[100m, 200m, 4x100m Beijing Olympics 2008]

[200m world record. Berlin 2009]

[100m world record. Berlin 2009]

The kinematics of Usain Bolt, the World's fastest human

Dr Andrew French

[Photo credit]

At the time of the London 2012 Olympics (where Bolt won Gold in a time of 9.63s), the 100m world record stood at **9.58s.** This was set at the Berlin World Championships in 2009.

So how *fast* did he go? What indeed does this statement actually mean? Did he pull away from the rest of the field, or slow down? To answer these questions we need to analyse the race using **kinematics*** (literally, the study of motion).

*From the Greek κίνημα, *kinema* (movement, motion)

In **kinematics** we describe motion by a **graph** in *three* ways:

1. Displacement vs time (t,x)
2. Velocity vs time (t,v)
3. Acceleration vs time (t,a)

- Displacement ***x*** is the *position vector* from a specified origin.

- Velocity ***v*** is the *rate of change of displacement* at any given instant

- Acceleration ***a*** is the *rate of change of velocity* at any given instant

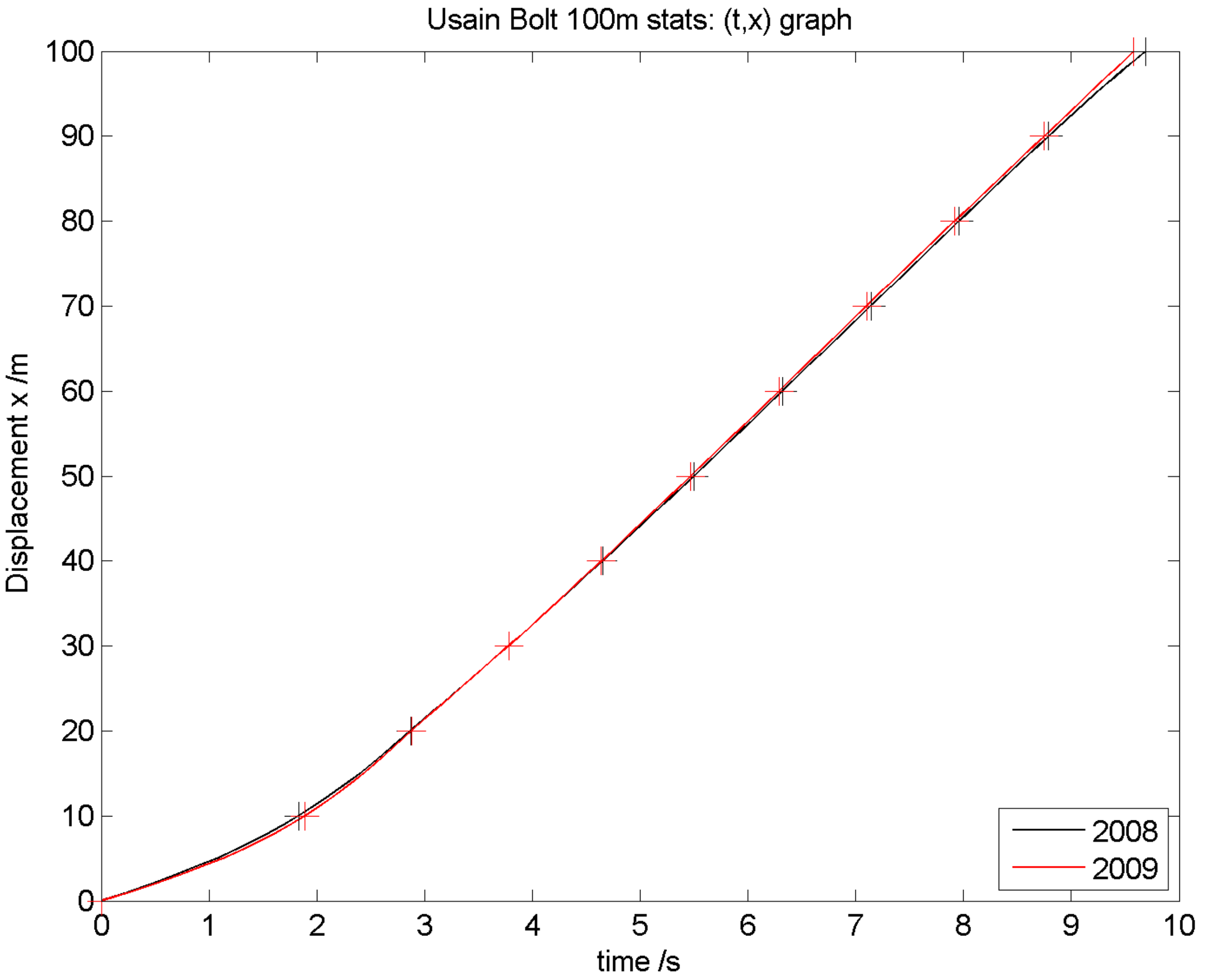
For simplicity at this stage we will consider displacements, velocities and accelerations in a **single direction**, i.e. down the 100m track. Note however that these quantities are actually **vectors** and therefore have both *magnitude* and *direction*.

