the original sample data created for Dam #1. While the observations are unchanged, this ensures all 100 bins are of equal width which is required in for Chi-Squared testing.

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With the new bins created, a new frequency distribution can be calculated. These values can then be compared to the theoretical values from a lognormal distribution, the results of which are in table 3 of the appendix.

Before conducting the Chi-Square goodness of fit test, any bin containing less than 5 observations will need to be combined. After this process, a Chi-Squared test can be conducted on the remaining 85 bins.



This returns

* Test statistic: 116.2903
* Degrees of freedom: 84
* P-value: 1.134088e-02

The Chi-Squared test assumes two hypotheses. The null hypothesis that the observed values follow the lognormal distribution and the alternative hypothesis that the observed data does not follow the lognormal distribution. The resulting p-value of the test (0.011) is less than 0.05, therefore the null hypothesis is rejected. This is a good indication that the Monte-Carlo simulation is a preferable method to a linear prediction model for this study.

# PART THREE – COMPARISON OF THE RESULTS

Benefit-Cost Ratio Comparisons

|  |  |  |
| --- | --- | --- |
|  | **Dam #1** | **Dam #2** |
| **Minimum** | 0.9664521 | 0.94066536 |
| **Maximum** | 2.04019710 | 2.05876319 |
| **Mean** | 1.42451484 | 1.39902473 |
| **Variance** | 0.02284927 | 0.02411871 |
| **Standard Deviation** | 0.15115976 | 0.15530200 |
| **SKEWNESS** | 0.1982165 | 0.1982165 |
| **P(α1 > 2)** | 0.0002 | 0.0004 |
| **P(α1 > 1.8)** | 0.0089 | 0.0085 |
| **P(α1 > 1.5)** | 0.3029 | 0.2473 |
| **P(α1 > 1.2)** | 0.9399 | 0.9074 |
| **P(α1 > 1)** | 0.9996 | 0.9991 |
| **P(α1 > α2)** | 0.5556 | 0.4444 |

# RECOMMENDATIONS AND CONCLUSION

Based on the statistical analysis conducted, the site for Dam #1 would be the preferred site for JET Corporation. The mean benefit-cost ratio is higher for Dam #1, as is both the minimum and maximum. In the head-to-head comparisons, Dam #1 outperforms Dam #2 in more than half of the comparisons. While both sites are financially viable, the probability of Dam #1 being viable (93.99%) is greater than Dam #2 (90.74%). Additionally, the risk profile for Dam #1 is lower, as seen in the standard deviation scores of 0.1511 versus 0.1553. All of these results point to Dam 1 being the preferred option.

