

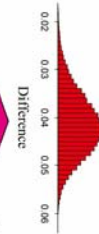
How to run “paired bootstrap test”

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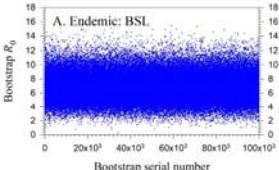
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Paired bootstrap test

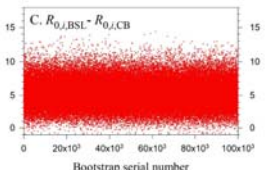
	Treatment A	Treatment B	Difference	Sorted
Bootstrap	① ② … ②	① ② … ②		
1	③ ⑦ … ⑧ $\lambda_{A,1}$	④ ⑦ … ⑧ $\lambda_{B,1}$	➡ Δ_1	
2	② ③ … ③ $\lambda_{A,2}$	⑤ ① … ① $\lambda_{B,2}$	➡ Δ_2	
3	⑨ ⑥ … ⑥ $\lambda_{A,3}$	① ③ … ③ $\lambda_{B,3}$	➡ Δ_3	
99,999	⑥ ⑧ … ⑧ $\lambda_{A,99999}$	① ⑦ … ⑦ $\lambda_{B,99999}$	➡ $\Delta_{99,999}$	
100,000	⑧ ⑦ … ⑦ $\lambda_{A,100000}$	④ ③ … ③ $\lambda_{B,100000}$	➡ $\Delta_{100,000}$	

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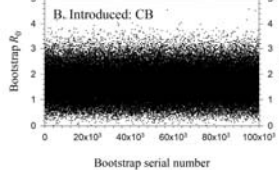
Paired bootstrap test



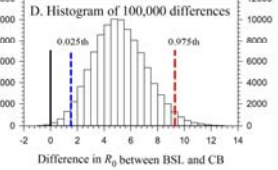
A. Endemic: BSL



C. $R_{0,BSL} - R_{0,CB}$



B. Introduced: CB



D. Histogram of 100,000 differences

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References

- Efron, B. and Tibshirani, R. J. 1993. An introduction to the bootstrap. Chapman & Hall, New York.
- Brandstätter, E. 1999. Confidence intervals as an alternative to significance testing. *Methods of Psychological Research Online*. 4: 33-46. (Internet: <http://www.ipn.uni-kiel.de/mpr/>)
- Huang, Y. B. and Hsin Chi. 2012. Assessing the application of the jackknife and bootstrap techniques to the estimation of the variability of the net reproductive rate and gross reproductive rate: a case study in *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae). *J. Agri. & Fore.* 61(1): 37-45.

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Important new reference

Wei, M. F., H. Chi, Y. F. Guo, X. W. Li, L. L. Zhao, and R. Y. Ma. 2020. Demography of *Cacopsylla chinensis* (Hemiptera: Psyllidae) reared on four cultivars of *Pyrus bretschneideri* and *P. communis* (Rosales: Rosaceae) pears with estimations of confidence intervals of specific life table statistics. *Journal of Economic Entomology* doi: 10.1093/jee/toaa149.

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2 steps for “paired bootstrap test”

1. Analyze life tables of all treatments go through A1, A2, and A3. You must use the same bootstrap number (B) for all life tables.
2. Use “C. PT (1 by 1)” to run paired bootstrap test.

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A1. 讀取資料檔案 (Read data file)

The screenshot shows the 'Age-Stage, Two-Sex Life Table Analysis' software interface. The 'Main procedures' section has 'A1. Read data' highlighted with a red arrow. The interface includes various input fields for demographic data and a sidebar with a portrait of Prof. Dr. Hsin Chi.

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A2. 基本分析 (Basic Run)

The screenshot shows the same software interface as A1, but with 'A2. Basic Run' highlighted with a red arrow. The 'Basic results' section shows calculated values for population parameters.

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A3. Bootstrap technique (Estimation of SEs)

A3. 使用自展法 (隨機重複取樣) 估算標準誤 (SEs)

The screenshot shows the software interface with a graph titled 'Survival rates for each age stage group'. The graph plots survival probability against age for Egg, Larva, Pupa, and Female stages. A red arrow points to the 'A3. Bootstrap' button in the main procedures list.

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Bootstrap is running!

The screenshot shows the software interface during a bootstrap run. A progress bar is visible, and status messages indicate 'Running bootstrap (B = 100000)', 'Estimated total time: 3 m.', and 'Bootstrap began at: 3/5/2021 12:31:08 PM'. A red arrow points to the 'A3. Bootstrap' button.

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Bootstrap completed!

The screenshot shows the software interface after the bootstrap process is complete. A histogram displays the distribution of bootstrap results for a parameter. A red arrow points to the 'A3. Bootstrap' button.