Let’s look at the displacement vs time graph first

Bolt’s 100m races. Time elapsed /s every 10m*

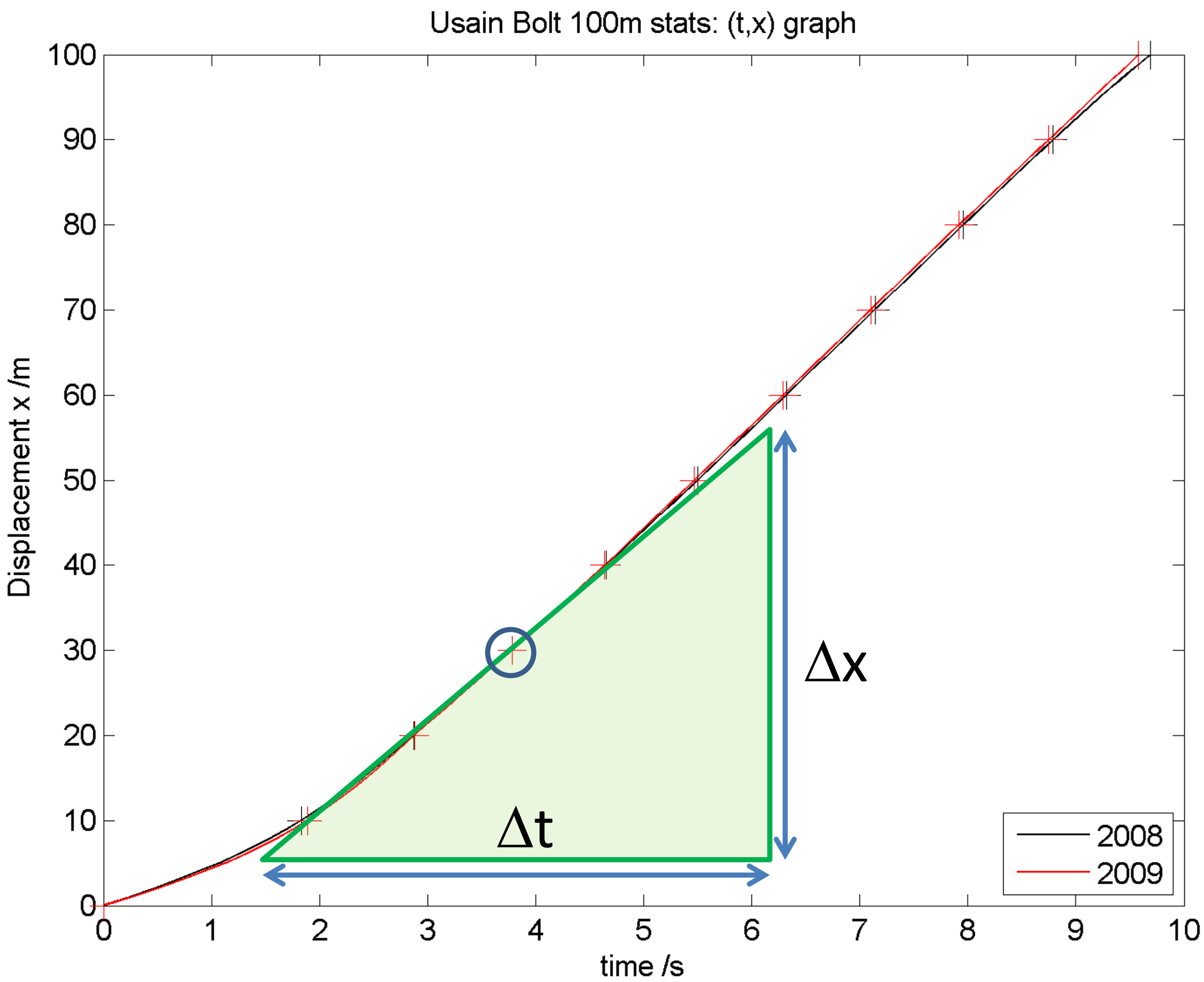
Bolt	10	20	30	40	50	60	70	80	90	100	
2008	1.83	2.87	3.78	4.65	5.5	6.32	7.14	7.96	8.79	9.69	Olympic final, Beijing
2009	1.89	2.88	3.78	4.64	5.47	6.29	7.10	7.92	8.75	9.58	World Champs, Berlin