# APPENDIX

## Table 1

|  |
| --- |
| **Dam 1**  Interval Frequency Relative\_Frequency Cumulative\_Frequency Cumulative\_Relative\_Frequency |
| 1 [0.966,0.977) 3 0.0003 3 0.0003 |
| 2 [0.977,0.988) 0 0.0000 3 0.0003 |
| 3 [0.988,0.999) 1 0.0001 4 0.0004 |
| 4 [0.999,1.01) 3 0.0003 7 0.0007 |
| 5 [1.01,1.02) 5 0.0005 12 0.0012 |
| 6 [1.02,1.03) 8 0.0008 20 0.0020 |
| 7 [1.03,1.04) 7 0.0007 27 0.0027 |
| 8 [1.04,1.05) 5 0.0005 32 0.0032 |
| 9 [1.05,1.06) 13 0.0013 45 0.0045 |
| 10 [1.06,1.07) 10 0.0010 55 0.0055 |
| 11 [1.07,1.08) 13 0.0013 68 0.0068 |
| 12 [1.08,1.1) 23 0.0023 91 0.0091 |
| 13 [1.1,1.11) 17 0.0017 108 0.0108 |
| 14 [1.11,1.12) 32 0.0032 140 0.0140 |
| 15 [1.12,1.13) 24 0.0024 164 0.0164 |
| 16 [1.13,1.14) 45 0.0045 209 0.0209 |
| 17 [1.14,1.15) 44 0.0044 253 0.0253 |
| 18 [1.15,1.16) 58 0.0058 311 0.0311 |
| 19 [1.16,1.17) 63 0.0063 374 0.0374 |
| 20 [1.17,1.18) 73 0.0073 447 0.0447 |
| 21 [1.18,1.19) 82 0.0082 529 0.0529 |
| 22 [1.19,1.2) 101 0.0101 630 0.0630 |
| 23 [1.2,1.21) 116 0.0116 746 0.0746 |
| 24 [1.21,1.22) 147 0.0147 893 0.0893 |
| 25 [1.22,1.23) 153 0.0153 1046 0.1046 |
| 26 [1.23,1.25) 151 0.0151 1197 0.1197 |
| 27 [1.25,1.26) 172 0.0172 1369 0.1369 |
| 28 [1.26,1.27) 174 0.0174 1543 0.1543 |
| 29 [1.27,1.28) 193 0.0193 1736 0.1736 |
| 30 [1.28,1.29) 184 0.0184 1920 0.1920 |
| 31 [1.29,1.3) 206 0.0206 2126 0.2126 |
| 32 [1.3,1.31) 210 0.0210 2336 0.2336 |
| 33 [1.31,1.32) 226 0.0226 2562 0.2562 |
| 34 [1.32,1.33) 252 0.0252 2814 0.2814 |
| 35 [1.33,1.34) 220 0.0220 3034 0.3034 |
| 36 [1.34,1.35) 291 0.0291 3325 0.3325 |
| 37 [1.35,1.36) 270 0.0270 3595 0.3595 |
| 38 [1.36,1.37) 264 0.0264 3859 0.3859 |
| 39 [1.37,1.39) 263 0.0263 4122 0.4122 |
| 40 [1.39,1.4) 255 0.0255 4377 0.4377 |
| 41 [1.4,1.41) 272 0.0272 4649 0.4649 |
| 42 [1.41,1.42) 277 0.0277 4926 0.4926 |
| 43 [1.42,1.43) 276 0.0276 5202 0.5202 |
| 44 [1.43,1.44) 292 0.0292 5494 0.5494 |
| 45 [1.44,1.45) 299 0.0299 5793 0.5793 |
| 46 [1.45,1.46) 273 0.0273 6066 0.6066 |
| 47 [1.46,1.47) 242 0.0242 6308 0.6308 |
| 48 [1.47,1.48) 248 0.0248 6556 0.6556 |
