Olympic Trial Running

Checks on Data

Data is running olympic trial data - 200,400,800, and 1500m runs only.

First, run Leven's Test of Homogeneity and D'Agostino Skewness Test on the model (Percent Difference by Stroke, Year, and Distance).

```
## Warning: package 'car' was built under R version 3.2.4
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value    Pr(>F)
## group  59  4.0231 < 2.2e-16 ***
##       408
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
##  D'Agostino skewness test
##
## data:  ot.data$per.diff
## skew = 0.72183, z = 5.85870, p-value = 4.664e-09
## alternative hypothesis: data have a skewness
```

This, therefore requires non parametric testing. For this, Kruskal-Wallis Rank Sum Test with Pairwise Wilcoxon post hocs will be used.

Main effect of year

The KW result will be first followed by the Wilcoxon post hoc tests with Holm-Bonferroni corrections (value = p value for given comparison).

```
## Source: local data frame [12 x 4]
##
##      year     mean       sd median(per.diff)
##    (fctr)    (dbl)    (dbl)            (dbl)
## 1    1972 17.44103 3.010350            17.53
## 2    1976 14.25897 2.422689            14.25
## 3    1980 13.59436 1.970626            13.17
## 4    1984 12.51077 1.723934            12.17
## 5    1988 12.25897 2.206221            12.01
## 6    1992 13.00872 1.806688            13.50
## 7    1996 12.37897 2.164488            12.53
## 8    2000 12.78487 1.819634            13.01
## 9    2004 12.78667 1.711748            13.02
## 10   2008 12.67564 2.233084            12.46
## 11   2012 12.61795 1.633990            13.15
## 12   2016 12.41513 1.823132            12.81
```

```
##
##  Kruskal-Wallis rank sum test
##
## data:  per.diff by year
## Kruskal-Wallis chi-squared = 86.588, df = 11, p-value = 7.747e-14
```

```
## [[1]]
## [1] X1    X2    value
## <0 rows> (or 0-length row.names)
##
## [[2]]
##      X1   X2    value
## 1  1976 1972 0.002144
## 2  1980 1972 0.000005
## 3  1984 1972 0.000000
## 4  1988 1972 0.000000
## 5  1992 1972 0.000000
## 6  1996 1972 0.000000
## 7  2000 1972 0.000000
## 8  2004 1972 0.000000
## 9  2008 1972 0.000000
## 10 2012 1972 0.000000
## 11 2016 1972 0.000000
##
## [[3]]
##      X1   X2    value
## 1  1976 1972 0.002144
## 13 1980 1976 1.000000
## 14 1984 1976 0.047226
## 15 1988 1976 0.048880
## 16 1992 1976 0.726880
## 17 1996 1976 0.045591
## 18 2000 1976 0.336448
## 19 2004 1976 0.237746
## 20 2008 1976 0.550018
## 21 2012 1976 0.048880
## 22 2016 1976 0.033462
##
## [[4]]
##      X1   X2    value
## 2  1980 1972 0.000005
## 13 1980 1976 1.000000
## 25 1984 1980 0.740924
## 26 1988 1980 0.629033
## 27 1992 1980 1.000000
## 28 1996 1980 1.000000
## 29 2000 1980 1.000000
## 30 2004 1980 1.000000
## 31 2008 1980 1.000000
## 32 2012 1980 1.000000
## 33 2016 1980 1.000000
##
## [[5]]
##      X1   X2    value
## 3  1984 1972 0.000000
## 14 1984 1976 0.047226
## 25 1984 1980 0.740924
## 37 1988 1984 1.000000
## 38 1992 1984 1.000000
## 39 1996 1984 1.000000
```

