What was the fastest 100m final?

J. R. Mureika  
Department of Computer Science  
University of Southern California  
Los Angeles, CA 90089-2520

Over the past 10 years, we’ve seen a number of exceptional sprint performances at the world class level. Of particular note has been the recent emergence of a handful of contenders to the title of “World’s Fastest Man”. A decade previous, we would have been talking Ben Johnson and Carl Lewis. Today, we find it hard to choose between Donovan Bailey, Frank Fredericks, Ato Boldon, and Maurice Greene. Of course, we can’t forget (recently stepped-down) European Sprint King Linford Christie, or former WR holder Leroy Burrell. The increase in number of top world class sprinters makes one wonder: what really was the fastest 100m final?

Recently, I’ve written several articles which have discussed correcting for wind effects in the sprints [1, 2]: this provides an easy way to compare most 100m times run in essentially any wind condition (head- or tail-wind). Unfortunately the model doesn’t take temperature into account, but susceptibility to temperature must almost certainly be an individual factor (proof: I find 15° weather pleasant and cool, while all other Californians don their parkas). The findings have been most interesting, and have re-written the record books to a certain degree.

In the following article, I will analyze the results from key races over the past 10 years. These include the 1983-1997 World Championships (WC) finals, 1984-1996 Olympic Games (OG) finals, and the 1996 Lausanne Grand Prix (LGP) final, in which Frank Fredericks ran his 9.86s PB into a 0.4 m/s headwind. The latter race was considered by many to be the finest 100m performance ever. In fact, after wind-correction, this adjusts to a calm 9.84s, numerically matching Donovan Bailey’s 9.84 (+0.7 m/s). Meanwhile, Bailey’s WR mark translates to a 9.88s, and is usurped by Fredericks’ Lausanne run (Table 1).

**Fastest average race times**

First, let’s look at the average wind-corrected times for each final (Ta-
The only race with a sub-10s average time is the 1996 LGP. This
low value is weighted by the fact that 4 of the competitors clocked sub-10s
runs, and 4th-7th place were within 0.01s of each other. The WR race in
Atlanta is ranked 3rd in terms of average time, and surprisingly the 1991
WC final (which featured the most legal sub-10s runs in a single race) ranks
only 4th. In fact, the average times of the 1996 OG and 1991 WC finals
are almost identical (after wind-correction). Near the bottom of the list are
the 1983 WC and 1984 OG, which featured few spectacular performances
(retroactively speaking). That is, with the exception of Carl Lewis, the times
were quite far off the WR of the time (Calvin Smith’s 9.93s from Colorado
Springs, 07 Jul 1983).

Note, however, that even though they were monumental races of their
day, the 1987 WC and 1988 OG runs are ranked last! This is due to the fact
that the last place finishers in each race (Pierfrancesco Pavoni ITA - 16.38,
Ray Stewart JAM - 12.26) were obviously not running at peak potential.
This raises a serious concern when dealing with the
overall average times of races.

It seems logical that one can divide a race into two distinct groups: the
top 4 or 5 finishers are most likely the serious medal contenders, and can be
taken to represent the “quality” of the final. Those who finish 5th-8th do so
for any number of reasons, which might include: (a) they don’t match the
calibre of the top finalists, and finish at the best of their ability, (b) they
pull up in the race or are running injured, or (c) they shut down before the
finish line because of mental duress (e.g. Merlene Ottey at the 1997 WC).

The average winning margin

Since the overall average time for a final can apparently be misleading,
as per the conclusion of the previous section, it might make more sense
to consider the average winning margins of each race. That is, by how
much, on average, did the gold medallist defeat his competitors? Adhering
to the KISS principle (Keep It Statistically Simple, not developed by Gene
Simmons), there is a straightforward expression for calculating this beast:

\[
\text{Average winning margin} = \frac{k}{k-1} \left( \text{Average time of first } k \text{ competitors} - \text{Winning time} \right).
\]

The winning margin can help up compare top finishing places in different
races, and can provide more information besides just how far ahead of the rest of the field was the gold medalist.

While the results from each race are wind-corrected to provide an easy ground for comparison, the quantity above is essentially independent of this correction. In a typical world class race (where the first and last place times fall within about a 0.3s interval), wind-correction roughly amounts to a shift of an overall constant (a couple hundredths of a second), and this overall constant cancels out in the above equation (trust me!). So, the average winning margin as calculated by this method will be the same regardless of whether or not the times are wind-corrected or official.

Tables 3, 5 rank the average finishing times for the top 3 and 4 competitors, while Tables 4, 6 order the winning margins in increasing order. This gives a sense of the “closeness” of the race: the smaller the average winning margin, the closer the finish, and the closer the calibre of the athletes in the final.