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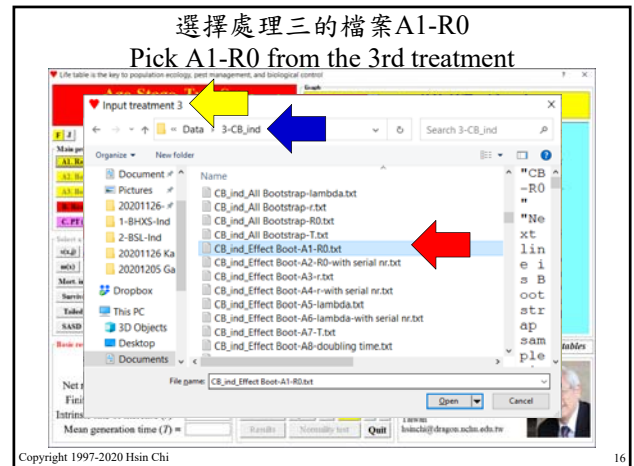
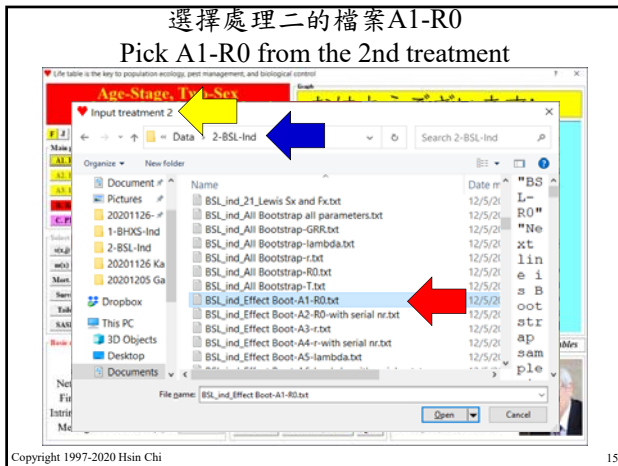
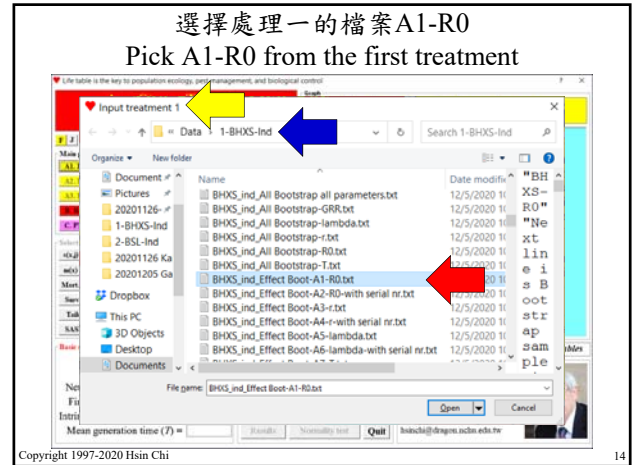
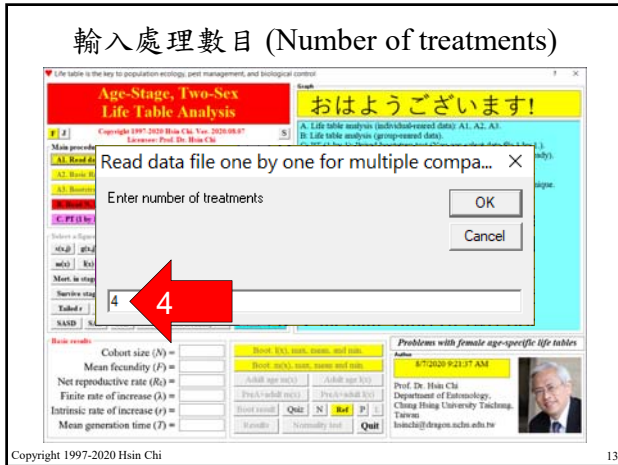
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2. 使用 C. PT (1 by 1) 執行 paired bootstrap test
Use C. PT (1 by 1) to run paired bootstrap test

The screenshot shows the software interface with 'C. PT (1 by 1)' highlighted with a yellow arrow in the main procedures list. The interface also shows the 'Tünaydın!' message.

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使用快速排序 (Use "Quick sort")

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使用512組 (Use 512 classes)

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分析完成 Completed

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分析結果之檔案名稱為
24-Paired boot test results, 在最後一個處理的檔案匣中。
Results of comparison are saved in the file "24-Paired boot test results-Ro.txt" located in the folder of the last treatment.