| 49 [1.48,1.49) 253 0.0253 6809 0.6809 |
| 50 [1.49,1.5) 226 0.0226 7035 0.7035 |
| 51 [1.5,1.51) 229 0.0229 7264 0.7264 |
| 52 [1.51,1.52) 226 0.0226 7490 0.7490 |
| 53 [1.52,1.54) 210 0.0210 7700 0.7700 |
| 54 [1.54,1.55) 189 0.0189 7889 0.7889 |
| 55 [1.55,1.56) 205 0.0205 8094 0.8094 |
| 56 [1.56,1.57) 190 0.0190 8284 0.8284 |
| 57 [1.57,1.58) 169 0.0169 8453 0.8453 |
| 58 [1.58,1.59) 145 0.0145 8598 0.8598 |
| 59 [1.59,1.6) 127 0.0127 8725 0.8725 |
| 60 [1.6,1.61) 135 0.0135 8860 0.8860 |
| 61 [1.61,1.62) 111 0.0111 8971 0.8971 |
| 62 [1.62,1.63) 106 0.0106 9077 0.9077 |
| 63 [1.63,1.64) 123 0.0123 9200 0.9200 |
| 64 [1.64,1.65) 89 0.0089 9289 0.9289 |
| 65 [1.65,1.66) 94 0.0094 9383 0.9383 |
| 66 [1.66,1.68) 67 0.0067 9450 0.9450 |
| 67 [1.68,1.69) 63 0.0063 9513 0.9513 |
| 68 [1.69,1.7) 57 0.0057 9570 0.9570 |
| 69 [1.7,1.71) 58 0.0058 9628 0.9628 |
| 70 [1.71,1.72) 46 0.0046 9674 0.9674 |
| 71 [1.72,1.73) 38 0.0038 9712 0.9712 |
| 72 [1.73,1.74) 49 0.0049 9761 0.9761 |
| 73 [1.74,1.75) 39 0.0039 9800 0.9800 |
| 74 [1.75,1.76) 30 0.0030 9830 0.9830 |
| 75 [1.76,1.77) 22 0.0022 9852 0.9852 |
| 76 [1.77,1.78) 34 0.0034 9886 0.9886 |
| 77 [1.78,1.79) 15 0.0015 9901 0.9901 |
| 78 [1.79,1.8) 16 0.0016 9917 0.9917 |
| 79 [1.8,1.81) 16 0.0016 9933 0.9933 |
| 80 [1.81,1.83) 20 0.0020 9953 0.9953 |
| 81 [1.83,1.84) 10 0.0010 9963 0.9963 |
| 82 [1.84,1.85) 10 0.0010 9973 0.9973 |
| 83 [1.85,1.86) 2 0.0002 9975 0.9975 |
| 84 [1.86,1.87) 7 0.0007 9982 0.9982 |
| 85 [1.87,1.88) 3 0.0003 9985 0.9985 |
| 86 [1.88,1.89) 2 0.0002 9987 0.9987 |
| 87 [1.89,1.9) 1 0.0001 9988 0.9988 |
| 88 [1.9,1.91) 4 0.0004 9992 0.9992 |
| 89 [1.91,1.92) 0 0.0000 9992 0.9992 |
| 90 [1.92,1.93) 1 0.0001 9993 0.9993 |
| 91 [1.93,1.94) 1 0.0001 9994 0.9994 |
| 92 [1.94,1.95) 1 0.0001 9995 0.9995 |
| 93 [1.95,1.97) 1 0.0001 9996 0.9996 |
| 94 [1.97,1.98) 1 0.0001 9997 0.9997 |
| 95 [1.98,1.99) 0 0.0000 9997 0.9997 |
| 96 [1.99,2) 1 0.0001 9998 0.9998 |
| 97 [2,2.01) 0 0.0000 9998 0.9998 |
| 98 [2.01,2.02) 0 0.0000 9998 0.9998 |
| 99 [2.02,2.03) 1 0.0001 9999 0.9999 |
| 100 [2.03,2.04] 1 0.0001 10000 1.0000 |