Photo credit



*
http://rcuksportscience.wikispaces.com/file/vie
Analysing+men+100m+Nspire.pdf

To find the **time, velocity graph** we could calculate the *gradient* of the (*t,x*) graph, at *different* times



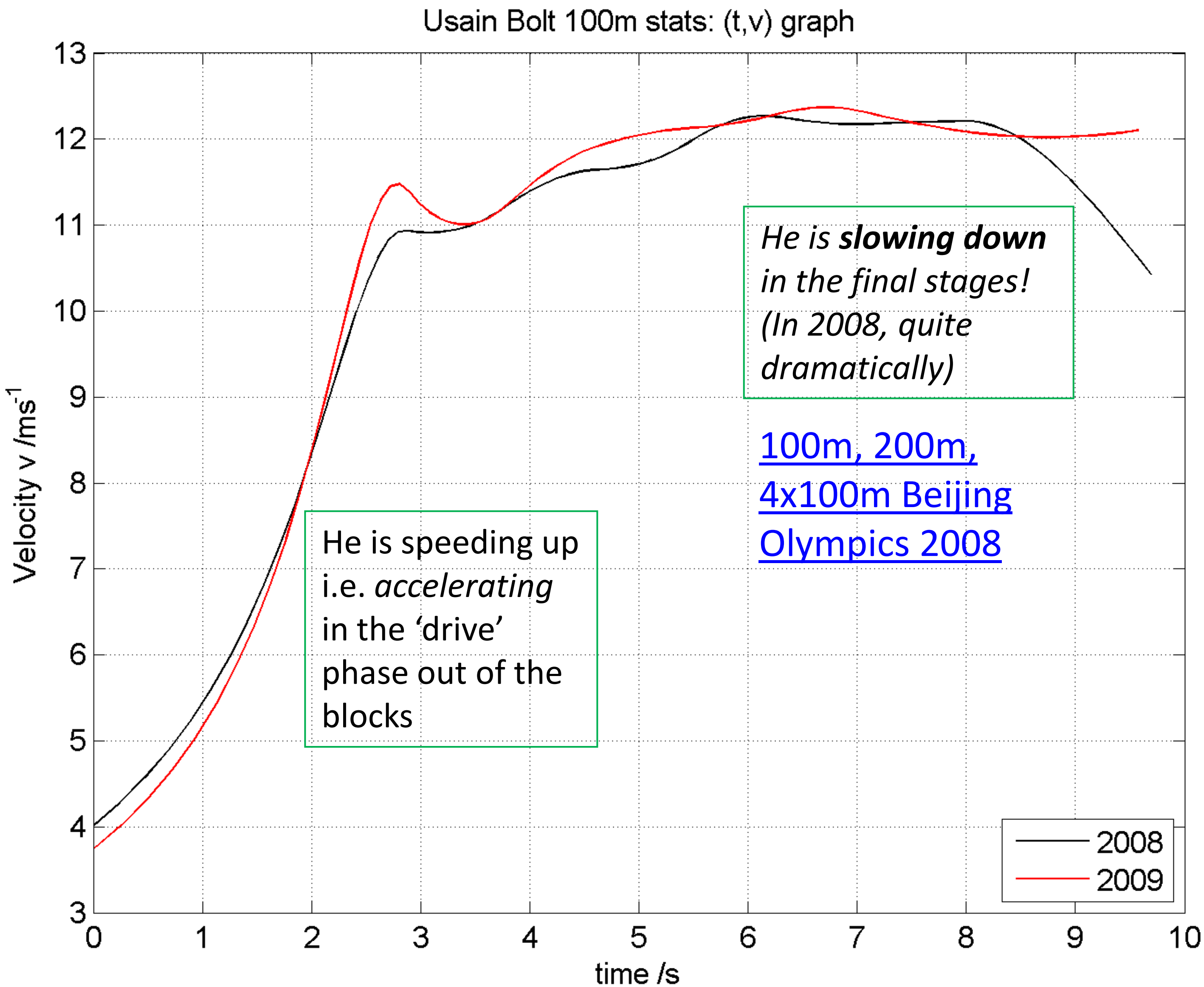
At ○

the *local gradient* is

