Single Precision Storage Default - Is it time to bid farewell?

presentation for Oceania Stata Conference 2025

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February 5, 2025

Why am I here?

- I have identified a legacy issue that is important enough (IMO) to warrant your attention.
- Last time around, I talked about **inefficiencies in Stata visualization workflows** (twoway/histogram/line/etc.).
- And I introduced my PLOT suite of **graphing commands for large datasets:**

```
ssc install plottabs
```

- Today, I want to highlight another issue and propose a readily-available solution

Illustrative example

Stata code

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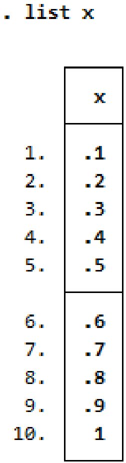

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     +----+
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list x if x <= .4
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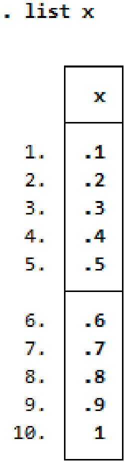

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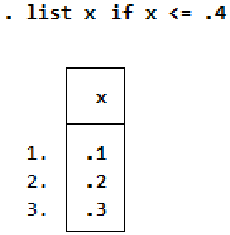

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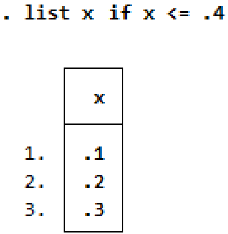
…huh? Where's **0.4**???



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- Computer architectures have been known to struggle with **non-integer numbers**, such as fractions, π, ρ, *etc*.

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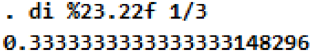

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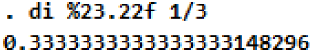

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- The exact sequence of numbers **outside the precision range** is IEEE-standardized and replicable across programming languages (on the same hardware).

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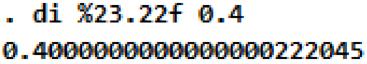

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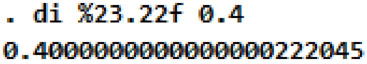

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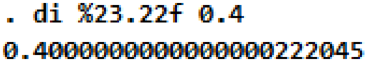

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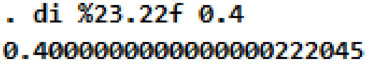

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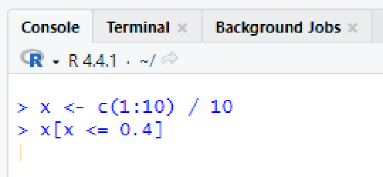
- Nope, this is not the reason. If it were, we should be able to replicate the same behavior across different programming languages.

Killing joy with R

- Let’s produce an equivalent workflow in **R**:



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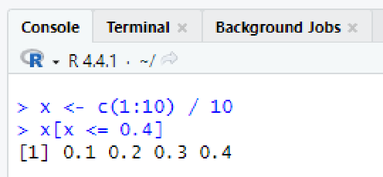

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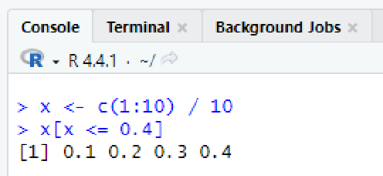

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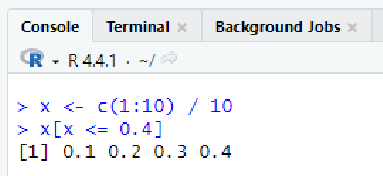

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- This makes intuitive sense, since the precision of the numbers **stored in the c() vector**, and the number used in the **conditional statement** use the same standard.
  - Fundamentally, we are asking whether 0.40000000000000000222045 is smaller or equal than 0.40000000000000000222045, which it is!

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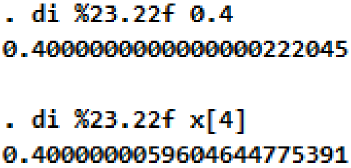

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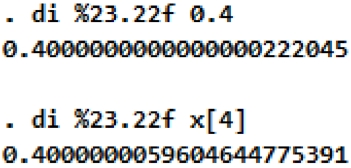

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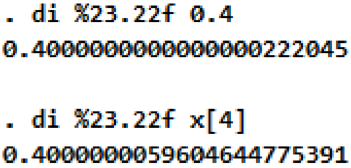

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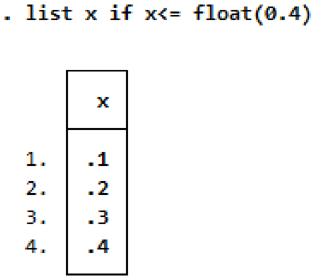
- That is why the stored number 0.4 does not satisfy the weak inequality restriction in `list x if x<= 0.4`.
- The stored value is **strictly greater** than the value used in the if-statement.

