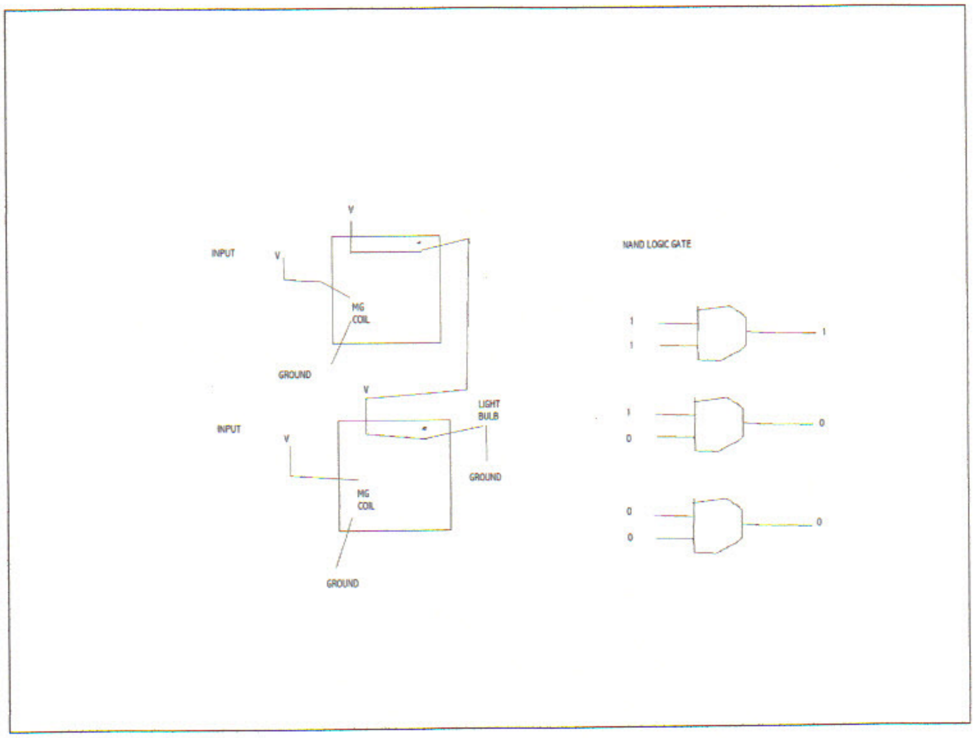
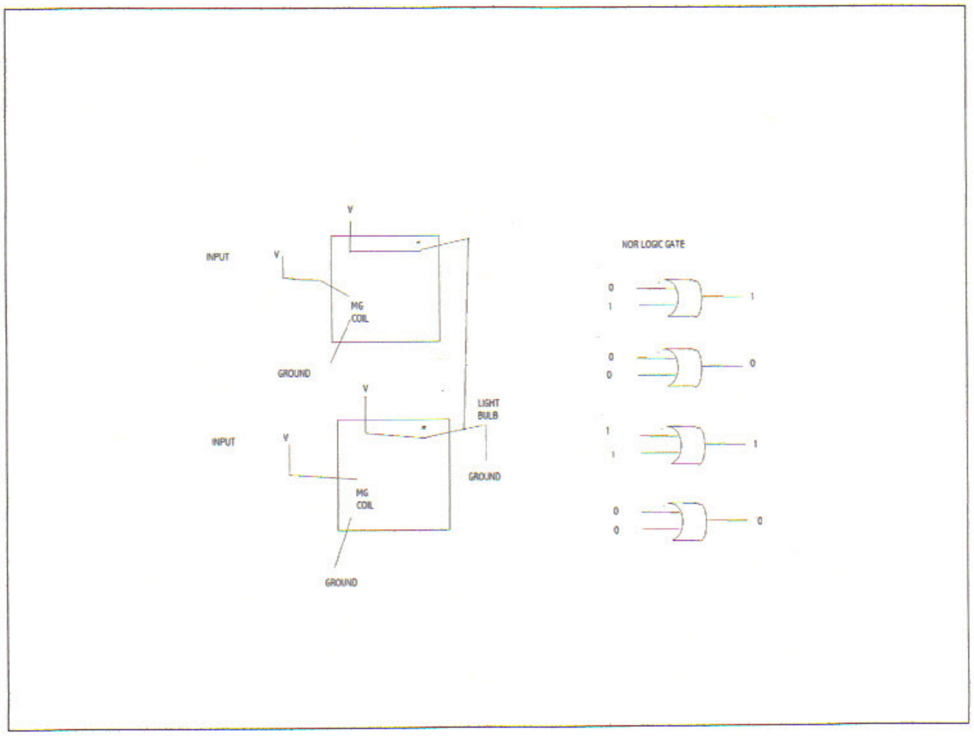