```
## 40 2000 1984 1.000000
## 41 2004 1984 1.000000
## 42 2008 1984 1.000000
## 43 2012 1984 1.000000
## 44 2016 1984 1.000000
##
## [[6]]
##      X1   X2    value
## 4  1988 1972 0.000000
## 15 1988 1976 0.048880
## 26 1988 1980 0.629033
## 37 1988 1984 1.000000
## 49 1992 1988 1.000000
## 50 1996 1988 1.000000
## 51 2000 1988 1.000000
## 52 2004 1988 1.000000
## 53 2008 1988 1.000000
## 54 2012 1988 1.000000
## 55 2016 1988 1.000000
##
## [[7]]
##      X1   X2   value
## 5  1992 1972 0.00000
## 16 1992 1976 0.72688
## 27 1992 1980 1.00000
## 38 1992 1984 1.00000
## 49 1992 1988 1.00000
## 61 1996 1992 1.00000
## 62 2000 1992 1.00000
## 63 2004 1992 1.00000
## 64 2008 1992 1.00000
## 65 2012 1992 1.00000
## 66 2016 1992 1.00000
##
## [[8]]
##      X1   X2    value
## 6  1996 1972 0.000000
## 17 1996 1976 0.045591
## 28 1996 1980 1.000000
## 39 1996 1984 1.000000
## 50 1996 1988 1.000000
## 61 1996 1992 1.000000
## 73 2000 1996 1.000000
## 74 2004 1996 1.000000
## 75 2008 1996 1.000000
## 76 2012 1996 1.000000
## 77 2016 1996 1.000000
##
## [[9]]
##      X1   X2    value
## 7  2000 1972 0.000000
## 18 2000 1976 0.336448
## 29 2000 1980 1.000000
## 40 2000 1984 1.000000
```

```
## 51 2000 1988 1.000000
## 62 2000 1992 1.000000
## 73 2000 1996 1.000000
## 85 2004 2000 1.000000
## 86 2008 2000 1.000000
## 87 2012 2000 1.000000
## 88 2016 2000 1.000000
##
## [[10]]
##      X1   X2    value
## 8  2004 1972 0.000000
## 19 2004 1976 0.237746
## 30 2004 1980 1.000000
## 41 2004 1984 1.000000
## 52 2004 1988 1.000000
## 63 2004 1992 1.000000
## 74 2004 1996 1.000000
## 85 2004 2000 1.000000
## 97 2008 2004 1.000000
## 98 2012 2004 1.000000
## 99 2016 2004 1.000000
##
## [[11]]
##       X1   X2    value
## 9   2008 1972 0.000000
## 20  2008 1976 0.550018
## 31  2008 1980 1.000000
## 42  2008 1984 1.000000
## 53  2008 1988 1.000000
## 64  2008 1992 1.000000
## 75  2008 1996 1.000000
## 86  2008 2000 1.000000
## 97  2008 2004 1.000000
## 109 2012 2008 1.000000
## 110 2016 2008 1.000000
##
## [[12]]
##       X1   X2   value
## 10  2012 1972 0.00000
## 21  2012 1976 0.04888
## 32  2012 1980 1.00000
## 43  2012 1984 1.00000
## 54  2012 1988 1.00000
## 65  2012 1992 1.00000
## 76  2012 1996 1.00000
## 87  2012 2000 1.00000
## 98  2012 2004 1.00000
## 109 2012 2008 1.00000
## 121 2016 2012 1.00000
##
## [[13]]
##       X1   X2    value
## 11  2016 1972 0.000000
## 22  2016 1976 0.033462
```

```
## 33  2016 1980 1.000000
## 44  2016 1984 1.000000
## 55  2016 1988 1.000000
## 66  2016 1992 1.000000
## 77  2016 1996 1.000000
## 88  2016 2000 1.000000
## 99  2016 2004 1.000000
## 110 2016 2008 1.000000
## 121 2016 2012 1.000000
```

