

Welcome to

**Co****N****G****A**

The logo for CONGA features the letters 'Co' in black, 'N' in red, 'G' in red, and 'A' in blue. The 'G' is stylized with a blue arrow pointing upwards and to the right. Above the 'G' is an infinity symbol ( $\infty$ ), and below it is a zero ( $0$ ).

The Fourth Conference on  
Next-Generation Arithmetic

March 1–2, 2023

For those of you who flew here, I hope your flights were at least *deterministic*.



# Updates

- We are in-person again! And larger than ever.
- Huge **thanks** to SCAsia and the team that made CoNGA '23 possible
- There's an explosion of work worldwide on NGA, esp. for ML.
- The Posit™ Standard was ratified March 2022; *differs from the original 2017 definition* in that  $eS = 2$  for *all precisions*, note.
- The battle to preserve legacy format IEEE Std 754™ is underway.

# Custom VLSI posit processor due *this year*

- The first full-custom VLSI RISC-V posit processor has been developed by Calligo Technologies Private Ltd. of Bangalore, India
- 8-core chip scheduled for tape-out in May 2023; 28 nm with expected optical shrink to 22 nm; silicon back by August 2023
- 32-bit ( $eS = 2$ ) and 64-bit ( $eS = 3$ ) posits; quire support for 32-bit
- PCIe accelerator board to be ready Sept. 2023; pricing not set yet
- Gnu Utils version 12.2: C, C++, Fortran, Python 3.8, and BLAS

# In September 2022, this happened:


- For the first time, ARITH let a posit paper get accepted and presented.
- *IEEE Spectrum* picked up on the news and wrote an online article. *64,000* reads in 24 hours!
- Went to print magazine in Dec 2022; *300,000 readers*

NEWS | ARTIFICIAL INTELLIGENCE

## Posits, a New Kind of Number, Improves the Math of AI

> The first posit-based processor core gave a ten-thousandfold accuracy boost

BY DINA GENKINA | 25 SEP 2022 | 4 MIN READ | □



HIROSHI WATANABE/GETTY IMAGES

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TAGS

- ARTIFICIAL INTELL.
- GPT-3
- COMPUTER ARCHITEC.
- MATHEMATICS
- FLOATING POINT
- POSIT
- MACHINE LEARNING

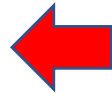
Training the large neural networks behind many modern AI tools requires real computational might: For example, OpenAI's most advanced language model, GPT-3, required an astounding million billion billions of operations to train, and cost about US \$5 million in compute time. Engineers think they have figured out a way to ease the burden by using a different way of representing numbers.

Back in 2017, John Gustafson, then jointly appointed at A\*STAR Computational Resources Centre and the National University of Singapore, and Isaac Yonemoto, then at Interplanetary Robot and Electric Brain Co., developed a new way of representing numbers. These numbers, called posits, were proposed as an improvement over the standard floating-point arithmetic processors used today.

Now, a team of researchers at the Complutense University of Madrid have developed the first processor core implementing the posit standard in hardware

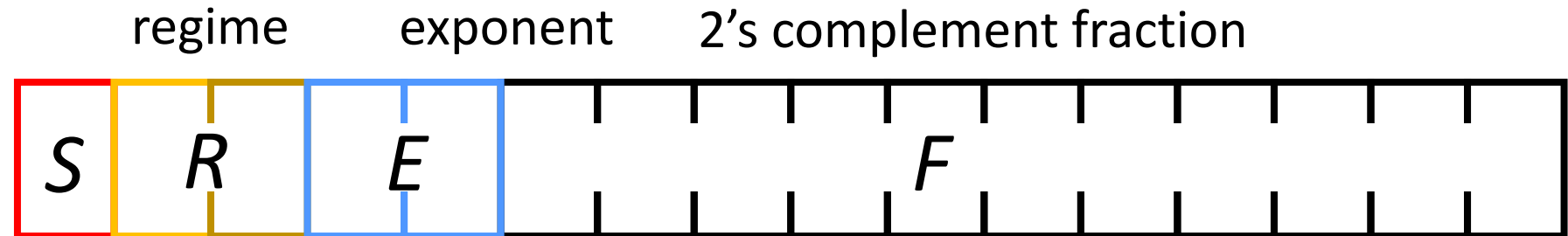
# Something I realized just after CoNGA '22

Regime	Value $k$
00000	$-\infty$
00001	-4
0001x	-3
001xx	-2
01xxx	-1
10xxx	0
110xx	1
1110x	2
11110	3
11111	4



Bits after LSB are all 0 bits. *Infinitely many.*

That means the formula for a posit value actually has *no* exceptions!  $2^{-\infty} = 0$ .  $-2^{\infty} = -\infty$ .



$$\text{scale} = (-1)^S(4k + E + S).$$

$$\text{value} = (1 - 3S + F) \times 2^{\text{scale}}. \text{ Period.}$$

# Breaking: an idea for A-to-D conversion

- Unlike floats, it is possible to build an analog-to-digital convertor (ADC) that converts signals *directly to posit form*, MSB to LSB. Like fixed-point ADCs.
- Could be key for android robot vision and hearing,  $10^{14}$  dynamic range like that of human vision and hearing.
- Like “ $\mu$ -law encoding” for audio transmission.