## Table 2

|  |
| --- |
| **Dam 2**  Interval Frequency Relative\_Frequency Cumulative\_Frequency Cumulative\_Relative\_Frequency |
| 1 [0.941,0.952) 1 0.0001 1 0.0001 |
| 2 [0.952,0.963) 0 0.0000 1 0.0001 |
| 3 [0.963,0.974) 3 0.0003 4 0.0004 |
| 4 [0.974,0.985) 2 0.0002 6 0.0006 |
| 5 [0.985,0.997) 3 0.0003 9 0.0009 |
| 6 [0.997,1.01) 2 0.0002 11 0.0011 |
| 7 [1.01,1.02) 3 0.0003 14 0.0014 |
| 8 [1.02,1.03) 7 0.0007 21 0.0021 |
| 9 [1.03,1.04) 10 0.0010 31 0.0031 |
| 10 [1.04,1.05) 13 0.0013 44 0.0044 |
| 11 [1.05,1.06) 22 0.0022 66 0.0066 |
| 12 [1.06,1.07) 27 0.0027 93 0.0093 |
| 13 [1.07,1.09) 29 0.0029 122 0.0122 |
| 14 [1.09,1.1) 35 0.0035 157 0.0157 |
| 15 [1.1,1.11) 40 0.0040 197 0.0197 |
| 16 [1.11,1.12) 52 0.0052 249 0.0249 |
| 17 [1.12,1.13) 52 0.0052 301 0.0301 |
| 18 [1.13,1.14) 77 0.0077 378 0.0378 |
| 19 [1.14,1.15) 75 0.0075 453 0.0453 |
| 20 [1.15,1.16) 89 0.0089 542 0.0542 |
| 21 [1.16,1.18) 88 0.0088 630 0.0630 |
| 22 [1.18,1.19) 127 0.0127 757 0.0757 |
| 23 [1.19,1.2) 132 0.0132 889 0.0889 |
| 24 [1.2,1.21) 156 0.0156 1045 0.1045 |
| 25 [1.21,1.22) 139 0.0139 1184 0.1184 |
| 26 [1.22,1.23) 176 0.0176 1360 0.1360 |
| 27 [1.23,1.24) 203 0.0203 1563 0.1563 |
| 28 [1.24,1.25) 209 0.0209 1772 0.1772 |
| 29 [1.25,1.26) 196 0.0196 1968 0.1968 |
| 30 [1.26,1.28) 235 0.0235 2203 0.2203 |
| 31 [1.28,1.29) 269 0.0269 2472 0.2472 |
| 32 [1.29,1.3) 219 0.0219 2691 0.2691 |
| 33 [1.3,1.31) 275 0.0275 2966 0.2966 |
| 34 [1.31,1.32) 303 0.0303 3269 0.3269 |
| 35 [1.32,1.33) 281 0.0281 3550 0.3550 |
| 36 [1.33,1.34) 251 0.0251 3801 0.3801 |
| 37 [1.34,1.35) 269 0.0269 4070 0.4070 |
| 38 [1.35,1.37) 278 0.0278 4348 0.4348 |
| 39 [1.37,1.38) 286 0.0286 4634 0.4634 |
| 40 [1.38,1.39) 302 0.0302 4936 0.4936 |
| 41 [1.39,1.4) 289 0.0289 5225 0.5225 |
| 42 [1.4,1.41) 288 0.0288 5513 0.5513 |
| 43 [1.41,1.42) 268 0.0268 5781 0.5781 |
| 44 [1.42,1.43) 302 0.0302 6083 0.6083 |
| 45 [1.43,1.44) 268 0.0268 6351 0.6351 |
| 46 [1.44,1.45) 284 0.0284 6635 0.6635 |
| 47 [1.45,1.47) 219 0.0219 6854 0.6854 |
| 48 [1.47,1.48) 244 0.0244 7098 0.7098 |
| 49 [1.48,1.49) 215 0.0215 7313 0.7313 |
| 50 [1.49,1.5) 209 0.0209 7522 0.7522 |
| 51 [1.5,1.51) 207 0.0207 7729 0.7729 |
| 52 [1.51,1.52) 199 0.0199 7928 0.7928 |
| 53 [1.52,1.53) 164 0.0164 8092 0.8092 |
| 54 [1.53,1.54) 165 0.0165 8257 0.8257 |
| 55 [1.54,1.56) 154 0.0154 8411 0.8411 |
| 56 [1.56,1.57) 142 0.0142 8553 0.8553 |
| 57 [1.57,1.58) 158 0.0158 8711 0.8711 |
| 58 [1.58,1.59) 136 0.0136 8847 0.8847 |
| 59 [1.59,1.6) 98 0.0098 8945 0.8945 |
| 60 [1.6,1.61) 108 0.0108 9053 0.9053 |
| 61 [1.61,1.62) 94 0.0094 9147 0.9147 |
| 62 [1.62,1.63) 99 0.0099 9246 0.9246 |
| 63 [1.63,1.65) 80 0.0080 9326 0.9326 |
| 64 [1.65,1.66) 69 0.0069 9395 0.9395 |
| 65 [1.66,1.67) 74 0.0074 9469 0.9469 |
| 66 [1.67,1.68) 60 0.0060 9529 0.9529 |
| 67 [1.68,1.69) 59 0.0059 9588 0.9588 |
| 68 [1.69,1.7) 51 0.0051 9639 0.9639 |
| 69 [1.7,1.71) 56 0.0056 9695 0.9695 |
| 70 [1.71,1.72) 37 0.0037 9732 0.9732 |
| 71 [1.72,1.73) 36 0.0036 9768 0.9768 |
| 72 [1.73,1.75) 37 0.0037 9805 0.9805 |
| 73 [1.75,1.76) 30 0.0030 9835 0.9835 |
| 74 [1.76,1.77) 20 0.0020 9855 0.9855 |
| 75 [1.77,1.78) 19 0.0019 9874 0.9874 |
| 76 [1.78,1.79) 28 0.0028 9902 0.9902 |
| 77 [1.79,1.8) 15 0.0015 9917 0.9917 |
| 78 [1.8,1.81) 16 0.0016 9933 0.9933 |
| 79 [1.81,1.82) 15 0.0015 9948 0.9948 |
| 80 [1.82,1.84) 9 0.0009 9957 0.9957 |
| 81 [1.84,1.85) 7 0.0007 9964 0.9964 |
| 82 [1.85,1.86) 4 0.0004 9968 0.9968 |
| 83 [1.86,1.87) 5 0.0005 9973 0.9973 |
| 84 [1.87,1.88) 5 0.0005 9978 0.9978 |
| 85 [1.88,1.89) 1 0.0001 9979 0.9979 |
| 86 [1.89,1.9) 0 0.0000 9979 0.9979 |
| 87 [1.9,1.91) 5 0.0005 9984 0.9984 |
| 88 [1.91,1.92) 3 0.0003 9987 0.9987 |
| 89 [1.92,1.94) 1 0.0001 9988 0.9988 |
| 90 [1.94,1.95) 2 0.0002 9990 0.9990 |
| 91 [1.95,1.96) 1 0.0001 9991 0.9991 |
| 92 [1.96,1.97) 2 0.0002 9993 0.9993 |
| 93 [1.97,1.98) 2 0.0002 9995 0.9995 |
| 94 [1.98,1.99) 0 0.0000 9995 0.9995 |
| 95 [1.99,2) 2 0.0002 9997 0.9997 |
| 96 [2,2.01) 0 0.0000 9997 0.9997 |
| 97 [2.01,2.03) 0 0.0000 9997 0.9997 |
| 98 [2.03,2.04) 1 0.0001 9998 0.9998 |
| 99 [2.04,2.05) 1 0.0001 9999 0.9999 |
| 100 [2.05,2.06] 1 0.0001 10000 1.0000 |

