# Mobile Teaching Statistics with Web Based Dynamic Graphical SW *eStat, www.estat.me*


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# Example of mobile teaching statistics by using *eStat*

- **Book + *eLecture* + *eStat Practice***

**[Example 2.2.2] (Male and Female Population by Age Group– Two Group Summary Data)**
**In 2015, the male and female populations by age group in Korea are shown in Table 2.2.3. Using this data, draw bar chart, pie chart, band graph, and line graph of the population by age group and examine their characteristics.**

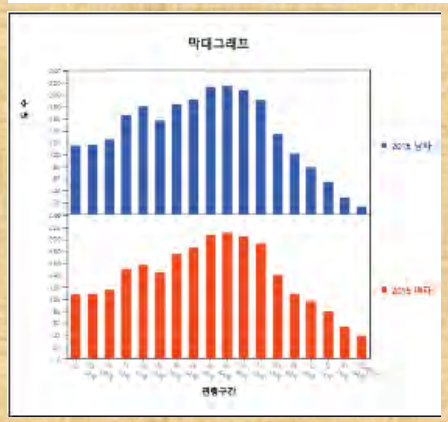
Table 2.2.3 male and female populations by age group in Korea
(KOSTAT Census 2015, unit 10,000)

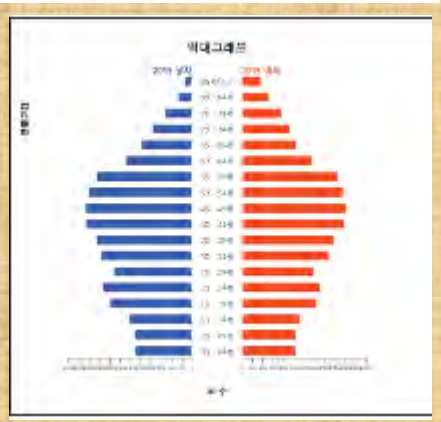
| Age Interval | 2015 Male | 2015 Female |
|---|---|---|
| 00 - 04 | 115 | 109 |
| 05 - 09 | 116 | 109 |
| 10 - 14 | 126 | 116 |
| 15 - 19 | 166 | 151 |
| 20 - 24 | 181 | 158 |
| 25 - 29 | 158 | 145 |
| 30 - 34 | 185 | 176 |
| 35 - 39 | 193 | 186 |
| 40 - 44 | 214 | 207 |
| 45 - 49 | 215 | 212 |
| 50 - 54 | 209 | 205 |
| 55 - 59 | 192 | 194 |
| 60 - 64 | 134 | 141 |
| 65 - 69 | 102 | 110 |
| 70 - 74 | 79 | 97 |
| 75 - 79 | 55 | 80 |
| 80 - 84 | 28 | 54 |
| over 85 | 13 | 39 |

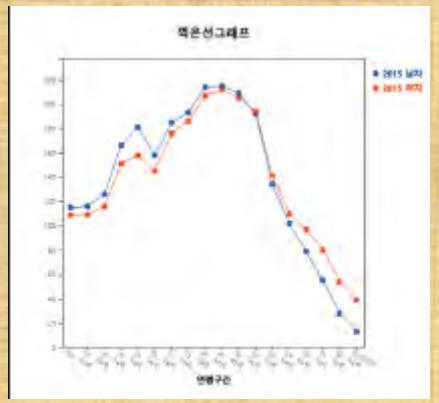
**QR for eStat**

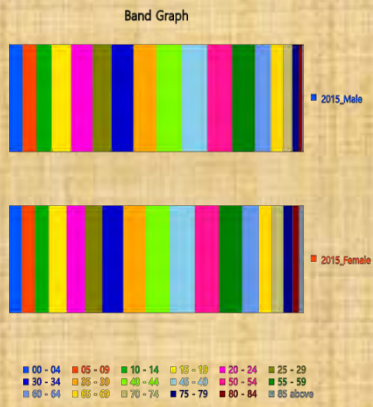

**QR for lecture movie**

**eStat practice**



# 1. *eStat* Project Background

- **Rapid Advance in Information Technology**
  **=> Big Data are generated**
  **=> Statistics is more important than any other era**
  **=> Data analysis by using a statistical packages is essential**
- **Statistics education by using SAS, SPSS, MINITAB, R become popular**
  **=> Statistical packages are good for data processing not enough for teaching statistics**
  **=> Teaching SAS or R is not easy for non-statistics major and elementary/middle school students**

# 2. *eStat* System Overview

◎ **Project started in 2012, supported partially by KNSO**

- **Web/Mobile based software by HTML5, CSS3, JavaScript**
- **Easy User Interface for all levels of students**
  **- mouse clicking only**
- **Dynamic graphs to amuse students by D3**
- **Data processing for raw and summary data**
- **Educational design of statistical outputs**
- **Capability for eLearning system**
- **Multilingual**

