

Re: Can helium filled footballs be kicked farther than air filled balls?

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As a first approach, seeing to the data, there is no evidence that it is not normal and the dispersions could be equal (sd1=2.52 , sd2=2.76) and the difference on means -1.35 (= 29.45-30.80).  
 The Student's t evaluation by the \*omnibus\* algorithm:

$$t_0 = |\text{mean1} - \text{mean2}| / s = - 1.613$$

$$s = (\text{ssd1} + \text{ssd2}) / (20 + 20 - 2) * (1/20 + 1/20) = 0.837$$

It can be seen that the critical value (at 5% confidence level) for not distinct means is +/-2.0244 (38df).  
 Therefore, there is not sufficient evidence that helium improves the performance (it is not surprising because the variation in the weight is negligible).

Using sophisticated software, we can get.

prob(abs(t) < t0) = 78.22%  
 and CI (5%) = [-3.044 ; 0.344].

By the program below I can compare (concerning the means and standard deviations), the performances of Bootstrap (B) set of simulated samples (with replacement) and the Permutation (P) set (without replacement).  
 A shorten list:

B	P
-1.352_0.673	-1.343_0.697
-1.349_0.672	-1.349_0.672
-1.351_0.674	-1.348_0.681
-1.349_0.661	-1.348_0.666
-1.354_0.670	-1.350_0.681

There is any possibility to doubt that the two procedures provide the same results.

This note is he response to those that are suspicious about the tests based on Permutation Samples (that I introduce since Nov. 30).

```
REM "HELIUM"
CLS
PRINT "***** AIR or HELIUM ? "
DIM x(20), xx(20), y(20), yy(20)
DATA 26,27,27,27,28,28,28,28,28,28,29,29,29
DATA 31,31,31,32,33,34,35
DATA 28,28,28,29,29,29,29,29,30,30,30,30,31,31
DATA 32,32,33,34,35,39
FOR i = 1 TO 20: READ x(i): xx(i) = x(i)
```

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```
mx = mx + x(i) / 20:
m2x = m2x + x(i) * x(i): NEXT i
FOR j = 1 TO 20: READ y(j): yy(j) = y(j)
my = my + y(j) / 20:
m2y = m2y + y(j) * y(j): NEXT j
PRINT " MEANS = ";
PRINT USING "###.## "; mx; my;
ssdx = m2x - 20 * mx * mx
ssdy = m2y - 20 * my * my
a0 = (ssdx + ssdy) / 38: nt = 1 / 20 + 1 / 20
sigma = SQR(a0 * nt)
PRINT USING " diff = ##.## ";
mx - my
varx = (m2x - 20 * mx * mx) / 19:
sx = SQR(varx)
vary = (m2y - 20 * my * my) / 19:
sy = SQR(vary)
PRINT " sd = ";
PRINT USING "###.## "; sx; sy;
PRINT USING " sigma = ##.## "; sigma
t = (mx - my) / sigma
PRINT USING " t0=###.### "; t;
PRINT " p(diff<=t0)= 0.1089 ";
PRINT " p(abs(diff)<t0 = 78.22% "
PRINT " diff C.I. ";
PRINT USING "[###.### ";
(mx - my) - 2.0244 * sigma;
PRINT USING " ###.###] ";
(mx - my) + 2.0244 * sigma
PRINT " BOOTSTRAP "
all = 20000
FOR rpt = 1 TO 10
FOR v = 1 TO all: d = 0
RANDOMIZE TIMER
FOR i = 1 TO 20: x = INT(20 * RND) + 1
y = INT(20 * RND) + 1
d = d + (x(x) - y(y)) / 20
NEXT i
dd = dd + d
d2 = d2 + d * d
IF ABS(d) > diff THEN ww = ww + 1
NEXT v
sqdb = d2 - dd ^ 2 / all
PRINT USING " ###.### ";
dd / all; sqdb / (all - 1);
dd = 0
PRINT "***** MOD. "; : cc = (20 * 21) / 2
FOR v = 1 TO all
RANDOMIZE TIMER
FOR L = 1 TO 20: xx(L) = x(L)
yy(L) = y(L): NEXT L
```

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```
x = 0
FOR ii = 1 TO 20
  10 g = INT(20 * RND) + 1
  IF xx(g) = 12345 THEN GOTO 10
  x = x + ii / cc * xx(g)
  xx(g) = 12345
NEXT ii
y = 0
FOR ii = 1 TO 20
  11 g = INT(20 * RND) + 1
  IF yy(g) = 12345 THEN GOTO 11
  y = y + ii / cc * yy(g)
  yy(g) = 12345
NEXT ii
d = x - y
dd = dd + d
d2 = d2 + d * d / all
NEXT v
v2 = d2 - dd * dd / (all - 1)
PRINT USING "###.### "; all; v2 / (all - 1)
dd = 0: d2 = 0
NEXT rpt : END
```

\_\_\_\_\_licas (Luis A. Afonso)

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• **References:**

- ◆ [Can helium filled footballs be kicked farther than air filled balls?](#)

◇ From: \"Luis A. Afonso\"

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