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	BHXS-R0	BSL-R0
Original =	7.53846153846154	6.78947368421053
Bootstrap mean =	7.54869169845106	6.78838837778219
Variance =	3.54872921141065	3.63258311379749
SE =	1.88380710568005	1.90593365933799
n	169	152

Difference 1 =	0.74898785425101	
	Difference 1 is the difference of two original values.	

Difference 2 =	0.76030332066887	
	Difference 2 is the difference of two bootstrap means.	

Difference 3 =	0.760303320669002	
	Difference 3 is the mean of all bootstrap differences.	
	With the increase of B, both diff. 2 and 3 will close to diff. 1.	

SE of differences =	2.67615514846563	

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```

*****
*Bootstrap t confidence intervals:
*95% CI: Lower Upper
* -4.4848644287383 6.0054710700763
*No signif. diff. btw. BHXS-R0 and BSL-R0.
*If the CI includes 0, there is no significant difference
*****
#####
#Percentile confidence intervals of differences:
#95% CI: Lower Upper
# -4.51573444689588 5.95776705862735
#No signif. diff. btw. BHXS-R0 and BSL-R0.
#If the CI includes 0, there is no significant difference.
#-----
#Number of insignif. diff. = 77530
#Number of signif. diff. = 22470
#P-value (based on bootstrap samples) = 0.7753
*****
    
```

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	BHXS-R0		CB-R0
Original =	7.53846153846154	↔	1.62631578947368
Bootstrap mean =	7.54869169845106	↔	1.62818399214701
Variance =	3.54872921141065		0.311392578092541
SE =	1.88380710568005		0.558025607022241
n	169		190

Difference 1 =	5.91214574898786		
	Difference 1 is the difference of two original values.		

Difference 2 =	5.92050770630405		
	Difference 2 is the difference of two bootstrap means.		

Difference 3 =	5.92050770630413		
	Difference 3 is the mean of all bootstrap differences.		
	With the increase of B, both diff. 2 and 3 will close to diff. 1.		

SE of differences =	1.96585602613466		
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```

*****
* Bootstrap t confidence intervals:
* 95% CI: Lower Upper
*          2.06750066589713 9.77351474671112
* Signif. diff. btw. BHXS-R0 and CB-R0.
* If the CI does not include 0, there is significant
* difference.
*****
#####
# Bootstrap percentile confidence intervals:
# 95% CI: Lower Upper
#          2.27699980181761 9.97052397445113
# Signif. diff. btw. BHXS-R0 and CB-R0.
# If the CI does not include 0, there is significant
# difference.
#####
# Number of insignif. diff. (neu) = 302
# Number of signif. diff. (neu) = 99698
# P-value (based on bootstrap samples) (neu) = 0.00302
#####
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```

Table 2: 右上角為兩處理之差，左下角為差值之CI下界

Table 2. Differences between treatments and lower CI (This CI is based on the bootstrap t confidence interval). [Upper right triangle: The difference between means (i,j)]. [Lower left triangle: Lower CI of difference between means (i,j) based on t]

	BHXS-R0	BSL-R0	CB-R0	CRB-R0
BHXS-R0	---	0.7603	5.9205	6.3443
BSL-R0	-4.4849	---	5.1602	5.584
CB-R0	2.0675 *	1.2664 *	---	0.4238
CRB-R0	2.5436 *	1.7404 *	-0.9965	---

*: Significant at 5% significance level
The bootstrap t confidence interval might be different from the bootstrap percentile confidence interval.

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Table 3: 右上角為兩處理之差，左下角為P值

Table 3. Differences between treatments and P-value [Upper right triangle: The difference between means (i,j)] [Lower left triangle: P-value of the test between (i,j)]

	BHXS-R0	BSL-R0	CB-R0	CRB-R0
BHXS-R0	---	0.7603	5.9205 *	6.3443 *
BSL-R0	0.7753	---	5.1602 *	5.584 *
CB-R0	0.003 *	0.0099 *	---	0.4238
CRB-R0	0.0015 *	0.0054 *	0.5536	---

*: Significant at 5% significance level

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Table 6. Preliminary table of differences between treatments.

(This table is only for VIPs. If you notice error, please inform Prof. Chi.) You can use the following table to mark the differences between treatments. Only the differences between the first few treatments are marked for you. Note well! If this table is not completed, you have to complete the rest "_" yourself. Attention! Not every "_" needs to be filled with a letter. This is a good practice of "critical thinking". "Thinking is the most important thing in science".

Treatment	Mean	SE	Difference
BHXS-R0	7.53846153846154	1.88380710568005	a
BSL-R0	6.78947368421053	1.90593365933799	a
CB-R0	1.62631578947368	0.558025607022241	b
CRB-R0	1.2046783625731	0.461751843292745	b

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سپاسگزارم
謝謝!
ขอบคุณครับ
Děkuji
Danke!
¡Muchas gracias!
Thank you!
ご清聴ありがとうございます
います!

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