While the increase from 3 to 4 finishers rearranges the lists, there are several key constants of note. In each case (Tables 3, 5), the fastest average race is the 1996 Lausanne Grand Prix, the wind-corrected World Record race which produced Fredericks’ headwind 9.86 dash. The Atlanta final (1996 OG) takes 2nd and 3rd place in the averages rankings, trailing the 96 LGP average finishes by roughly 0.02s. It posts the 2nd smallest winning margin for top 3, but slips to to 4th for the top 4 finalists.

The 1991 WC final holds its ranking as the “closest” race, yielding a winning margin of 0.035s and 0.044s for top 3 and 4 placings. As noted earlier, this race posted the most sub-10s marks ever, but after a wind-correction treatment, the average top 3 and 4 times rank only 5th and 4th, respectively. This is a good example of how a race can seem faster than it really is because of tailwind effects, but even after correction can still be considered quite an impressive sprint!

Conversely, the races with the lowest average for top 3 and 4 are the 1984 OG and 1983 and 1987 WCs. Likewise, these represent the largest average winning margins. This information is quite useful: in each race, Carl Lewis was the clear winner. Apparently he was quite ahead of his time! Interestingly enough, Lewis is also a factor in the 1991 WC race, posting his legal
(and new WR) 9.86s jolt.

The 1987 WC and 1988 OG

As we all know too well, the 1987 WC and 1988 OG finals were particularly out of the ordinary. Ben Johnson’s then-WR marks of 9.83s and 9.79s were themselves about 10 years ahead of their time, having been only recently clocked by other world class contenders after wind-correction. The 9.83s mark (+1.0 m/s) corresponds to a 9.89s still-air run, which has been matched or bettered by several athletes in recent years (Bailey, Greene at 9.88s, and Bailey, Christie, Burrell at 9.89s). Meanwhile, the 9.79s (+1.1) adjusts to 9.85s, having only been topped by Fredericks’ infamous 1996 LGP mark.

If we were to consider the results to be official, how would the findings be affected? Table 7 shows the appropriate statistics for the races in question, including Johnson’s stricken marks. Again, the overall averages are unusually high, due to the lackluster clockings of 8th place (10.948s and 10.346s). Without last place, the overall averages lower to 10.193s and 10.059s, ranking these after the 1997 WC and 1995 WC.

Despite the anomalous last place times, the winning margin considered earlier is unaffected by these. For the Johnson races, we have the average top 3 times of 10.007s and 9.970s, with similar respective winning margins of 0.176s and 0.180s. According to this, the Seoul final would rank 6th for top 3 finishers, and would mark one of the largest winning margins for the races considered. In terms of top 4 finishers, we have 10.055s and 9.985s, with winning margins of 0.220s and 0.180s. Again, these constitute some of the largest winning margins, and help to show that Ben Johnson’s performances were well in advance of the rest of the world (if we ignore why they were at such a level).

Winning margins and World Record progression

Another interesting way to judge the “calibre” of a 100m final is obviously to compare it to the current WR performance. The long/triple jump always have a WR mark at the side of the pits, so the spectators can get an idea of how close/far the competitor was from the crown. Why not have one in the sprints?
This can roughly be done in a similar manner to the way that the winning margin was calculated earlier. The question asked is: how far behind the WR were the top k competitors in this race? Along with the winning margins, Tables 3 and 5 list the deviation of the top 3 and 4 average times from the WR (see also Table 8).

For the cases where the WR was set in the race, the winning margins and the deviation from the WR are the same, since they’re calculated in exactly the same manner. For the other cases, the method is slightly modified. Instead of using the earlier expression involving the fraction $k/(k - 1)$, we just simply subtract the WR time from the average of the top 3 and 4.

Note a slight difference here. In order to obtain this quantity with a minimal amount of work, I have not wind-corrected these quantities. Had I done this, I would have spent quite a while going back through the record books to find the wind-corrected WRs of each year, since we know that a great performance can be masked by a suitably strong head-wind (e.g. Bailey’s 10.03s in Abbotsford earlier this year [2]). So, to make the numbers more “useful” to the naked eye, the wind conditions are not performed, which can skew the data a bit when the wind conditions for the WR race are sufficiently different for the race in question (case and point: the 1996 LGP winning margin v.s. the deviation from the 9.85 WR).