## Table 3

|  | **Bin\_Number** | | **Bin\_Lower** | | **Bin\_Upper** | | **Bin\_Midpoint** | | **Observed\_Freq** | | **Theoretical\_Freq** | | **Observed\_Prop** | | **Theoretical\_Prop** | | **Difference** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | |  | |  | |  | |  | |  | |  |  |  | |  | |
| **1** | | 1 | | 0.917783 | | 0.928493 | | 0.923138 | | 1 | | 0.161 | 0.0001 | 0.000016 | | 1 | |
| **2** | | 2 | | 0.928493 | | 0.939203 | | 0.933848 | | 0 | | 0.242 | 0.0000 | 0.000024 | | 0 | |
| **3** | | 3 | | 0.939203 | | 0.949912 | | 0.944557 | | 0 | | 0.358 | 0.0000 | 0.000036 | | 0 | |
| **4** | | 4 | | 0.949912 | | 0.960622 | | 0.955267 | | 1 | | 0.521 | 0.0001 | 0.000052 | | 0 | |
| **5** | | 5 | | 0.960622 | | 0.971332 | | 0.965977 | | 0 | | 0.748 | 0.0000 | 0.000075 | | -1 | |
| **6** | | 6 | | 0.971332 | | 0.982041 | | 0.976687 | | 0 | | 1.058 | 0.0000 | 0.000106 | | -1 | |
| **7** | | 7 | | 0.982041 | | 0.992751 | | 0.987396 | | 2 | | 1.477 | 0.0002 | 0.000148 | | 1 | |
| **8** | | 8 | | 0.992751 | | 1.003461 | | 0.998106 | | 1 | | 2.032 | 0.0001 | 0.000203 | | -1 | |
| **9** | | 9 | | 1.003461 | | 1.014171 | | 1.008816 | | 2 | | 2.759 | 0.0002 | 0.000276 | | -1 | |
| **10** | | 10 | | 1.014171 | | 1.024880 | | 1.019526 | | 6 | | 3.699 | 0.0006 | 0.000370 | | 2 | |
| **11** | | 11 | | 1.024880 | | 1.035590 | | 1.030235 | | 5 | | 4.898 | 0.0005 | 0.000490 | | 0 | |
| **12** | | 12 | | 1.035590 | | 1.046300 | | 1.040945 | | 9 | | 6.406 | 0.0009 | 0.000641 | | 3 | |
| **13** | | 13 | | 1.046300 | | 1.057010 | | 1.051655 | | 6 | | 8.280 | 0.0006 | 0.000828 | | -2 | |
| **14** | | 14 | | 1.057010 | | 1.067719 | | 1.062364 | | 9 | | 10.581 | 0.0009 | 0.001058 | | -2 | |
| **15** | | 15 | | 1.067719 | | 1.078429 | | 1.073074 | | 17 | | 13.371 | 0.0017 | 0.001337 | | 4 | |
| **16** | | 16 | | 1.078429 | | 1.089139 | | 1.083784 | | 13 | | 16.715 | 0.0013 | 0.001671 | | -4 | |
| **17** | | 17 | | 1.089139 | | 1.099848 | | 1.094494 | | 21 | | 20.675 | 0.0021 | 0.002068 | | 0 | |
| **18** | | 18 | | 1.099848 | | 1.110558 | | 1.105203 | | 29 | | 25.313 | 0.0029 | 0.002531 | | 4 | |
| **19** | | 19 | | 1.110558 | | 1.121268 | | 1.115913 | | 27 | | 30.682 | 0.0027 | 0.003068 | | -4 | |
| **20** | | 20 | | 1.121268 | | 1.131978 | | 1.126623 | | 47 | | 36.830 | 0.0047 | 0.003683 | | 10 | |
| **21** | | 21 | | 1.131978 | | 1.142687 | | 1.137332 | | 38 | | 43.794 | 0.0038 | 0.004379 | | -6 | |
| **22** | | 22 | | 1.142687 | | 1.153397 | | 1.148042 | | 58 | | 51.597 | 0.0058 | 0.005160 | | 6 | |
| **23** | | 23 | | 1.153397 | | 1.164107 | | 1.158752 | | 69 | | 60.247 | 0.0069 | 0.006025 | | 9 | |
