Transcomputation

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Course agenda

- Transreal arithmetic
- Relational operators & sketching graphs
- Trans-two’s-complement & transfloat
- Equations, functions, gradient
- Rotation, angle, polar-transcomplex numbers

Course agenda

- Transvectors, polar-transcomplex arithmetic
- Physics & modelling
- Logic, sets & antinomies, knowledge
- Hardware & software
- Revision

Lecture 1

Comparison

- Mathematics checks for division by zero and, if found, it fails
- Transmathematics checks for division by zero and always succeeds

Conclusion

- Transreal arithmetic contains real arithmetic
- Each real number is finite
- There are three non-finite, transreal numbers: negative infinity, nullity, positive infinity
- Transcomputation extends all other computation

Lecture 2

Conclusion

- There are no indefinite or undefined results in transreal arithmetic
- Transreal, relational operators are total
- We can sketch transreal functions

Lecture 3

Conclusion

- Trans-two's complement has the same number of positive and negative numbers and removes the weird number and wrap-around
- Has the same topology as the transfloats
- Is a discrete approximation to the topology of the transreals

Conclusion

- Transfloat preserves the semantics of zero and equality, potentially doubles the accuracy of float calculations, has irredundant relops, is totally ordered when a position is imposed on nullity
- Has the same topology as trans-two's-complement
- Is a discrete approximation to the topology of the transreals

Lecture 4

Conclusion

$$a \circ b \circ c \ldots = A \circ B \circ C \ldots$$

- An equation is satisfied by any selection of arguments that makes it true

- An equation is not satisfied by any selection of arguments that makes it false

Conclusion

$$f(a \circ b \circ c \ldots) = V$$

- A function has exactly one value, V, for each allowable selection of arguments
- If all selections are allowable, the function is total
- If some selection is not allowable, the function is partial