$$v = \frac{\Delta x}{\Delta t}$$

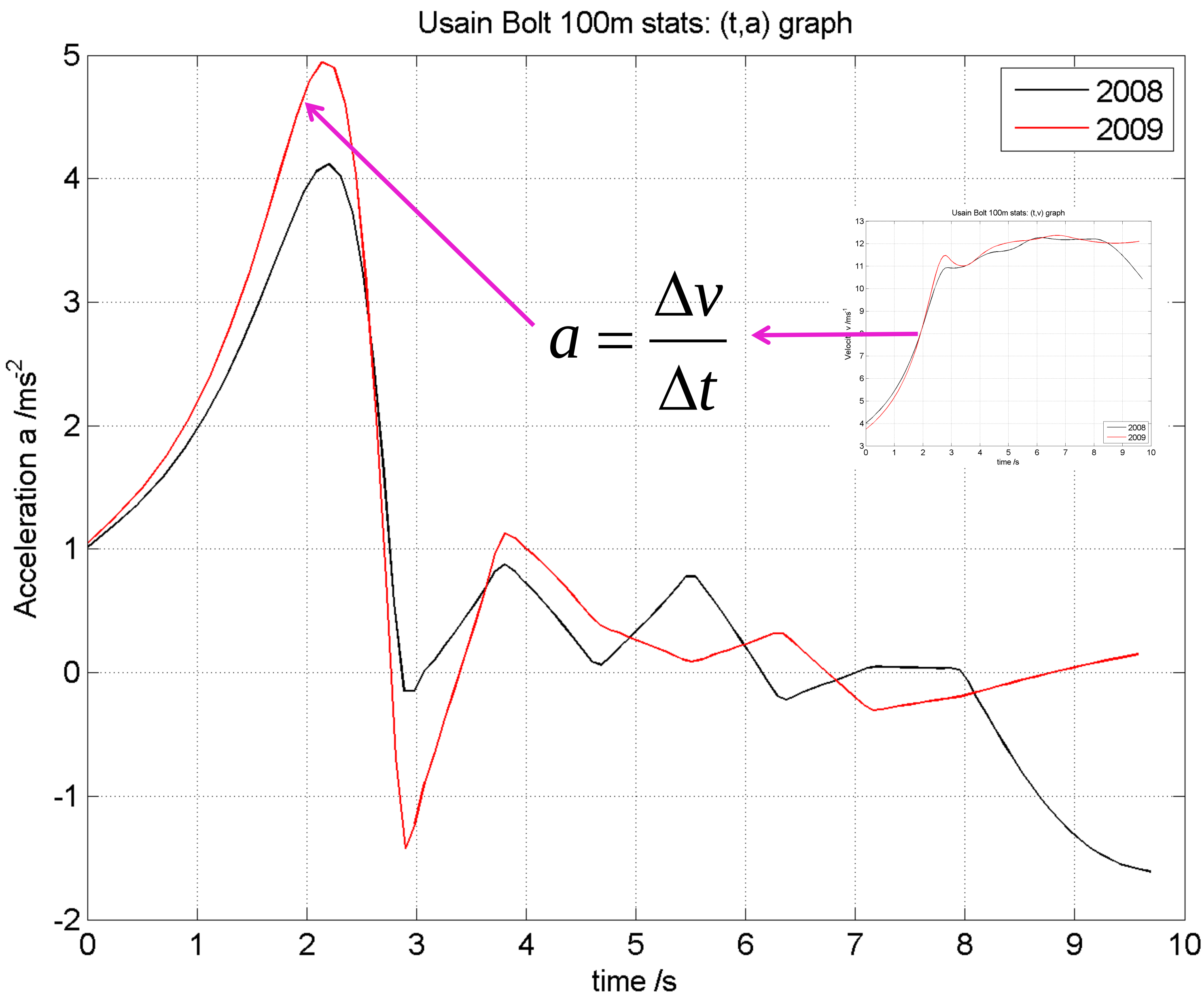
$= 11.2 ms^{-1}$

The graph below has been constructed from the *local gradients* calculated *every second* along a *smooth curve* drawn between the elapsed time data recorded at 10m intervals