| **24** | | 24 | | 1.164107 | | 1.174816 | | 1.169462 | | 72 | | 69.735 | 0.0072 | 0.006974 | | 2 | |
| **25** | | 25 | | 1.174816 | | 1.185526 | | 1.180171 | | 101 | | 80.032 | 0.0101 | 0.008003 | | 21 | |
| **26** | | 26 | | 1.185526 | | 1.196236 | | 1.190881 | | 92 | | 91.091 | 0.0092 | 0.009109 | | 1 | |
| **27** | | 27 | | 1.196236 | | 1.206946 | | 1.201591 | | 108 | | 102.842 | 0.0108 | 0.010284 | | 5 | |
| **28** | | 28 | | 1.206946 | | 1.217655 | | 1.212301 | | 133 | | 115.198 | 0.0133 | 0.011520 | | 18 | |
| **29** | | 29 | | 1.217655 | | 1.228365 | | 1.223010 | | 124 | | 128.050 | 0.0124 | 0.012805 | | -4 | |
| **30** | | 30 | | 1.228365 | | 1.239075 | | 1.233720 | | 141 | | 141.273 | 0.0141 | 0.014127 | | 0 | |
| **31** | | 31 | | 1.239075 | | 1.249785 | | 1.244430 | | 168 | | 154.727 | 0.0168 | 0.015473 | | 13 | |
| **32** | | 32 | | 1.249785 | | 1.260494 | | 1.255139 | | 152 | | 168.258 | 0.0152 | 0.016826 | | -16 | |
| **33** | | 33 | | 1.260494 | | 1.271204 | | 1.265849 | | 194 | | 181.705 | 0.0194 | 0.018170 | | 12 | |
| **34** | | 34 | | 1.271204 | | 1.281914 | | 1.276559 | | 199 | | 194.899 | 0.0199 | 0.019490 | | 4 | |
| **35** | | 35 | | 1.281914 | | 1.292623 | | 1.287269 | | 195 | | 207.673 | 0.0195 | 0.020767 | | -13 | |
| **36** | | 36 | | 1.292623 | | 1.303333 | | 1.297978 | | 227 | | 219.858 | 0.0227 | 0.021986 | | 7 | |
| **37** | | 37 | | 1.303333 | | 1.314043 | | 1.308688 | | 217 | | 231.295 | 0.0217 | 0.023130 | | -14 | |
| **38** | | 38 | | 1.314043 | | 1.324753 | | 1.319398 | | 225 | | 241.834 | 0.0225 | 0.024183 | | -17 | |
| **39** | | 39 | | 1.324753 | | 1.335462 | | 1.330107 | | 215 | | 251.338 | 0.0215 | 0.025134 | | -36 | |
| **40** | | 40 | | 1.335462 | | 1.346172 | | 1.340817 | | 221 | | 259.687 | 0.0221 | 0.025969 | | -39 | |
| **41** | | 41 | | 1.346172 | | 1.356882 | | 1.351527 | | 241 | | 266.780 | 0.0241 | 0.026678 | | -26 | |
| **42** | | 42 | | 1.356882 | | 1.367591 | | 1.362237 | | 276 | | 272.536 | 0.0276 | 0.027254 | | 3 | |
| **43** | | 43 | | 1.367591 | | 1.378301 | | 1.372946 | | 261 | | 276.898 | 0.0261 | 0.027690 | | -16 | |
| **44** | | 44 | | 1.378301 | | 1.389011 | | 1.383656 | | 269 | | 279.831 | 0.0269 | 0.027983 | | -11 | |
| **45** | | 45 | | 1.389011 | | 1.399721 | | 1.394366 | | 275 | | 281.322 | 0.0275 | 0.028132 | | -6 | |
| **46** | | 46 | | 1.399721 | | 1.410430 | | 1.405076 | | 305 | | 281.383 | 0.0305 | 0.028138 | | 24 | |
| **47** | | 47 | | 1.410430 | | 1.421140 | | 1.415785 | | 261 | | 280.043 | 0.0261 | 0.028004 | | -19 | |
| **48** | | 48 | | 1.421140 | | 1.431850 | | 1.426495 | | 280 | | 277.355 | 0.0280 | 0.027736 | | 3 | |
| **49** | | 49 | | 1.431850 | | 1.442560 | | 1.437205 | | 282 | | 273.387 | 0.0282 | 0.027339 | | 9 | |