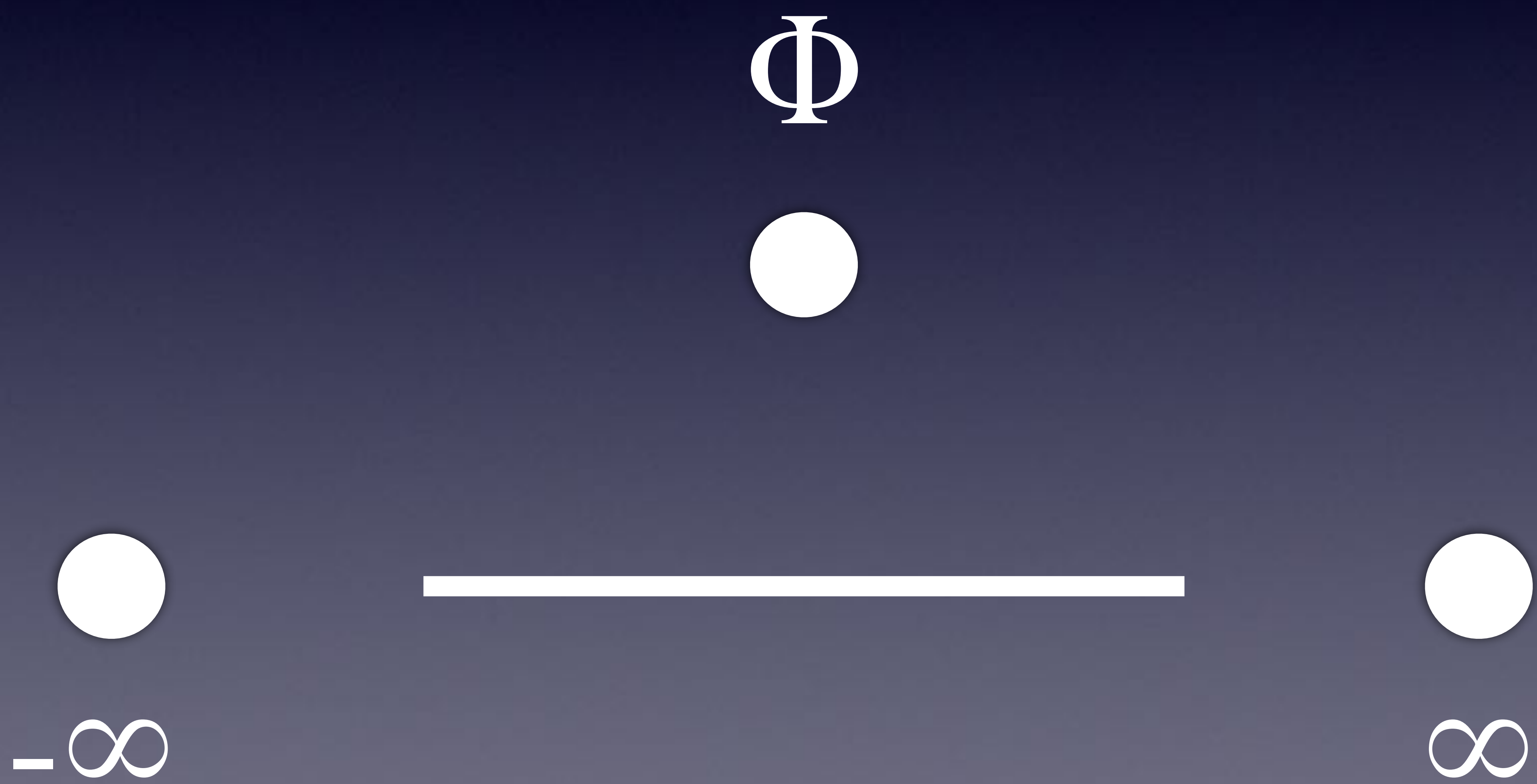
Conclusion

- The line equation, $y = mx + c$, defines a total function, $f(x) = mx + c$, but they do not describe all lines, i.e. the range does not contain all lines

- Totalising the domain of a function is not enough. We also need a range that describes exactly what we want