If we rewire the connections between the two coils, as above, and vary the input values in order to get a Boolean valued output, then the total system represents what we now call a NOR logic gate.

Of course, these mechanical relays operate much slower than the corresponding designs which use vacuum tubes. According to Martin Davis in his book "The Universal Computer", it was Alan Turing looking at an RCA radio catalog in March 1943 sailing back across the Atlantic from Princeton, NJ to Cambridge England who first realized that vacumn tubes could carry the kind of logical switching that had previously been done by mechanical relays.

In order to construct a half adder using these mechanical relay gates (or, equivalently, vacuum tubes,transistors, integrated circuit boards) we can combine two nand gates and and or gate to get an exclusive or gate, then add another nand get to get the half adder.
In order to construct a logic machine to add two arbitrary sequences of binary digits we need to have a machine with two binary inputs plus a carry input binary digit. And, its output will need to have a sum binary digit and a carry digit. Such a logic gate can be put together the above half adder with an or logic gate and is called a full adder. We then string together sequences of full adders for each of the number of binary digits that will be summed (eg. To add two binary 8 place numbers we would need 8 full adders wired together.

We have now constructed a logic machine which can be used to perform the actions that the successor function does on a integer (we take one input to the adder as the number and the other as the binary number one). However, in actual practice the successor function is better represented by something called a feedback register. The feedback register is made up of logic gates called flip-flops.



The flip-flop was invented in 1918 by the work of radio physicists W. H. Eccles and F.W. Jordan. There are several different types. If you look at the table of binary input and output values you will notice that it is possible to use the device to store information (eg. Row three gives an output of either Q or ~Q, the value stored on an input value of binary 0). This property is in contrast to any of the adder machines above and it what allows groups of flip-flops to be use as data registers and counters.

Turing, in his seminal paper on the theory of computing represented functions in terms of pairs of binary domain and range values on a linear two way tape. But, when he attempted to write the input, output values in order to create what we later came to make a "function call" in terms of state diagrams he found it to be fairly complicated. The paper gives an example of how to write a function to compute the square root of 2 in a simple Turing machine, and most current books include instructions of how to add two numbers in which are represented this way. But, the number of states and transition connections between the states multiplies quickly when one tries to represent the positive integers as arguments for a function call. To simplify this greatly, idea of the computer containing a "shift register" to hold values to be computed (similarly to how a Chinese abacus stores partial values during a computation) adds to our ability to understand how the programs of the modern machines can be created. A shift register is a set of electronic switches which can "count" and store integer values to be used in the computer's calculations. These registers use "hardware" and not "software" to implement what we called the "successor" function that generates all the positive integers inductively. As you recall the existence of a "null set" and of a "successor function" which operates on it was the critical beginning conceptual material needed to be able to determine from the Peano postulates wheither a set of objects can be considered mathematically "isomorphic" to the positive integers. Since "shift registers" hide the workings of how the register represents the null set and the successor function inside of their wiring it is instructive for those trying to understand the philosophy of all of this to look, as above, into exactly how this is done. For more details about how modern digitals computers and microprocessors I recommend the reference by Petzold already given. Also, the early 1970s Heathkit course in Digital Techniques contains much more information about how Boolean functions can be used to generate timing signals for the Control Part of the microprocessor which transfer data from the shift registers and memory to the adders and back. An interesting algorithm called "Karnaugh Mapping" is using to create the sequential and combinatorial logic circuits required. It uses reasoning very similar to that in George Booles seminal book "Symbolic Logic". It transforms the Boolean polynomial into a minimal expression by examining the Boolean function's Truth Table. It separates out what the coefficients of the different terms in the Boolean functions (polynomials) have to be given a set of input and output Boolean values.