| **50** | | 50 | | 1.442560 | | 1.453269 | | 1.447914 | | 267 | | 268.224 | 0.0267 | 0.026822 | | -1 | |
| **51** | | 51 | | 1.453269 | | 1.463979 | | 1.458624 | | 280 | | 261.963 | 0.0280 | 0.026196 | | 18 | |
| **52** | | 52 | | 1.463979 | | 1.474689 | | 1.469334 | | 263 | | 254.711 | 0.0263 | 0.025471 | | 8 | |
| **53** | | 53 | | 1.474689 | | 1.485398 | | 1.480044 | | 239 | | 246.583 | 0.0239 | 0.024658 | | -8 | |
| **54** | | 54 | | 1.485398 | | 1.496108 | | 1.490753 | | 216 | | 237.700 | 0.0216 | 0.023770 | | -22 | |
| **55** | | 55 | | 1.496108 | | 1.506818 | | 1.501463 | | 198 | | 228.185 | 0.0198 | 0.022818 | | -30 | |
| **56** | | 56 | | 1.506818 | | 1.517528 | | 1.512173 | | 217 | | 218.159 | 0.0217 | 0.021816 | | -1 | |
| **57** | | 57 | | 1.517528 | | 1.528237 | | 1.522882 | | 224 | | 207.744 | 0.0224 | 0.020774 | | 16 | |
| **58** | | 58 | | 1.528237 | | 1.538947 | | 1.533592 | | 209 | | 197.055 | 0.0209 | 0.019706 | | 12 | |
| **59** | | 59 | | 1.538947 | | 1.549657 | | 1.544302 | | 212 | | 186.204 | 0.0212 | 0.018620 | | 26 | |
| **60** | | 60 | | 1.549657 | | 1.560366 | | 1.555012 | | 174 | | 175.295 | 0.0174 | 0.017529 | | -1 | |
| **61** | | 61 | | 1.560366 | | 1.571076 | | 1.565721 | | 171 | | 164.422 | 0.0171 | 0.016442 | | 7 | |
| **62** | | 62 | | 1.571076 | | 1.581786 | | 1.576431 | | 142 | | 153.672 | 0.0142 | 0.015367 | | -12 | |
| **63** | | 63 | | 1.581786 | | 1.592496 | | 1.587141 | | 144 | | 143.123 | 0.0144 | 0.014312 | | 1 | |
| **64** | | 64 | | 1.592496 | | 1.603205 | | 1.597851 | | 165 | | 132.841 | 0.0165 | 0.013284 | | 32 | |
| **65** | | 65 | | 1.603205 | | 1.613915 | | 1.608560 | | 149 | | 122.885 | 0.0149 | 0.012288 | | 26 | |
| **66** | | 66 | | 1.613915 | | 1.624625 | | 1.619270 | | 119 | | 113.301 | 0.0119 | 0.011330 | | 6 | |
| **67** | | 67 | | 1.624625 | | 1.635335 | | 1.629980 | | 122 | | 104.129 | 0.0122 | 0.010413 | | 18 | |
| **68** | | 68 | | 1.635335 | | 1.646044 | | 1.640689 | | 91 | | 95.399 | 0.0091 | 0.009540 | | -4 | |
| **69** | | 69 | | 1.646044 | | 1.656754 | | 1.651399 | | 89 | | 87.130 | 0.0089 | 0.008713 | | 2 | |
| **70** | | 70 | | 1.656754 | | 1.667464 | | 1.662109 | | 89 | | 79.338 | 0.0089 | 0.007934 | | 10 | |
| **71** | | 71 | | 1.667464 | | 1.678173 | | 1.672819 | | 69 | | 72.029 | 0.0069 | 0.007203 | | -3 | |
| **72** | | 72 | | 1.678173 | | 1.688883 | | 1.683528 | | 63 | | 65.204 | 0.0063 | 0.006520 | | -2 | |
| **73** | | 73 | | 1.688883 | | 1.699593 | | 1.694238 | | 61 | | 58.858 | 0.0061 | 0.005886 | | 2 | |
| **74** | | 74 | | 1.699593 | | 1.710303 | | 1.704948 | | 58 | | 52.982 | 0.0058 | 0.005298 | | 5 | |