# 2. *eStat* System Overview

## ◎ *eStat* modules

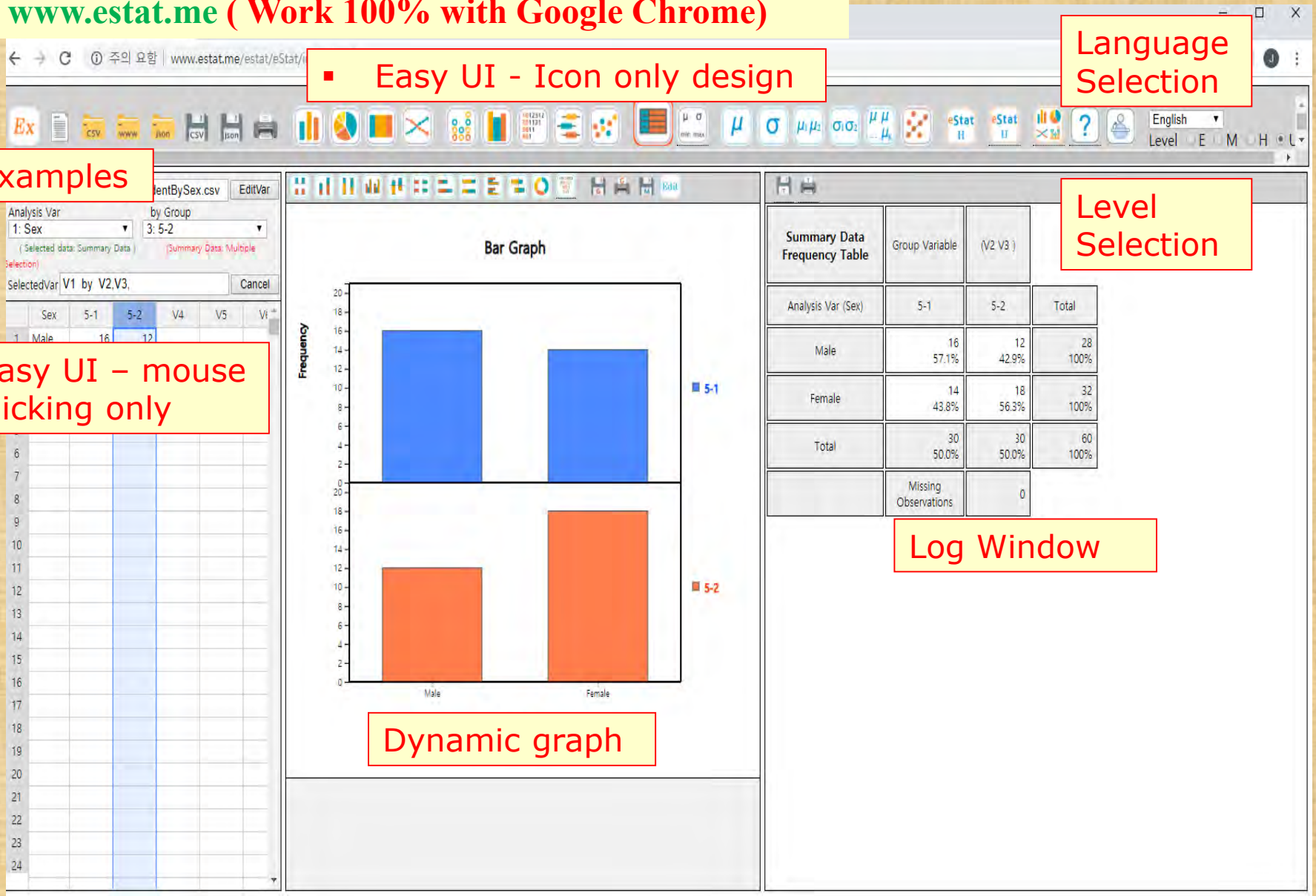
- **Elementary School**
- **Middle School**
- **High School**
- **University**


**Binomial, Normal, Sampling Distribution, Law of Large Number, Confidence Interval**

**Distributions – Binomial, Poisson, Hypergeometric, Normal, Exponential**
**Estimation & Testing Hypothesis – parameters for 1, 2, many populations(ANOVA)**
**Nonparametric Tests – Wilcoxon, Kruskal-Wallis, Friedman**
**Correlation and Regression**

# 2. *eStat* System Overview

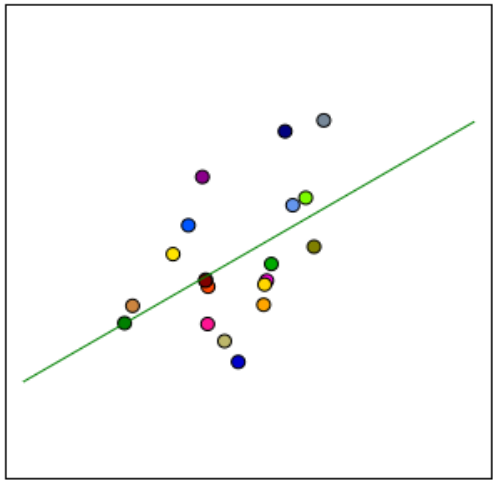
**www.estat.me ( Work 100% with Google Chrome)**



# 2. *eStatU* System Menu

## eStatU - University Statistics Education SW

- Uniform Random Number
- Binomial Experiment
- Binomial Distribution
- Poisson Distribution
- Geometric Distribution
- HyperGeometric Distribution
- Exponential Distribution
- Normal Experiment
- Normal Distribution
- t Distribution
- ChiSquare Distribution
- F Distribution
- Wilcoxon Signed Rank Sum Dist.
- Wilcoxon Rank Sum Distribution
- Kruskal-Wallis H Distribution
- Friedman S Distribution
- HSD Studentized Range Dist.



Contact: jjlee@ssu.ac.kr


- Law of Large Number
- Population vs Sample
- Dist of Sample Means
- Confidence Interval
- Correlation Coefficient
- Regression Experiment

- Testing Hypothesis $\mu$
- Testing $\mu$ - C, $\beta$
- Testing $\mu$ - C, n
- Testing Hypothesis $\sigma^2$
- Testing Hypothesis p
- Testing Hypothesis $\mu_1$, $\mu_2$
- Testing Hypothesis $\sigma_1^2$, $\sigma_2^2$
- Testing Hypothesis $p_1$, $p_2$
- Testing Hypothesis ANOVA
- Sign Test
- Signed Rank Sum Test
- Rank Sum Test
- Kruskal-Wallis Test
- Friedman Test
- Goodness of Fit Test
- Testing Independence

# 2. *eStat* System Overview

## ◎ Data and Dynamic Graph

- **Support csv and json format**
- **Support summary and raw data for data processing**
- **Dynamic graph**

File 000Summary_StudentBySex.csv

Analysis Var: 1: Sex ▼ | by Group: 3: 5-2

( Selected data: Summary Data ) (Summary Data: Multip

SelectedVar V1 by V2,V3,

| | Sex | 5-1 | 5-2 | V4 | V5 |
|---|---|---|---|---|---|
| 1 | Male | 16 | 12 | | |
| 2 | Female | 14 | 18 | | |