Musings

All this being said and done, how can we answer the question at hand? Which race really is the fastest 100m? The easiest answer is that there is no definite answer. It all depends on what is meant by the fastest. Here are some points to consider:

- The 1996 LGP produced the fastest wind-corrected time ever (9.84s), and as a partial result yields the smallest average times (including overall, top 3, and top 4 finishers)

- The 1991 WC race, while not seeming so fast after wind-correction, was the closest race of all those considered, and could be understood to have had the most on-equal-par athletes competing
• Carl Lewis’ performances in the 1980s were several years ahead of their time, putting him far above the competition of the time.

The results would tend to suggest that there are more exceptional World Class athletes today who are of equal calibre than ever before. It’s interesting to think what these lists might look like in another ten years!

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References
[1] J. R. Mureika, “What really are the best 100m performances?”, Athletics: Canada’s National Track and Field / Running Magazine (July 1997) (also physics/9705004).

[2] J. R. Mureika, “Another dash into the record books (wind -2.1 m/s)”, Athletics: Canada’s National Track and Field / Running Magazine, (September 1997).
1. Frank Fredericks 9.84 (9.86, -0.4) Lausanne GP 1996
2. Donovan Bailey 9.88 (9.84, +0.7) Atlanta OG 1996
3. Maurice Greene 9.88 (9.86, +0.2) Athens WC 1997

Table 1: Top 3 fastest individuals (as of 01 Sep 1997)

| Rank | Year | Event | Time  |
|------|------|-------|-------|
| 1    | 1996 | LGP   | 9.981s|
| 2    | 1993 | WC    | 10.029|
| 3    | 1996 | OG    | 10.033|
| 4    | 1991 | WC    | 10.038|
| 5    | 1997 | WC    | 10.044|
| 6    | 1992 | OG    | 10.133|
| 7    | 1995 | WC    | 10.161|
| 8    | 1983 | WC    | 10.249|
| 9    | 1984 | OG    | 10.256|
| 10   | 1988 | OG    | 10.417|
| 11   | 1987 | WC    | 11.100|

Table 2: Fastest Races (average, all competitors)
1. 1996 LGP 9.890 (1. Fredericks 9.84, 2. Bailey 9.91, 3. Boldon 9.92)
2. 1996 OG 9.917 (1. Bailey 9.88, 2. Fredericks 9.93, 3. Boldon 9.94)
3. 1997 WC 9.923 (1. Greene 9.88, 2. Bailey 9.93, 3. Montgomery 9.96)
4. 1993 WC 9.947 (1. Christie 9.89, 2. Cason 9.94, 3. Mitchell 10.01)
5. 1991 WC 9.953 (1. Lewis 9.93, 2. Burrell 9.95, 3. Mitchell 9.98)
6. 1988 OG 10.030 (1. Lewis 9.99, 2. Christie 10.04, 3. Smith 10.06)
7. 1992 OG 10.037 (1. Christie 9.99, 2. Fredericks 10.05, 3. Mitchell 10.07)
8. 1995 WC 10.070 (1. Bailey 10.03, 2. Surin 10.09, 3. Boldon 10.09)
9. 1987 WC 10.110 (1. Lewis 9.99, 2. Stewart 10.14, 3. Christie 10.20)
10. 1984 OG 10.153 (1. Lewis 10.01, 2. Graddy 10.21, 3. Johnson 10.24)
11. 1983 WC 10.249 (1. Lewis 10.06, 2. Smith 10.20, 3. King 10.23)

Table 3: Fastest Top 3 Finishers (average)

| Winning margin | Deviation from WR |
|----------------|-------------------|
| 1. 1991 WC     | 0.035             |
| 2. 1996 OG     | 0.056             |
| 3. 1995 WC     | 0.060             |
| 4. 1997 WC     | 0.065             |
| 5. 1992 OG     | 0.071             |
| 6. 1996 LGP    | 0.075             |
| 7. 1988 OG     | 0.080             |
| 8. 1993 WC     | 0.086             |
| 9. 1983 WC     | 0.155             |
| 10. 1987 WC    | 0.180             |
| 11. 1984 OG    | 0.215             |

Table 4: Smallest average winning margins and deviation from WR, top 3

8
1. 1996 LGP 9.913 (4. Drummond 9.98)
2. 1997 WC 9.935 (4. Fredericks 9.97)
3. 1996 OG 9.945 (4. Mitchell 10.03)
4. 1991 WC 9.963 (4. Christie 9.99)
5. 1993 WC 9.970 (4. Lewis 10.04)
6. 1988 OG 10.050 (4. Mitchell 10.11)
7. 1992 OG 10.058 (4. Surin 10.12)
8. 1995 WC 10.085 (4. Fredericks 10.13)
9. 1987 WC 10.148 (4. Kovacs 10.26)
10. 1984 OG 10.185 (4. Brown 10.28)
11. 1983 WC 10.188 (4. Wells 10.26)