Quod Erat Demonstrandum

- We get the correct behavior if we force the value in the if-statement to be of the same precision (`float`) as the stored value:



```
. list x if x<= float(0.4)

     +----+
     |  x |
     |----|
  1. | .1 |
  2. | .2 |
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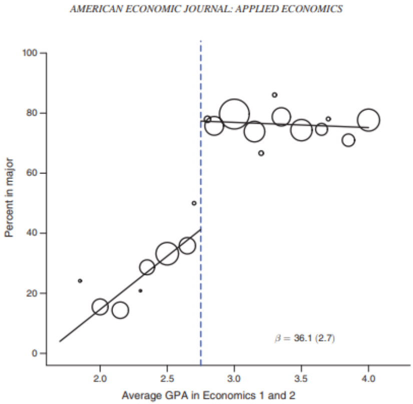
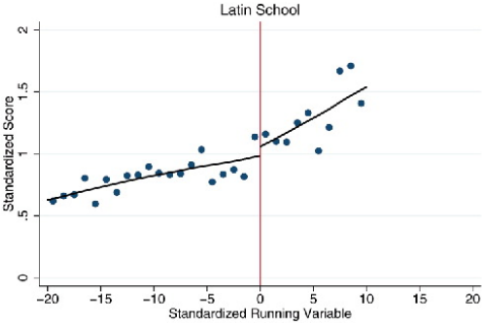
> *"This is unlikely to affect any calculated result because Stata performs all internal calculations in double precision."*

- Well, I disagree.
- The problem is that this behavior is **unexpected**, and it is capable of producing **calculation & data construction errors** that can be **extremely damaging to modern causal inference designs**.

RDD: Regression Discontinuity Debacle

- Many causal designs operate with cut-off points, and a correct classifications of observations in the vicinity of the cutoff point is critical:





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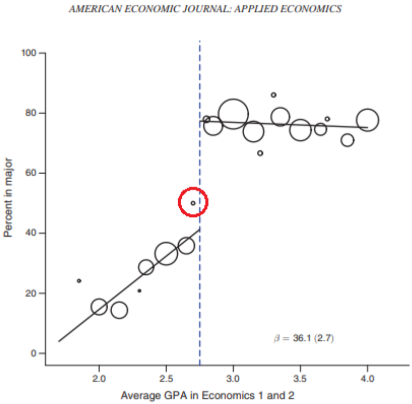

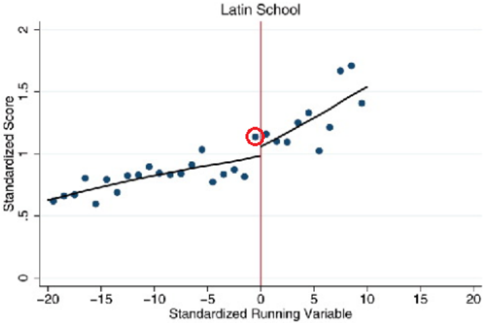

Well, that's not great...

- Yup.
- These precision issues introduce another layer of uncertainty that can hamper reliability and replicability of scientific studies.
- IMHO, we should endeavor to eliminate these hidden traps, especially when solutions are readily available.

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In the meantime, we can set the precision standard manually:

```
set type double
*caution: ’set type float’ will NOT override double for arithmetic ops
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set obs 10
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Pseudocode:

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if type(x) = float ---> evaluate: x<= float(0.4)
if type(x) = double --> evaluate: x<= double(0.4)
if type(x) = quad ----> evaluate: x<= quad(0.4)
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if type(x) = double --> evaluate: x<= double(0.4)
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- This is more cumbersome (and could run into problems with complex operations where the correct use might be ambiguous), but it would avoid making datasets larger by default.

Takeaways

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- Unless the single-precision default has some other justification that supersedes the concerns presented here, **I say that it is time to bid it a heartfelt farewell.**
- The Stata practitioners will thank you for it.

  (or they would if they were aware of this issue to start with)

Thank you for your attention!

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