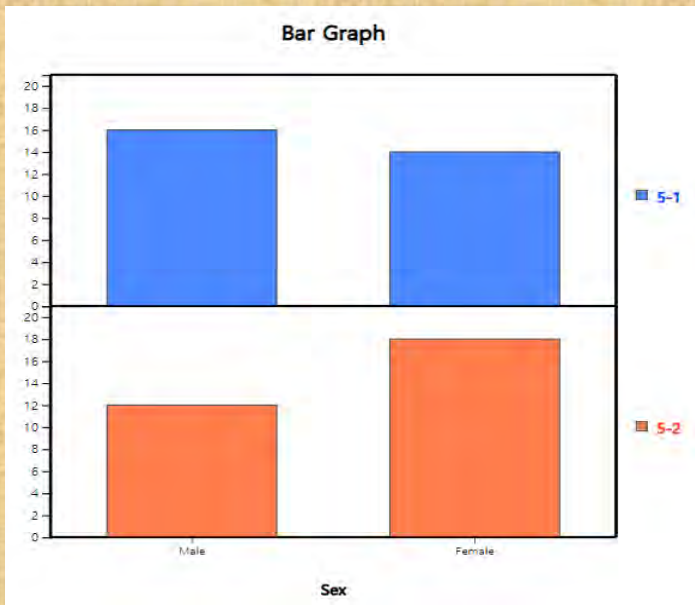
File 021Discrete_MathPreferenc

Analysis Var: 2: MathPref ▼ | by Group: 1: Sex

( Selected data: Raw Data ) (Summary Data: Mu

SelectedVar V2 by V1,

| | Sex | MathPref | V3 | V4 |
|---|---|---|---|---|
| 1 | 1 | 3 | | |
| 2 | 2 | 1 | | |
| 3 | 1 | 3 | | |
| 4 | 2 | 1 | | |
| 5 | 1 | 3 | | |
| 6 | 1 | 1 | | |
| 7 | 1 | 2 | | |
| 8 | 2 | 2 | | |
| 9 | 2 | 3 | | |
| 10 | 1 | 2 | | |



# 2. *eStat* System

## ◎ Graphical Result of Statistical Analysis - ANOVA

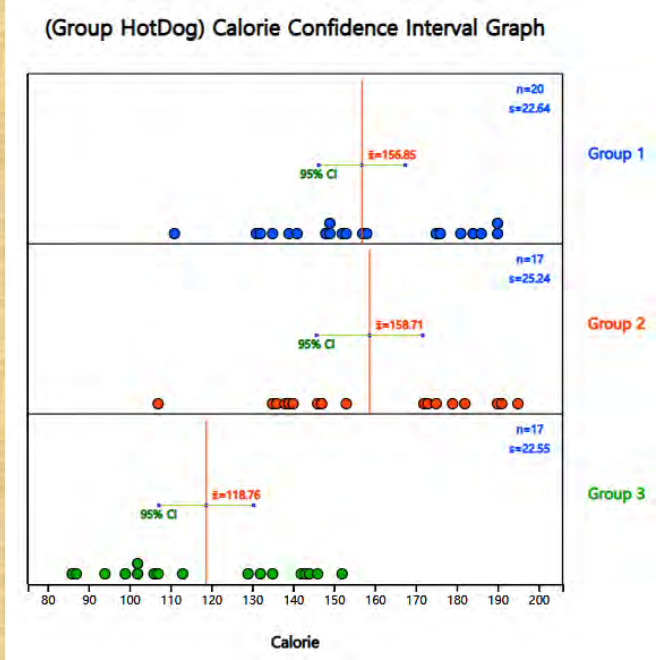
File 033Cont_CalorieByHotDogT

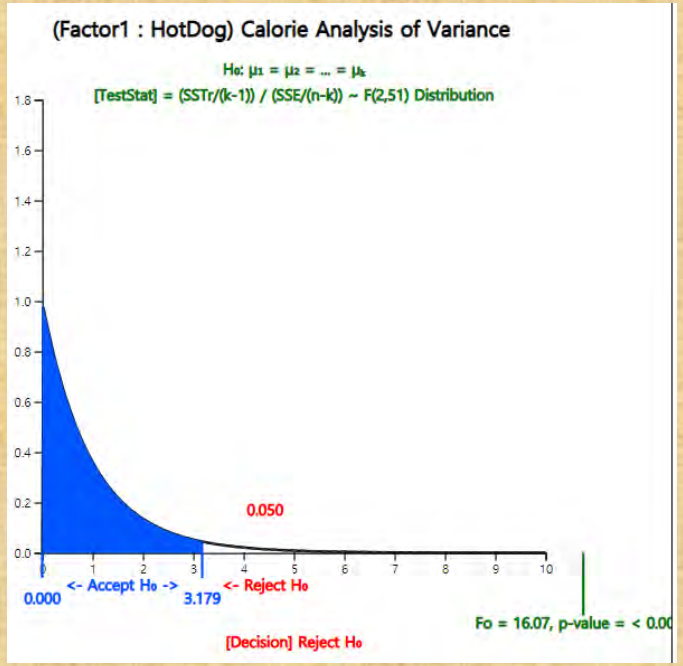
Analysis Var: 2: Calorie | by Group: 1: HotDog

( Selected data: Raw Data ) (Select up to two g

SelectedVar: V2 by V1,

| | HotDog | Calorie | V3 | V4 |
|---|---|---|---|---|
| 1 | 1 | 186 | | |
| 2 | 1 | 181 | | |
| 3 | 1 | 176 | | |
| 4 | 1 | 149 | | |
| 5 | 1 | 184 | | |
| 6 | 1 | 190 | | |
| 7 | 1 | 158 | | |
| 8 | 1 | 139 | | |
| 9 | 1 | 175 | | |
| 10 | 1 | 148 | | |
| 11 | 1 | 152 | | |
| 12 | 1 | 111 | | |
| 13 | 1 | 141 | | |
| 14 | 1 | 153 | | |
| 15 | 1 | 190 | | |