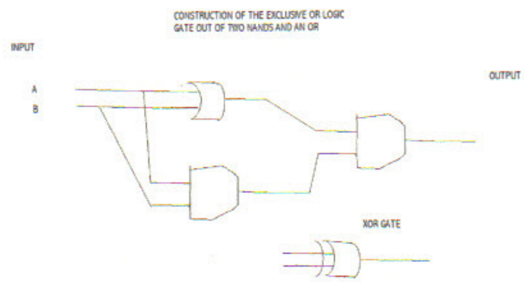
"Code, The Hidden Language of Computer Hardware and Software", by Charles Petzold, Microsoft Press, 2000.

"The Universal Computer" by Martin Davis, 2000 page 174.

"Individual Learning Program in Digital Techniques", Heathkit Continuing Education, Benton Harbor, MI, 1975

Invented in 1952 by Edward W. Veitch and developed further in 1953 by Maurice Karnaugh (November 1953. M. Karnaugh, "The Map Method for Synthesis of Combinational Logic Circuits". *Transactions of the American Institute of Electrical Engineers part I* **72** (9): 593–599. 1952. Edward Veitch, "A Chart Method for Simplifying Truth Functions". *ACM Annual Conference/Annual Meeting: Proceedings of the 1952 ACM Annual Meeting (Pittsburg)* (ACM, NY): pp. 127–133.

, a telecommunications engineer at Bell Labs.



B INPUT

A INPUT

XOR	0	1
0	0	1
1	1	0

Some Definitions of Terminology Related to These Ideas

Algorithm -- A procedure that conducts a calculation in an ordered manner for the purpose of solving a problem.

Antecedent -- The IF part of a conditional statement.

Attribute -- Defines the qualities or values contained in a class and the type of information that make up a class. For example, the class car can have the attributes "type of engine" and "top speed".

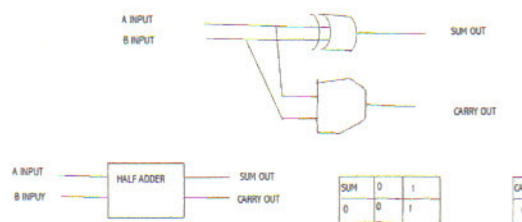
Attribute value -- An actual number or confidence factor representing the degree of certainty with which a factor is known.

Class -- Defines the structure (in terms of its attributes) and behavior(in terms of its associated methods and procedures) of an object. When it becomes an instance, it then holds the actual data values of a particular realization of this type of object in the knowledge base. For example: a class called human beings might have attributes related to the parts that differentiate our physical beings and categories such as those related to its our mental and spiritual capacities. Some of the associated methods and procedures of this class could be thinking, talking, walking. It can be considered as a subclass of another class such as the class of living beings. The author and the reader are both specific instances of a human being object.

Clause – A formula to be included in conditional statement which contain a goal. Clauses do not contain the terms which are displayed functional or predicate arguments in the more standard way of writing logical statements. If the clauses in the consequents are restricted to always being positive the clause is called a Horn clause.

Consequent -- The THEN part of a conditional statement.

Forward-Chaining -- Forward-chaining reasoning is an inferencing strategy in which the questions are structured from the specific to the general. That is, it starts with user supplied or known facts or data and concludes new facts about the situation based on the information found in the knowledge base. This process will continue until no further conclusions can be reached from



SUM	0	1
0	0	1
1	1	0

CARRY	0	1
0	0	0
1	0	1

Object -- General term for a programming entity that has a record type data structure along with attribute values and procedures or methods that enable it to represent something concrete or abstract. It can be contrasted with other programming entities such as facts, rules, procedures, or methods. An object's structure is defined by its class and attribute definitions. A class declaration is a data template involved in representing knowledge which defines the structure of an object. For example, in the class "human being" mentioned above some of the slots might be height and weight.