Table 5: Fastest Top 4 Finishers (average)

| Winning margin | Deviation from WR |
|----------------|-------------------|
| 1. 1991 WC     | 0.044             |
| 2. 1997 WC     | 0.073             |
| 1995 WC        | 0.073             |
| 4. 1988 OG     | 0.080             |
| 5. 1996 OG     | 0.087             |
| 6. 1992 OG     | 0.091             |
| 7. 1996 LGP    | 0.097             |
| 8. 1993 WC     | 0.107             |
| 9. 1983 WC     | 0.171             |
| 10. 1987 WC    | 0.211             |
| 11. 1984 OG    | 0.233             |

Table 6: Smallest average winning margins and deviation from WR, top 4
Table 7: Stats for 1987 WC and 1988 OG, including Ben Johnson’s performances

| Race     | Overall average (no 8th) | Average winning top 3 | Average winning top 4 | Average winning margin |
|----------|-------------------------|-----------------------|-----------------------|------------------------|
| 1987 WC  | 10.948                  | 10.007                | 10.055                | 0.176                  |
| 1988 OG  | 10.417                  | 9.970                 | 9.985                 | 0.180                  |

Table 8: 100m world record progression, 1983 - 1997.

| WR       | Athlete         | Date       | Location    |
|----------|-----------------|------------|-------------|
| 9.93 (+1.0) | Carl Lewis USA | 30 Aug 1987 | Rome        |
| 9.92 (+1.1) | Carl Lewis USA | 24 Sep 1988 | Seoul       |
| 9.90 (+1.9) | Leroy Burrell USA | 14 Jun 1991 | New York    |
| 9.86 (+1.2) | Carl Lewis USA | 25 Aug 1991 | Tokyo       |
| 9.85 (+1.2) | Leroy Burrell USA | 06 Jul 1994 | Lausanne    |
| 9.84 (+0.7) | Donovan Bailey CAN | 27 Jul 1996 | Atlanta     |
| Athlete                  | 1997 WC, Athens (wind +0.2 m/s) | 1995 WC, Gothenburg (+1.0) | 1993 WC, Stuttgart (+0.3) | 1991 WC, Tokyo (+1.2) |
|-------------------------|--------------------------------|---------------------------|---------------------------|-----------------------|
|                         | Official | Wind-corrected | Official | Wind-corrected | Official | Wind-corrected | Official | Wind-corrected | Official | Wind-corrected |
| 1. Maurice Greene (USA) | 9.86     | 9.88          | 9.97     | 10.03         | 9.87     | 9.89          | 9.86     | 9.88          | 9.86     | 9.89          |
| 2. Donovan Bailey (CAN) | 9.91     | 9.93          | 10.03    | 10.09         | 9.92     | 9.94          | 9.91     | 9.98          | 9.88     | 9.95          |
| 3. Tim Montgomery (USA) | 9.94     | 9.96          | 10.03    | 10.09         | 9.99     | 10.01         | 9.91     | 9.98          | 9.88     | 9.95          |
| 4. Frank Fredericks (NAM)| 9.95   | 9.97          | 10.07    | 10.13         | 9.92     | 10.01         | 9.99     | 10.01         | 9.95     | 10.02         |
| 5. Ato Boldon (TRI)     | 10.02    | 10.04         | 10.07    | 10.13         | 10.02    | 10.04         | 10.02    | 10.05         | 10.02    | 10.05         |
| 6. Davidson Ezinwa (NIG)| 10.10    | 10.12         | 10.12    | 10.18         | 10.10    | 10.16         | 10.12    | 10.20         | 10.18    | 10.20         |
| 7. Bruny Surin (CAN)    | 10.12    | 10.14         | 10.20    | 10.26         | 10.12    | 10.18         | 10.18    | 10.20         | 10.18    | 10.20         |
| 8. Mike Marsh (USA)     | 10.29    | 10.31         | 10.29    | 10.35         | 10.29    | 10.35         | 10.18    | 10.20         | 10.18    | 10.20         |
| Year | Event | 1st | 2nd |
|------|-------|-----|-----|
| 1987 WC, Rome (+1.0) | DQ. Ben Johnson (CAN) | 9.83 | 9.89 |
|      | 1. Carl Lewis (USA) | 9.93 | 9.99 |
|      | 2. Raymond Stewart (JAM) | 10.08 | 10.14 |
|      | 3. Linford Christie (GBR) | 10.14 | 10.20 |
|      | 4. Attila Kovacs (HUN) | 10.20 | 10.26 |
|      | 5. Viktor Bryzgin (USR) | 10.25 | 10.31 |
|      | 6. Lee McRae (USA) | 10.34 | 10.41 |
|      | 7. Pierfrancesco Pavoni (ITA) | 16.23 | 16.38 |
| 1983 WC, Helsinki (-0.3) | 1. Carl Lewis (US) | 10.07 | 10.06 |
|      | 2. Calvin Smith (US) | 10.21 | 10.20 |
|      | 3. Emmit King (US) | 10.24 | 10.23 |
|      | 4. Allan Wells (GB) | 10.27 | 10.26 |
|      | 5. Juan Nez (DR) | 10.29 | 10.28 |
|      | 6. Christian Haas (WG) | 10.32 | 10.31 |
|      | 7. Paul Narracott (Aus) | 10.33 | 10.31 |
|      | 8. Desai Williams (Can) | 10.36 | 10.34 |
| 1996 LGP, Lausanne (-0.4) | 1. Frank Fredericks (NAM) | 9.86 | 9.84 |
|      | 2. Donavan Bailey (CAN) | 9.93 | 9.91 |
|      | 3. Ato Boldon (TRI) | 9.94 | 9.92 |
|      | 4. Jon Drummond (USA) | 10.00 | 9.98 |
|      | 5. Linford Christie (GBR) | 10.04 | 10.02 |
|      | 6. Bruny Surin (CAN) | 10.05 | 10.03 |
|      | 7. Leroy Burrel (USA) | 10.05 | 10.03 |
|      | 8. Dennis Mitchell (USA) | 10.15 | 10.12 |
| 1996 OG, Atlanta (+0.7) | 1. Donovan Bailey (CAN) | 9.84 | 9.88 |
|      | 2. Frank Fredericks (NAM) | 9.89 | 9.93 |
|      | 3. Ato Boldon (TRI) | 9.90 | 9.94 |
|      | 4. Dennis Mitchell (USA) | 9.99 | 10.03 |
|      | 5. Mike Marsh (USA) | 10.00 | 10.05 |
|      | 6. Davidson Ezinwa (NGR) | 10.14 | 10.19 |
|      | 7. Michael Green (JAM) | 10.16 | 10.21 |
|      | 8. Linford Christie (GBR) | DQ |
Table 9: Major competition results, 1983-1997