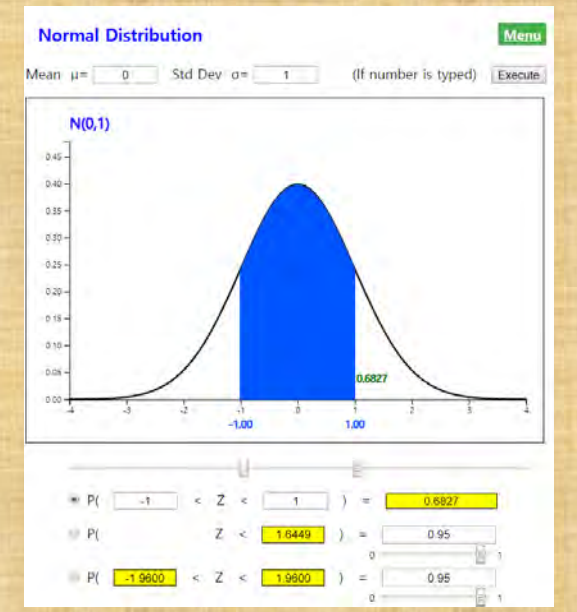



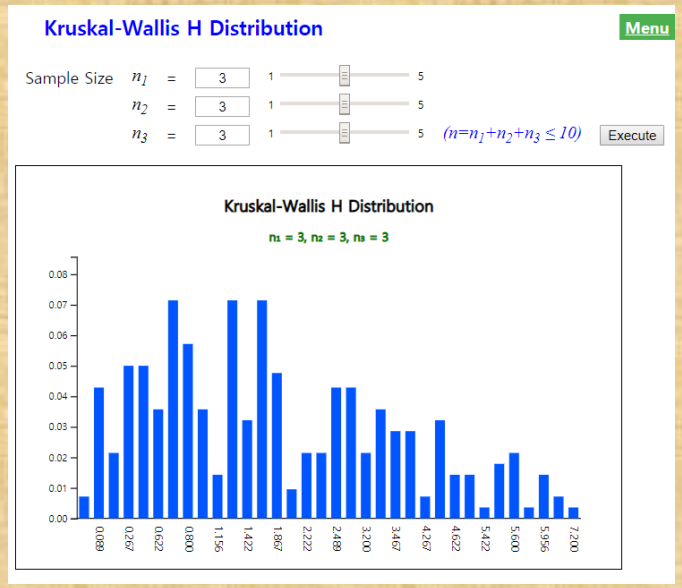

**Analysis of Variance**

| Factor | Sum of Squares | deg of freedom | Mean Squares | F value | p value |
|---|---|---|---|---|---|
| Treatment | 17692.195 | 2 | 8846.098 | 16.074 | < 0.0001 |
| Error | 28067.138 | 51 | 550.336 | | |
| Total | 45759.333 | 53 | | | |

# 2. *eStat* System

## ◎ All tables of statistical distributions are on smart-phone




| Normal Distribution | μ = 0 | σ = 1.000 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| x | P(X ≤ x) | x | P(X ≤ x) | x | P(X ≤ x) | x | P(X ≤ x) | x | P(X ≤ x) | x | P(X ≤ x) | x | P(X ≤ x) | x | P(X ≤ x) |
| -3.99 | 0.0000 | -2.99 | 0.0014 | -1.99 | 0.0233 | -0.99 | 0.1611 | 0.01 | 0.5040 | 1.01 | 0.8438 | 2.01 | 0.9778 | 3.01 | 0.9987 |
| -3.98 | 0.0000 | -2.98 | 0.0014 | -1.98 | 0.0239 | -0.98 | 0.1635 | 0.02 | 0.5080 | 1.02 | 0.8461 | 2.02 | 0.9783 | 3.02 | 0.9987 |
| -3.97 | 0.0000 | -2.97 | 0.0015 | -1.97 | 0.0244 | -0.97 | 0.1660 | 0.03 | 0.5120 | 1.03 | 0.8485 | 2.03 | 0.9788 | 3.03 | 0.9988 |
| -3.96 | 0.0000 | -2.96 | 0.0015 | -1.96 | 0.0250 | -0.96 | 0.1685 | 0.04 | 0.5160 | 1.04 | 0.8508 | 2.04 | 0.9793 | 3.04 | 0.9988 |
| -3.95 | 0.0000 | -2.95 | 0.0016 | -1.95 | 0.0256 | -0.95 | 0.1711 | 0.05 | 0.5199 | 1.05 | 0.8531 | 2.05 | 0.9798 | 3.05 | 0.9989 |
| -3.94 | 0.0000 | -2.94 | 0.0016 | -1.94 | 0.0262 | -0.94 | 0.1736 | 0.06 | 0.5239 | 1.06 | 0.8554 | 2.06 | 0.9803 | 3.06 | 0.9989 |
| -3.93 | 0.0000 | -2.93 | 0.0017 | -1.93 | 0.0268 | -0.93 | 0.1762 | 0.07 | 0.5279 | 1.07 | 0.8577 | 2.07 | 0.9808 | 3.07 | 0.9989 |
| -3.92 | 0.0000 | -2.92 | 0.0018 | -1.92 | 0.0274 | -0.92 | 0.1788 | 0.08 | 0.5319 | 1.08 | 0.8599 | 2.08 | 0.9812 | 3.08 | 0.9990 |
| -3.91 | 0.0000 | -2.91 | 0.0018 | -1.91 | 0.0281 | -0.91 | 0.1814 | 0.09 | 0.5359 | 1.09 | 0.8621 | 2.09 | 0.9817 | 3.09 | 0.9990 |
| -3.90 | 0.0000 | -2.90 | 0.0019 | -1.90 | 0.0287 | -0.90 | 0.1841 | 0.10 | 0.5398 | 1.10 | 0.8643 | 2.10 | 0.9821 | 3.10 | 0.9990 |
| -3.89 | 0.0001 | -2.89 | 0.0019 | -1.89 | 0.0294 | -0.89 | 0.1867 | 0.11 | 0.5438 | 1.11 | 0.8665 | 2.11 | 0.9826 | 3.11 | 0.9991 |
| -3.88 | 0.0001 | -2.88 | 0.0020 | -1.88 | 0.0301 | -0.88 | 0.1894 | 0.12 | 0.5478 | 1.12 | 0.8686 | 2.12 | 0.9830 | 3.12 | 0.9991 |
| -3.87 | 0.0001 | -2.87 | 0.0021 | -1.87 | 0.0307 | -0.87 | 0.1922 | 0.13 | 0.5517 | 1.13 | 0.8708 | 2.13 | 0.9834 | 3.13 | 0.9991 |
| -3.86 | 0.0001 | -2.86 | 0.0021 | -1.86 | 0.0314 | -0.86 | 0.1949 | 0.14 | 0.5557 | 1.14 | 0.8729 | 2.14 | 0.9838 | 3.14 | 0.9992 |
| -3.85 | 0.0001 | -2.85 | 0.0022 | -1.85 | 0.0322 | -0.85 | 0.1977 | 0.15 | 0.5596 | 1.15 | 0.8749 | 2.15 | 0.9842 | 3.15 | 0.9992 |
| -3.84 | 0.0001 | -2.84 | 0.0023 | -1.84 | 0.0329 | -0.84 | 0.2005 | 0.16 | 0.5636 | 1.16 | 0.8770 | 2.16 | 0.9846 | 3.16 | 0.9992 |
| -3.83 | 0.0001 | -2.83 | 0.0023 | -1.83 | 0.0336 | -0.83 | 0.2033 | 0.17 | 0.5675 | 1.17 | 0.8790 | 2.17 | 0.9850 | 3.17 | 0.9992 |

