The time-course of biological phenomena – illustrated with the London Marathon

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PeerJ…

**Supplementary Material 2**

**Maple code to calculate statistical moments**

# Enter parameter values and press run icon '!!!'

> restart:r:=0.38:c:=1.6:t:=4.64:Run !!!;

factorial(factorial(factorial(Run)))

> F:=x->1-(1-r/(1+exp(-c\*(x-t))))^x:

> f:=x->diff(F(x),x):

# CDF plot

> plot(F(x),x=0..20,thickness=2);

# PDF plot

> plot(f(x),x=0..20,thickness=2);

# Solve percentiles including median

> percentile1:=fsolve(F(x)=0.01,x);

percentile1 := 1.956918337

> percentile10:=fsolve(F(x)=0.1,x);

percentile10 := 3.164261017

> percentile20:=fsolve(F(x)=0.2,x);

percentile20 := 3.595858638

> percentile30:=fsolve(F(x)=0.3,x);

percentile30 := 3.887311327

> percentile40:=fsolve(F(x)=0.4,x);

percentile40 := 4.128909119

# Median

> mmedian:=fsolve(F(x)=0.5,x);

mmedian := 4.353437645

> percentile60:=fsolve(F(x)=0.6,x);

percentile60 := 4.582316963

> percentile70:=fsolve(F(x)=0.7,x);

percentile70 := 4.840454557

> percentile80:=fsolve(F(x)=0.8,x);

percentile80 := 5.178475930

> percentile90:=fsolve(F(x)=0.9,x);

percentile90 := 5.791734101

> percentile99:=fsolve(F(x)=0.99,x);

percentile99 := 9.637684509

# Mode

> mmode:=fsolve(diff(f(x),x),x,0..10\*t);

mmode := 4.307149699

# Mean

> ex1:=evalf(int(1-F(x),x=0..10\*t)):mmean:=ex1;

mmean := 4.494238717

# Variance

> ex2:=evalf(2\*int(x\*(1-F(x)),x=0..10\*t)):mvar:=ex2-ex1^2;

mvar := 1.83115361

# Standard deviation

> msd:=mvar^(1/2);

msd := 1.353201245

# Skewness

> ex3:=evalf(3\*int(x^2\*(1-F(x)),x=0..10\*t)):omega:=mmean/msd:mskew:=((omega^3)/(mmean^3))\*ex3-omega\*(3+omega^2);

mskew := 2.33523413

# Excess kurtosis

> ex4:=evalf(4\*int(x^3\*(1-F(x)),x=0..10\*t)):mkurt:=((omega^4)/(mmean^4))\*ex4-4\*omega\*mskew-(omega^2)\*(6+omega^2)-3;

mkurt := 13.8355518

# Entropy

> ment:=-evalf(int(f(x)\*log[2](f(x)),x=0..10\*t));

ment := 2.210195761

# Alternative excess kurtosis

> mkurt2:=((omega^4)/(mmean^4))\*ex4-4\*((omega^4)/(mmean^3))\*ex3+(3\*omega^2)\*(2+omega^2)-3;

mkurt2 := 13.8355513

>