Systems Engineering

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Evolutionary and revolutionary effects of transcomputation

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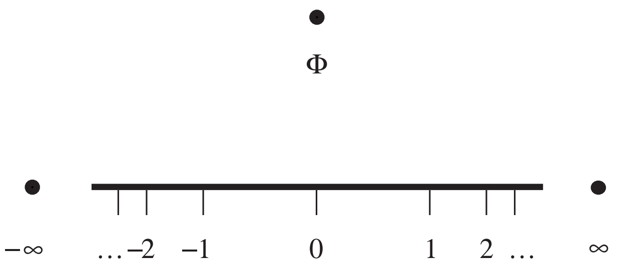
Evolution

Transcomputation is any computation that uses a *transarithmetic*.

Transreal arithmetic uses a subset of the algorithms of real arithmetic to deliver a superset of real arithmetic. This superset is *total:* every arithmetical operation can be applied to any numbers with the result being a number.

Transcomplex arithmetic is a total superset of complex arithmetic and is obtained by using transreal arithmetic in a special geometrical construction. See right.

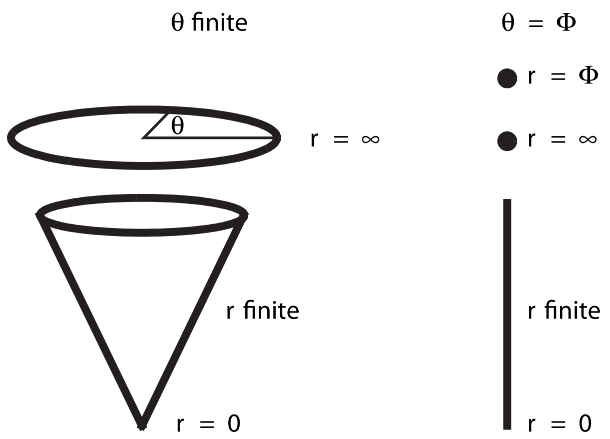
- Replace *minus zero* and all *NaNs* in *IEEE 754 floating-point arithmetic* with transreal numbers, thereby doubling the range of real numbers encoded by the floating-point bits or else halving the threshold at which floating-point numbers underflow to denormal numbers near zero
- Transcomplex numbers are total. They already contain the *point at infinity* and the *line at infinity* which are ordinarily used to compactify complex spaces. They also contain points that are ordinarily omitted from complex analysis so any round-off error still produces a validly analyzed case
- Totality guarantees that if a program compiles then it has no logical run-time errors. This improves reliability and simplifies verification
- The *transreal-number line* looks like a simple evolution of the real and extended-real number lines:



Revolution

The totality of transreal and transcomplex computations means that:

- In-line programs can be completely pipelined so that a *program* completes execution every clock tick
- A molecular dynamics program, that is resident in memory, shares data about the previous iteration with *n* molecules in the current iteration so *n pairwise molecular updates* can be completed every clock-tick
- Hardware is simplified to the extent that we expect to manufacture a 1 PFLOP computer, with a power budget of 10 kW, at a price of $5 m
- All previously described complex-number spaces map onto the *transcomplex-number space* but this has parts that are new to mathematics:



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