| Kruskal-Wallis H Distribution | k = 3 | | |
|---|---|---|---|
| | $n_1$ = 3 | $n_2$ = 3 | $n_3$ = 3 |
| x | P(X = x) | P(X ≤ x) | P(X ≥ x) |
| 0.000 | 0.0071 | 0.0071 | 1.0000 |
| 0.089 | 0.0429 | 0.0500 | 0.9929 |
| 0.089 | 0.0214 | 0.0714 | 0.9500 |
| 0.267 | 0.0500 | 0.1214 | 0.9286 |
| 0.356 | 0.0500 | 0.1714 | 0.8786 |
| 0.622 | 0.0357 | 0.2071 | 0.8286 |
| 0.622 | 0.0714 | 0.2786 | 0.7929 |
| 0.800 | 0.0571 | 0.3357 | 0.7214 |
| 1.067 | 0.0357 | 0.3714 | 0.6643 |
| 1.156 | 0.0143 | 0.3857 | 0.6286 |
| 1.156 | 0.0714 | 0.4571 | 0.6143 |
| 1.422 | 0.0321 | 0.4893 | 0.5429 |
| 1.689 | 0.0714 | 0.5607 | 0.5107 |
| 1.867 | 0.0476 | 0.6083 | 0.4393 |
| 1.867 | 0.0095 | 0.6179 | 0.3917 |
| 2.222 | 0.0214 | 0.6393 | 0.3821 |
| 2.400 | 0.0214 | 0.6607 | 0.3607 |

# 2. *eStat* System

## ◎ Modules for Home Work Assignment - eStatU

### Testing Hypothesis $\mu_1$, $\mu_2$

Menu

**[Hypothesis]** $H_o : \mu_1 - \mu_2 = D$ 0

$H_1 : \mu_1 - \mu_2 \neq D$ $H_1 : \mu_1 - \mu_2 > D$ $H_1 : \mu_1 - \mu_2 < D$

**[Test Type]** t test , Variance Assumption $\sigma_1^2 = \sigma_2^2$ $\sigma_1^2 \neq \sigma_2^2$

Significance Level $\alpha$ = 5% 1%

Sampling Type independent sample paired sample

**[Sample Data]** *Input either sample data using BSV or sample statisti*

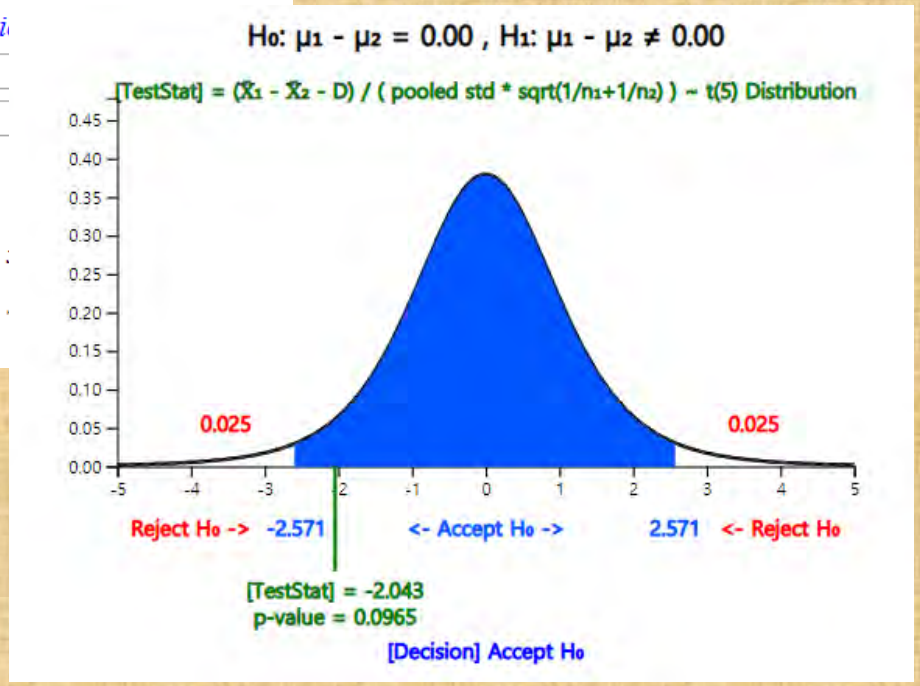
Sample 1 1 2 3 4

Sample 2 3 5 6

**[Sample Statistics]**

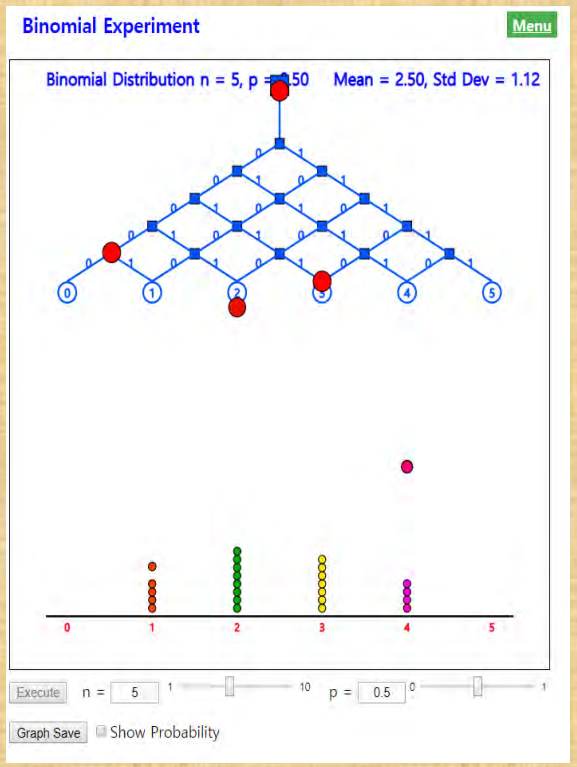
| | | | | | | |
|---|---|---|---|---|---|---|
| Sample Size | $n_1$ | = | 4 | $n_2$ | = | 3 |
| Sample Mean | $\bar{x}_1$ | = | 2.50 | $\bar{x}_2$ | = | 4.67 |
| Sample Variance | $s_1^2$ | = | 1.67 | $s_2^2$ | = | 2.33 |