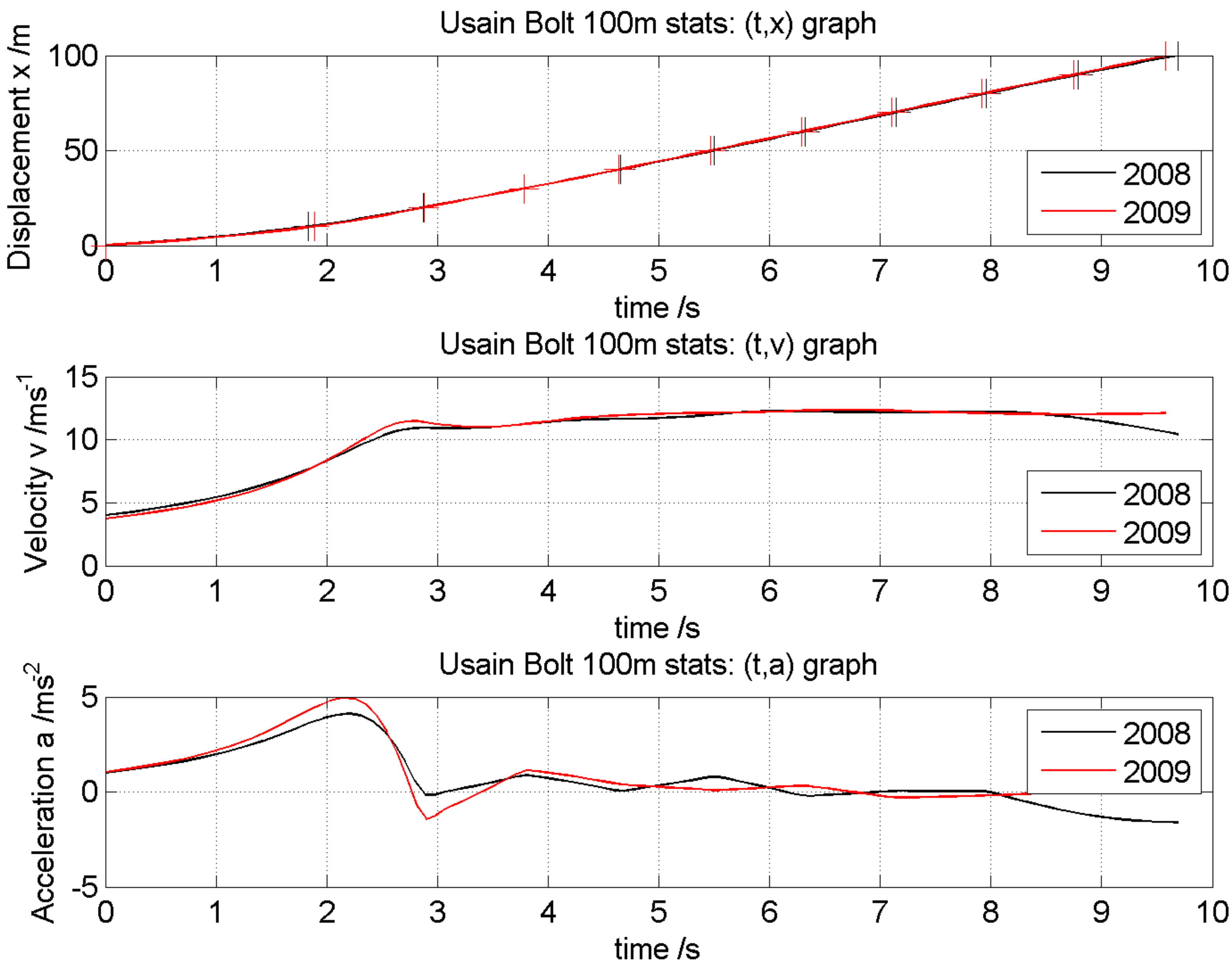


[100m, 200m, 4x100m Beijing Olympics 2008]()

We can go one step further and find the graph of *acceleration vs time* by working out the local gradients of the (t,v) graph.



For a complete view we can compare (*t*,*x*), (*t*,*v*) and (*t*,*a*) traces.
Note the time axis must be the *same scale* for each graph.



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