Main Effect for Distance

The KW result will be first followed by the Wilcoxon post hoc tests with Holm-Bonferroni corrections (value = p value for given comparison).

```
## Source: local data frame [5 x 4]
##
##   distance     mean       sd median(per.diff)
##      (fctr)    (dbl)    (dbl)            (dbl)
## 1       100 10.76310 1.304660           10.685
## 2      1500 13.96271 2.314637           13.675
## 3       200 11.99396 1.782750           11.820
## 4       400 14.11750 2.161179           13.875
## 5       800 14.99302 2.008115           14.625
```

```
##
##  Kruskal-Wallis rank sum test
##
## data:  per.diff by distance
## Kruskal-Wallis chi-squared = 211.46, df = 4, p-value < 2.2e-16
```

```
## [[1]]
##     X1  X2 value
## 1 1500 100 0e+00
## 2  200 100 5e-06
## 3  400 100 0e+00
## 4  800 100 0e+00
##
## [[2]]
##     X1   X2 value
## 2  200  100 5e-06
## 6  200 1500 0e+00
## 11 400  200 0e+00
## 12 800  200 0e+00
##
## [[3]]
##     X1   X2    value
## 3  400  100 0.000000
## 7  400 1500 0.680563
## 11 400  200 0.000000
## 16 800  400 0.001605
##
## [[4]]
##     X1   X2    value
## 4  800  100 0.000000
```

```
## 8  800 1500 0.000101
## 12 800  200 0.000000
## 16 800  400 0.001605
##
## [[5]]
##     X1   X2    value
## 1 1500  100 0.000000
## 6  200 1500 0.000000
## 7  400 1500 0.680563
## 8  800 1500 0.000101
```

Figures

Figure 1: Gender gap for each year and event

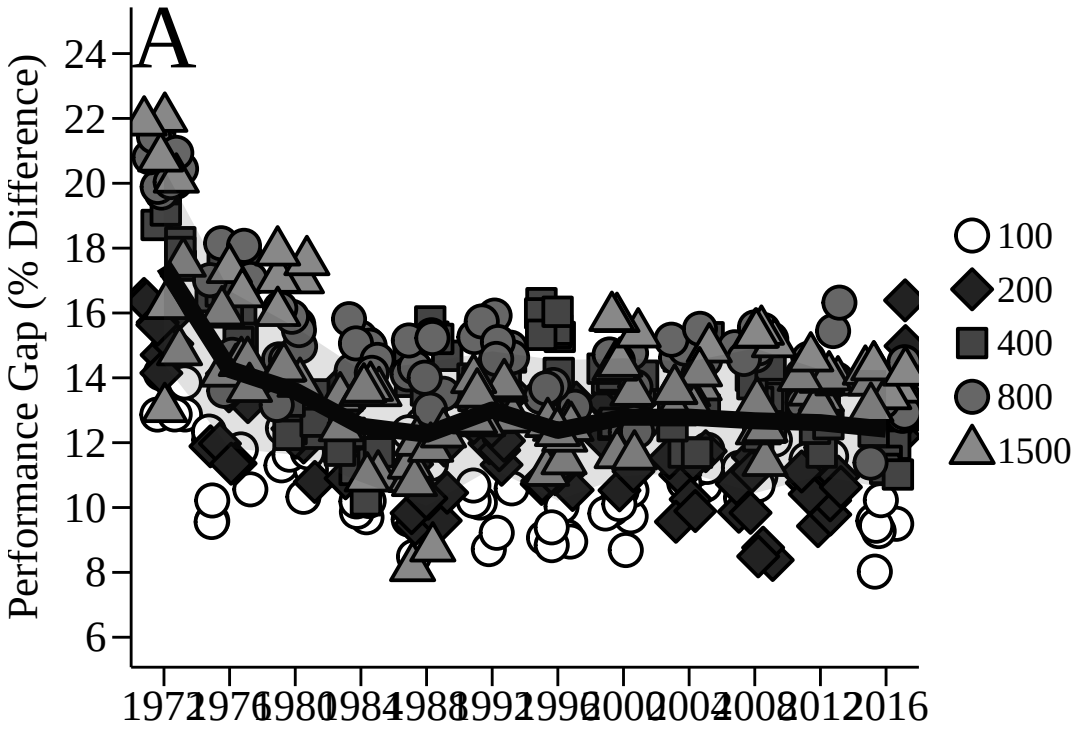

Figure 2: LOESS Smoothing Plot for each year and distance