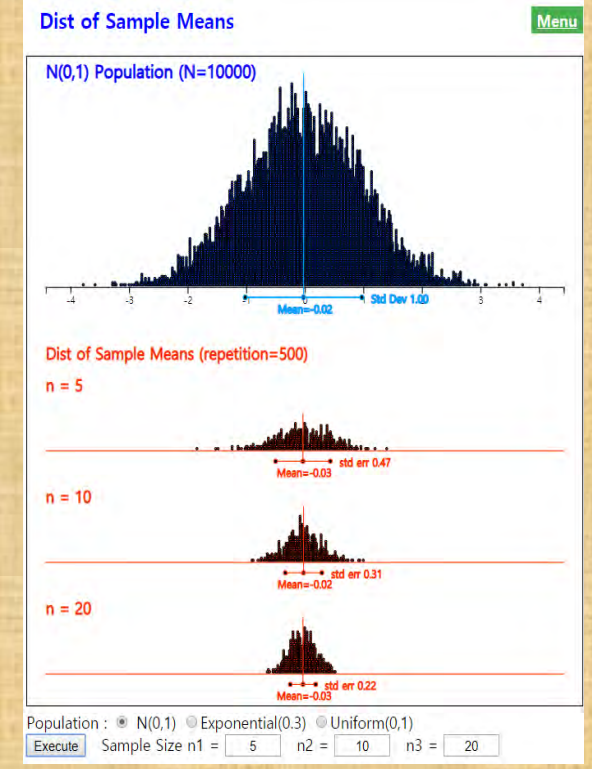
Execute

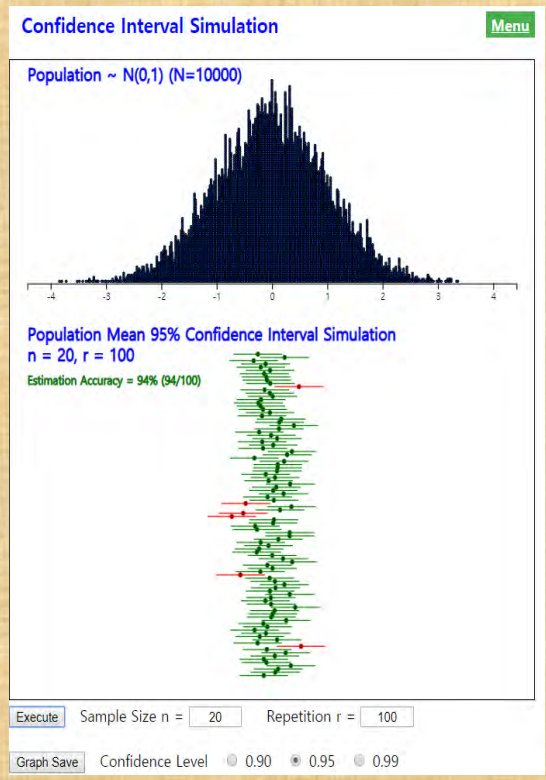


# 2. *eStat* System

## ◎ Simulation Experiments



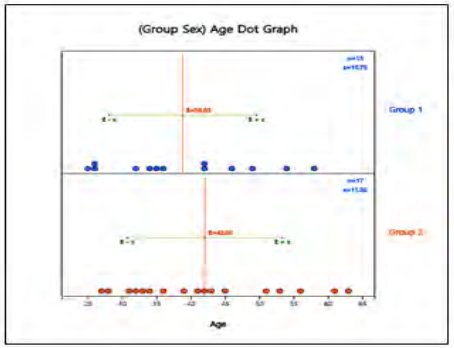



# 3. *eStat* Mobile Teaching

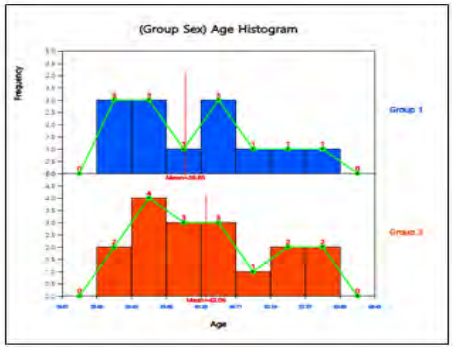
## - Data Visualization

### 3.2.2 Visualization of Continuous Data with Group

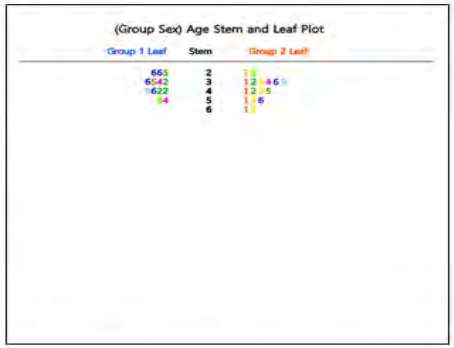
[Example 3.2.2] (age – two group continuous data)
The data on the gender and age of a middle school teacher is ⇨ 02English ⇨ 032 Continuous_TeacherAgeByGender.csv. Use 「eStat」 to draw a dot graph, histogram, stem and leaf plot.




<Figure 3.2.6-2> Dot graph of age by gender with mean




<Figure 3.2.7-2> Histogram of age by gender with polygon

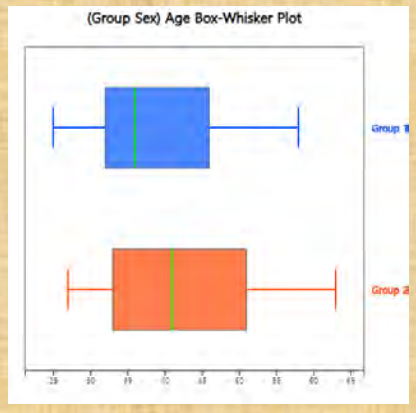



<Figure 3.2.9-2> Both direction stem and leaf plot of age by sex

| | Sex | Age |
|---|---|---|
| 1 | 1 | 26 |
| 2 | 1 | 34 |
| 3 | 2 | 28 |
| 4 | 2 | 39 |
| 5 | 1 | 32 |
| 6 | 1 | 36 |
| 7 | 2 | 41 |
| 8 | 2 | 42 |
| 9 | 1 | 26 |
| 10 | 1 | 25 |
| 11 | 2 | 33 |
| 12 | 2 | 43 |
| 13 | 1 | 54 |
| 14 | 1 | 49 |
| 15 | 2 | 56 |