| Year        | Location     | Rank | Name             | Time (100m) | Time (200m) |
|-------------|--------------|------|------------------|-------------|-------------|
| 1992 OG     | Barcelona (+0.5) | 1.   | Linford Christie (GBR) | 9.96        | 9.99        |
|             |              | 2.   | Frankie Fredericks (NAM) | 10.02       | 10.05       |
|             |              | 3.   | Dennis Mitchell (USA) | 10.04       | 10.07       |
|             |              | 4.   | Bruny Surin (CAN) | 10.09       | 10.12       |
|             |              | 5.   | Leroy Burrell (USA) | 10.10       | 10.13       |
|             |              | 6.   | Olapade Adeniken (NGR) | 10.12       | 10.15       |
|             |              | 7.   | Ray Stewart (JAM) | 10.22       | 10.25       |
|             |              | 8.   | Davidson Ezinwa (NGR) | 10.26       | 10.30       |
| 1988 OG     | Seoul (+1.1)  | 1.   | Carl Lewis (USA) | 9.79        | 9.85        |
|             |              | 2.   | Linford Christie (GBR) | 9.97        | 10.04       |
|             |              | 3.   | Calvin Smith (USA) | 9.99        | 10.06       |
|             |              | 4.   | Dennis Mitchell (USA) | 10.04       | 10.11       |
|             |              | 5.   | Robson da Silva (BRA) | 10.11       | 10.18       |
|             |              | 6.   | Desai Williams (CAN) | 10.11       | 10.18       |
|             |              | 7.   | Ray Stewart (JAM) | 12.26       | 12.36       |
| 1984 OG     | Los Angeles (+0.2) | 1.   | Carl Lewis (USA) | 9.99        | 10.01       |
|             |              | 2.   | Sam Graddy (USA) | 10.19       | 10.21       |
|             |              | 3.   | Ben Johnson (CAN) | 10.22       | 10.24       |
|             |              | 4.   | Ron Brown (USA) | 10.26       | 10.28       |
|             |              | 5.   | Mike McFarlene (GBR) | 10.27       | 10.29       |
|             |              | 6.   | Ray Stewart (JAM) | 10.29       | 10.31       |
|             |              | 7.   | Donovan Reid (GBR) | 10.33       | 10.34       |
|             |              | 8.   | Tony Sharpe (CAN) | 10.35       | 10.37       |