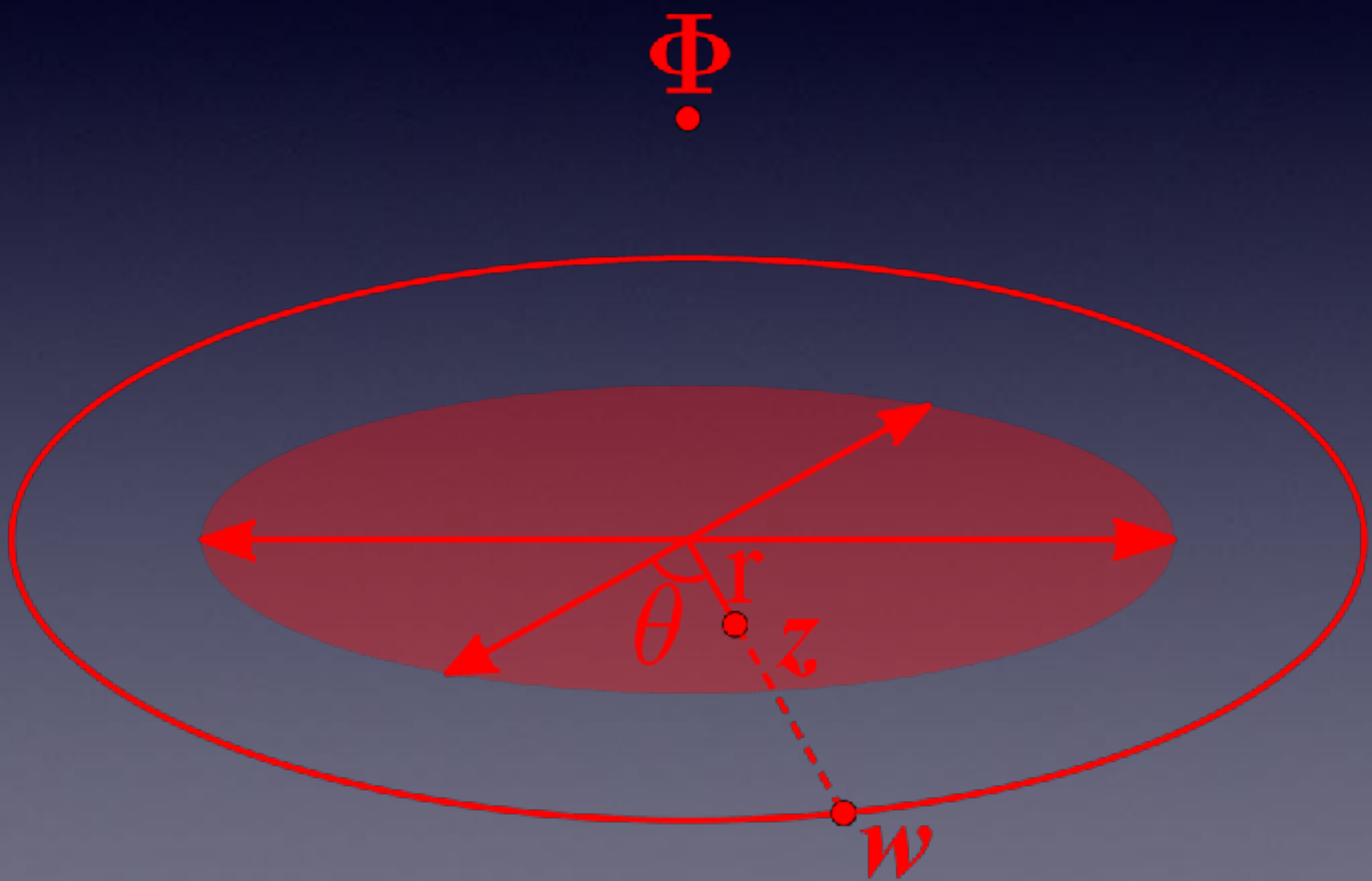
Lecture 5

Transreal number line



Construction

$$\mathbb{C}^T = \mathbb{C} \cup \left\{(\infty,\theta);\, \theta \in (-\pi,\pi]\right\} \cup \{\Phi\}$$