**eStat practice**

| Histogram Frequency Table | Group Name | (Sex) | |
|---|---|---|---|
| Interval ( Age) | Group 1 (Group 1) | Group 2 (Group 2) | Total |
| 1 [25.00, 30.43) | 3 (23.1%) | 2 (11.8%) | 5 (16.7%) |
| 2 [30.43, 35.86) | 3 (23.1%) | 4 (23.5%) | 7 (23.3%) |
| 3 [35.86, 41.29) | 1 (7.7%) | 3 (17.6%) | 4 (13.3%) |
| 4 [41.29, 46.71) | 3 (23.1%) | 3 (17.6%) | 6 (20.0%) |
| 5 [46.71, 52.14) | 1 (7.7%) | 1 (5.9%) | 2 (6.7%) |
| 6 [52.14, 57.57) | 1 (7.7%) | 2 (11.8%) | 3 (10.0%) |
| 7 [57.57, 63.00) | 1 (7.7%) | 2 (11.8%) | 3 (10.0%) |
| Total | 13 (100%) | 17 (100%) | 30 (100%) |



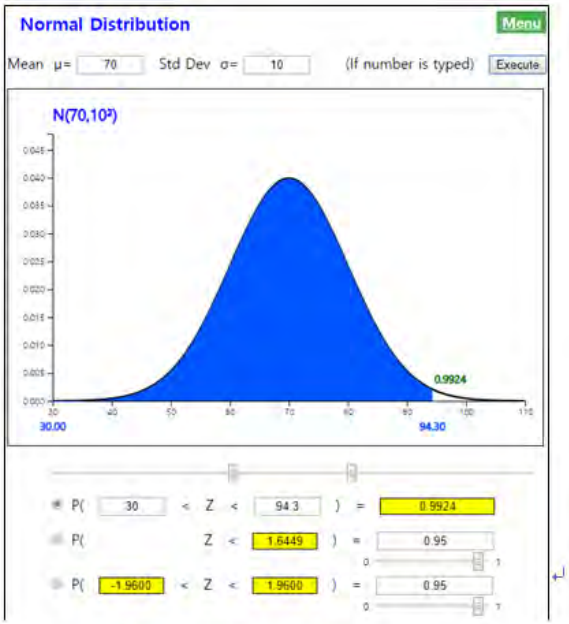
# 3. *eStat* Mobile Teaching

# - Normal Distribution

### 5.4.1 Normal Distribution

[Example 5.4.4] If the mid-term scores (X) of the Statistics course follows a normal distribution with an average of 70 points and a standard deviation of 10 test results X, calculate the following probabilities. Check the calculated value by using 「eStatU.

1) P(X < 94.3)  2) P(X > 57.7)  3) P(57.7 < X < 94.3)




<Figure 5.4.12> Probability calculation of general normal distribution

**eStat practice**

| 정규분포 | μ = 0 | σ = 1.000 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| p | P(X ≤ x) = p | p | P(X ≤ x) = p | p | P(X ≤ x) = p | p | P(X ≤ x) = p | p | P(X ≤ x) = |
| 0.005 | -2.576 | 0.205 | -0.824 | 0.405 | -0.240 | 0.605 | 0.266 | 0.805 | 0.860 |
| 0.010 | -2.326 | 0.210 | -0.806 | 0.410 | -0.228 | 0.610 | 0.279 | 0.810 | 0.878 |
| 0.015 | -2.170 | 0.215 | -0.789 | 0.415 | -0.215 | 0.615 | 0.292 | 0.815 | 0.896 |
| 0.020 | -2.054 | 0.220 | -0.772 | 0.420 | -0.202 | 0.620 | 0.305 | 0.820 | 0.915 |
| 0.025 | -1.960 | 0.225 | -0.755 | 0.425 | -0.189 | 0.625 | 0.319 | 0.825 | 0.935 |
| 0.030 | -1.881 | 0.230 | -0.739 | 0.430 | -0.176 | 0.630 | 0.332 | 0.830 | 0.954 |
| 0.035 | -1.812 | 0.235 | -0.722 | 0.435 | -0.164 | 0.635 | 0.345 | 0.835 | 0.974 |
| 0.040 | -1.751 | 0.240 | -0.706 | 0.440 | -0.151 | 0.640 | 0.358 | 0.840 | 0.994 |
| 0.045 | -1.695 | 0.245 | -0.690 | 0.445 | -0.138 | 0.645 | 0.372 | 0.845 | 1.015 |
| 0.050 | -1.645 | 0.250 | -0.674 | 0.450 | -0.126 | 0.650 | 0.385 | 0.850 | 1.036 |
| 0.055 | -1.598 | 0.255 | -0.659 | 0.455 | -0.113 | 0.655 | 0.399 | 0.855 | 1.058 |
| 0.060 | -1.555 | 0.260 | -0.643 | 0.460 | -0.100 | 0.660 | 0.412 | 0.860 | 1.080 |
| 0.065 | -1.514 | 0.265 | -0.628 | 0.465 | -0.088 | 0.665 | 0.426 | 0.865 | 1.103 |
| 0.070 | -1.476 | 0.270 | -0.613 | 0.470 | -0.075 | 0.670 | 0.440 | 0.870 | 1.126 |
| 0.075 | -1.440 | 0.275 | -0.598 | 0.475 | -0.063 | 0.675 | 0.454 | 0.875 | 1.150 |
| 0.080 | -1.405 | 0.280 | -0.583 | 0.480 | -0.050 | 0.680 | 0.468 | 0.880 | 1.175 |
| 0.085 | -1.372 | 0.285 | -0.568 | 0.485 | -0.038 | 0.685 | 0.482 | 0.885 | 1.200 |
| 0.090 | -1.341 | 0.290 | -0.553 | 0.490 | -0.025 | 0.690 | 0.496 | 0.890 | 1.227 |
| 0.095 | -1.311 | 0.295 | -0.539 | 0.495 | -0.013 | 0.695 | 0.510 | 0.895 | 1.254 |
| 0.100 | -1.282 | 0.300 | -0.524 | 0.500 | 0.000 | 0.700 | 0.524 | 0.900 | 1.282 |