| **75** | | 75 | | 1.710303 | | 1.721012 | | 1.715657 | | 53 | | 47.562 | 0.0053 | 0.004756 | | 5 | |
| **76** | | 76 | | 1.721012 | | 1.731722 | | 1.726367 | | 64 | | 42.583 | 0.0064 | 0.004258 | | 21 | |
| **77** | | 77 | | 1.731722 | | 1.742432 | | 1.737077 | | 35 | | 38.025 | 0.0035 | 0.003803 | | -3 | |
| **78** | | 78 | | 1.742432 | | 1.753141 | | 1.747787 | | 34 | | 33.868 | 0.0034 | 0.003387 | | 0 | |
| **79** | | 79 | | 1.753141 | | 1.763851 | | 1.758496 | | 27 | | 30.090 | 0.0027 | 0.003009 | | -3 | |
| **80** | | 80 | | 1.763851 | | 1.774561 | | 1.769206 | | 19 | | 26.667 | 0.0019 | 0.002667 | | -8 | |
| **81** | | 81 | | 1.774561 | | 1.785271 | | 1.779916 | | 22 | | 23.576 | 0.0022 | 0.002358 | | -2 | |
| **82** | | 82 | | 1.785271 | | 1.795980 | | 1.790626 | | 27 | | 20.795 | 0.0027 | 0.002079 | | 6 | |
| **83** | | 83 | | 1.795980 | | 1.806690 | | 1.801335 | | 14 | | 18.299 | 0.0014 | 0.001830 | | -4 | |
| **84** | | 84 | | 1.806690 | | 1.817400 | | 1.812045 | | 16 | | 16.066 | 0.0016 | 0.001607 | | 0 | |
| **85** | | 85 | | 1.817400 | | 1.828110 | | 1.822755 | | 16 | | 14.073 | 0.0016 | 0.001407 | | 2 | |
| **86** | | 86 | | 1.828110 | | 1.838819 | | 1.833464 | | 8 | | 12.301 | 0.0008 | 0.001230 | | -4 | |
| **87** | | 87 | | 1.838819 | | 1.849529 | | 1.844174 | | 8 | | 10.729 | 0.0008 | 0.001073 | | -3 | |
| **88** | | 88 | | 1.849529 | | 1.860239 | | 1.854884 | | 10 | | 9.339 | 0.0010 | 0.000934 | | 1 | |
| **89** | | 89 | | 1.860239 | | 1.870948 | | 1.865594 | | 2 | | 8.111 | 0.0002 | 0.000811 | | -6 | |
| **90** | | 90 | | 1.870948 | | 1.881658 | | 1.876303 | | 6 | | 7.031 | 0.0006 | 0.000703 | | -1 | |
| **91** | | 91 | | 1.881658 | | 1.892368 | | 1.887013 | | 1 | | 6.083 | 0.0001 | 0.000608 | | -5 | |
| **92** | | 92 | | 1.892368 | | 1.903078 | | 1.897723 | | 1 | | 5.252 | 0.0001 | 0.000525 | | -4 | |
| **93** | | 93 | | 1.903078 | | 1.913787 | | 1.908432 | | 3 | | 4.526 | 0.0003 | 0.000453 | | -2 | |
| **94** | | 94 | | 1.913787 | | 1.924497 | | 1.919142 | | 2 | | 3.893 | 0.0002 | 0.000389 | | -2 | |
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| **96** | | 96 | | 1.935207 | | 1.945916 | | 1.940562 | | 0 | | 2.865 | 0.0000 | 0.000286 | | -3 | |
| **97** | | 97 | | 1.945916 | | 1.956626 | | 1.951271 | | 0 | | 2.451 | 0.0000 | 0.000245 | | -2 | |
| **98** | | 98 | | 1.956626 | | 1.967336 | | 1.961981 | | 1 | | 2.093 | 0.0001 | 0.000209 | | -1 | |
| **99** | | 99 | | 1.967336 | | 1.978046 | | 1.972691 | | 1 | | 1.785 | 0.0001 | 0.000178 | | -1 | |
| **100** | | 100 | | 1.978046 | | 1.988755 | | 1.983400 | | 1 | | 1.519 | 0.0001 | 0.000152 | | -1 | |

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