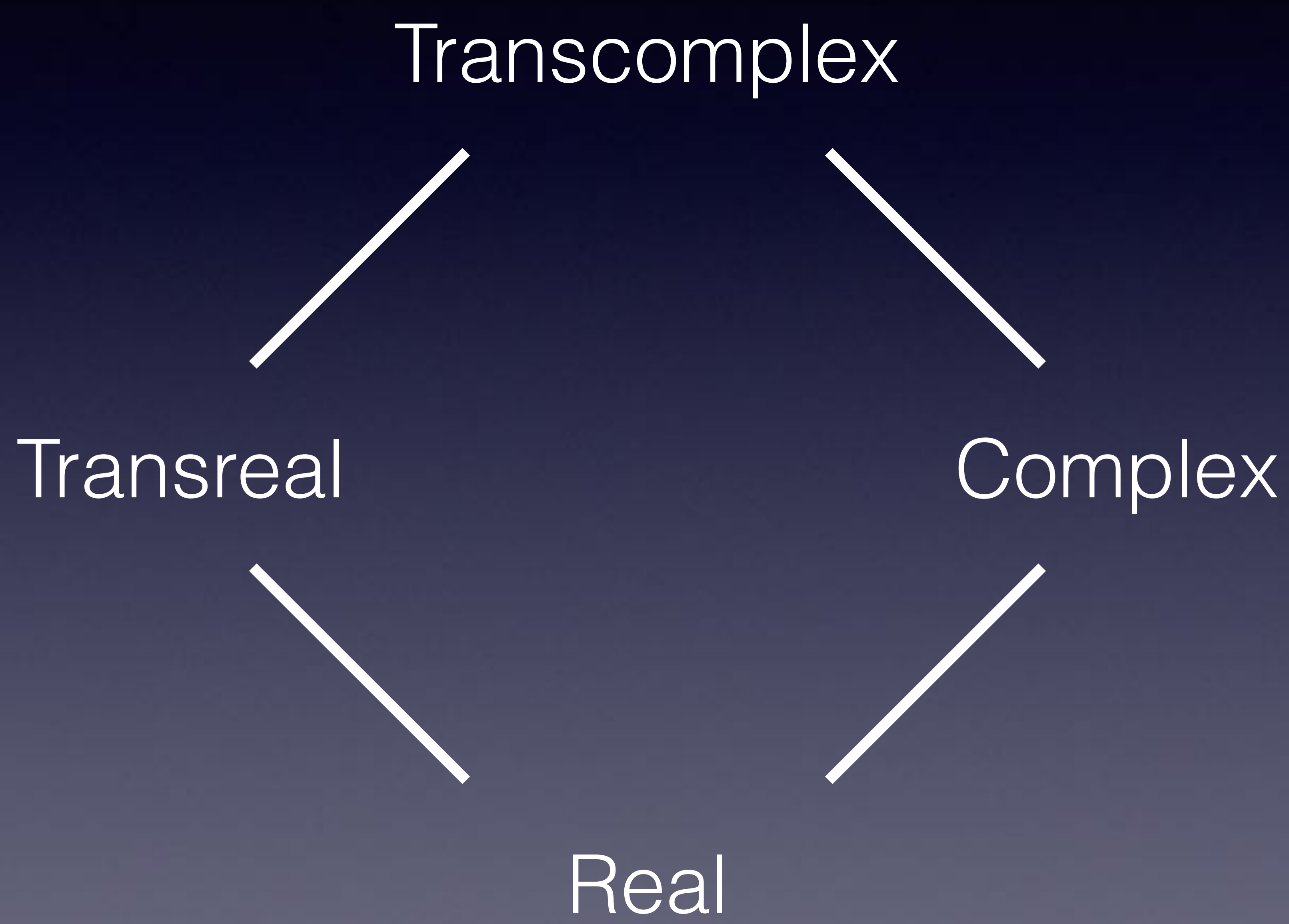
Angle

- All transreal angles can be defined via the unit real cone

Conclusion

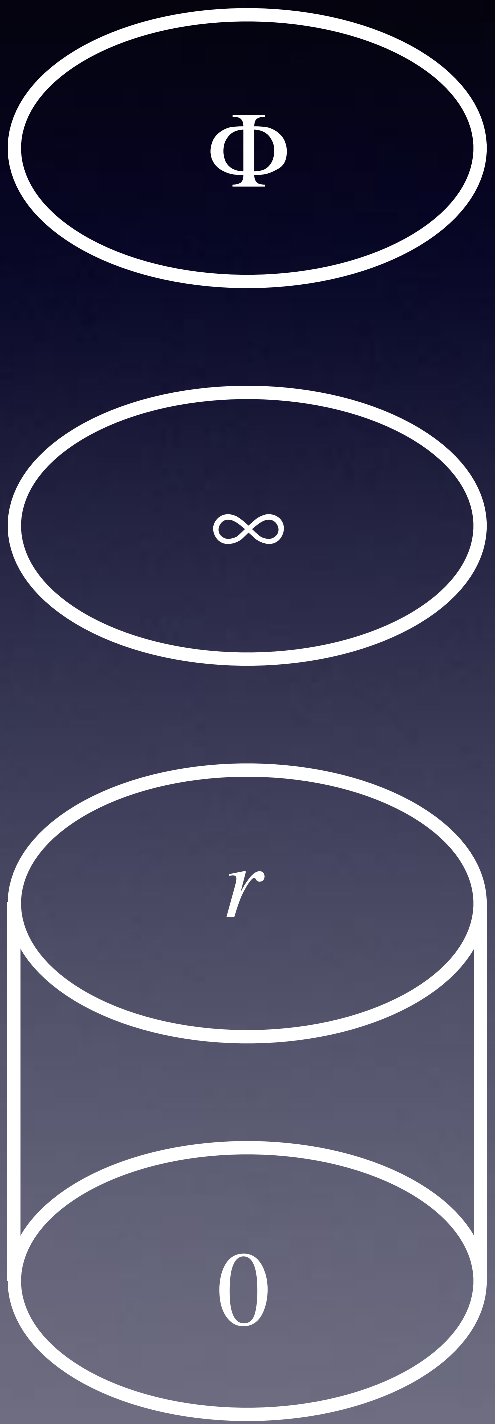
- All transreal angles can be defined on the real unit cone
- The polar-complex plane is generated by rotating the real line
- The polar-transcomplex plane is generated by rotating the transreal line
- Polar-trancomplex multiplication and division are lexically identical, respectively, to polar-complex multiplication and division

Conclusion



Lecture 6

Transreal cylinder



Conclusion

- The sum of any transvector with the nullity vector is the nullity vector

- The sum of opposite infinite vectors is the nullity vector

- The sum of two general infinite vectors is their unique bisector

- The sum of an infinite vector with a finite vector is the infinite vector

Conclusion

- The sum of infinite vectors is non-associative so the order additions are done in matters

Conclusion

- Polar-transcomplex addition is transvector addition
- Polar-transcomplex subtraction is the addition of a vector in the opposite direction
- Polar-trancomplex multiplication and division are lexically identical, respectively, to polar-complex multiplication and division

Lecture 7

Conclusion

- Transreal and transcomplex arithmetic are total and consistent
- We may use transarithmetics in a model
- Newton's modified Laws of Motion can hide the physical mass in the computed mass of nullity but the physical mass can always be recovered via gravitation so there is no loss of information
- We can compute with a model!

Lecture 8

Knowledge

- Knowledge can be expressed in digital or discrete systems
- But knowledge is embedded in the physcial universe so must conform to physics
- Von Neumann computers make the physically impossible assumption that information can travel faster than light
- Hypothesis: the more direct the conformance, the more efficient the computation

Conclusion

- We need a total logic that covers at least the concepts: True, False, Contradiction, Gap
- We need to work with at least classes of both sets and antinomies, not just sets
- Knowledge may be discrete or continuous but it must conform to the physical arrangement of the universe

Lecture 9

Pipeline machines

- Totallity + known waiting time = ideal pipeline concurrency
- Pipelines deliver energy efficiency and unlimited scalability with constant computational efficiency

Conclusion

- Power efficient because all tokens move a short distance per clock tick
- Scalable to any size with constant efficiency
- Safer code because totality removes many exceptions
- Enormous throughput of repeated computations
- Might deliver exascale on 20 MW power budget

This lecture

Conclusion

- The course has introduced transmathematics and transcomputation
- What are your thoughts and feelings about the course content and structure?
- Do you have any questions?