# 3. *eStat* Mobile Teaching

# - Kruskal Wallis ANOVA

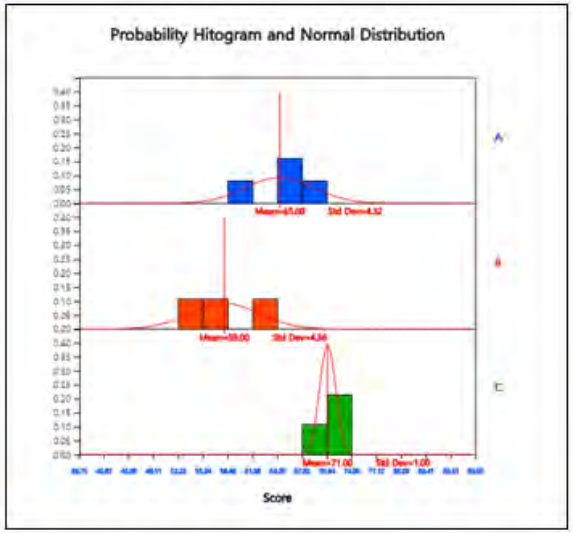
**eStat practice**

## 10.3.1 Completely Randomized Design: Kruskal-Wallis Test

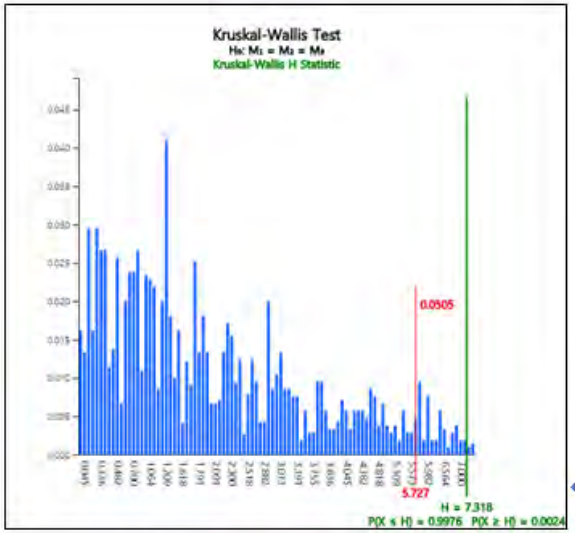
[Example 10.3.1] The results of a survey of job satisfaction by sampling employees of three companies are as follows: From this data, can you say that the three companies have different job satisfaction levels?

Company A 69 67 65 59
Company B 56 63 55
Company C 71 72 70

1) Draw a histogram of the data to see if the average job satisfaction level of the three companies can be tested in a parametric way.
2) Using the nonparametric method, test whether the three companies can be said to have different job satisfaction levels. a significant level of 5%




<Figure 10.3.3> Histogram by company




<Figure 10.3.6> Kruskal-Wallis test

**Testing Hypothesis ANOVA** Menu

[Hypothesis] $H_0: \mu_1 = \mu_2 = \ldots = \mu_k$
$H_1$ : *At least one pair of means is different*

[Test Type] *F test* (ANOVA)
Significance Level $\alpha$ = 5% 1%

[Sample Data] *Input either sample data using BSV or sample statistics at the next boxes*

| | |
|---|---|
| Sample 1 | 69 67 65 59 |
| Sample 2 | 56 63 55 |
| Sample 3 | 71 72 70 |
| Sample 4 | |

[Sample Statistics]

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $n_1$ = | 4 | $n_2$ = | 3 | $n_3$ = | 3 | $n_4$ = | |
| $m_1$ = | 65.00 | $m_2$ = | 58.00 | $m_3$ = | 71.00 | $m_4$ = | |
| $s_1^2$ = | 18.67 | $s_2^2$ = | 19.00 | $s_3^2$ = | 1.00 | $s_4^2$ = | |

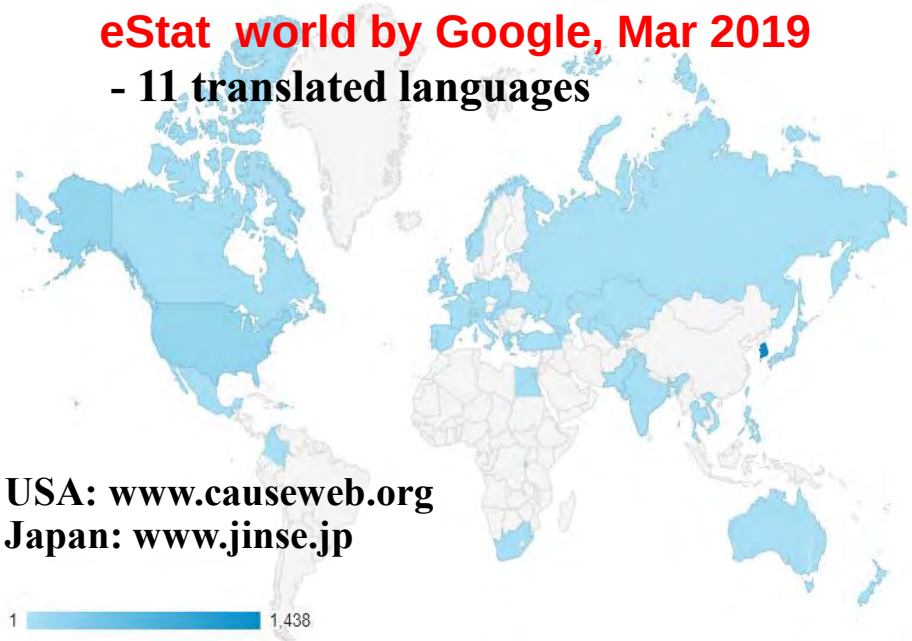
Execute

| Kruskal-Wallis Test | Analysis Var | Score | | |
|---|---|---|---|---|
| Statistics | Observation | Mean | Std Dev | Rank Sum |
| 1 (A) | 4 | 65.000 | 4.320 | 21.00 |
| 2 (B) | 3 | 58.000 | 4.359 | 7.00 |
| 3 (C) | 3 | 71.000 | 1.000 | 27.00 |
| Total | 10 | 64.700 | 6.237 | 55.00 |
| Missing Observations | 0 | | | |
| Hypothesis | | | | |
| $H_0: M_1 = M_2 = M_3$ | [TestStat] | H | P(X ≤ H) | P(X ≥ H) |
| At least one pair of locations is different | H | 7.318 | 0.9976 | 0.0024 |

# 4. Conclusion

- ***eStat*** **is an integrated statistical software for teaching as well as data processing to all level of students.**
- **To continue this freeware *eStat* project,**
  **=> international collaboration among statistician, mathematics education, school teachers to share experience, idea, and technology**

**eStat world by Google, Mar 2019**
**- 11 translated languages**




**USA: www.causeweb.org**
**Japan: www.jinse.jp**

**JoongAng Daily, May 2018, Korea**