Recursion -- A process by which a data type, predicate or function is defined in terms of itself. This situation of self relation allows the function or predicate to be computed in an orderly manner.

Stream -- An ordered set of objects tied together one to another. It has a first, but not necessarily a last element.

Variable -- A name that represents the value of an unknown object.

Word -- A name.

OBJECT-ORIENTED ALGORITHM TO GROUP OR CLUSTER SETS OF EXAMPLE DATA IN CATEGORIES

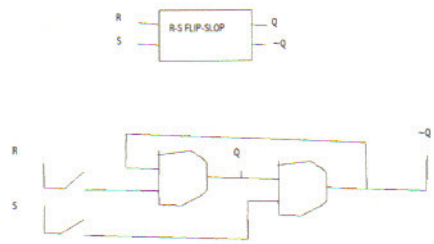
Start off with an initial set of clusters which partition a set of sample data into groups.

For each example in a series of new data samples:

a) Compute the mean or centroid, or some other mapping that quantizes or compresses the groups of data sample into a small number of values.

b) Place each new example in the cluster which most closely matches (resembles or is contiguous to) the initial categories.

A FULL ADDER CAN BE CONSTRUCTED FROM TWO HALF ADDERS AND AN OR GATE



INPUTS		OUTPUTS	
S	R	Q	~Q
1	0	1	0
0	1	0	1
0	0	Q	~Q
1	1	not allowed	

Consider the fact that modern computers define the number one using a hardware implemention of shift registers. Simple functions and subroutines are also sometimes implemented using that lamba calculus of routines and co-routines implemented without defining what sets are. The question now comes up, is it possible to bypass the earlier complicated definitions and axioms of set theory in order to use the these simple items are fundamental elements in the calculus of natural numbers recursive functions and logical relations. To do this see the references, A.P. Morse, “A Theory of Sets” Academic Press, New York, 1965

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The above definition of One, in turn, allows us to understand what mathematical and scientific/theological Oneness is. Above we have explained why, "How do you define the number One?" was so important to mathematicians, and scientists, in the last century. Philosophically Hume obviously understood this. Which is why he thought so deeply about it. And, we must understand this in order to understand what these two different things are and the important fundamental question to our ethical and philosophical theories of well-being and truth.

To see why understanding the details of how we define this concept of One allowed the invention of a computer we understand the concept of a Turing machine. This concept wasn't invented by Turing until some years after Hilbert wrote his book on how to formalize numbers and mathematics using Frege's definitions. It was Turing's great idea, arrived at while studying Hilbert's ideas on how to formalize logic and set theory using recursive functions that we can code the recursive functions with the natural numbers and thus represent them inside of the framework of a small set of registers (to store the values of the results of the computations) and a single one-dimensional tape (to store the coded numbers of the recursive functions along with the sequence of functions and terms needed to define the computer program as an algorithm).

We have seen above that in order to define natural numbers using a well-defined concept of what one is the concept of a relation, in addition to that of a function is needed. The variable arguments that go inside of relations are called terms. Given a set of operation symbols Ops and an arity function from that set to the natural numbers we have an ordered pair which makes up what is called the operational type of the relation.

And, what about its theological importance? Leibnitz, as well as Hume (who was not a theologian), put a lot of thought into this problem of definition of a theological One in terms of logical symbols. His definition of equality of objects or concepts was,
"Things are the same as each other, of which one can be substituted for the other without loss of truth." His use of the term "Truth" here takes us beyond the problem of defining equality inside of just the world of numbers or sets of objects. Is it in fact the case as Dr. Kronecker has said, "God created the integers (and the science of nature that depends on using them to count and measure) and all else is the work of man." If an understanding of Oneness in terms of natural science is all that we want, then the definition of One from the above paragraph in set theoretical logical terms: "The number One is the cardinality (similarity class of one-one functions) of the set whose only member is the empty set."
Solves the problem. With an understanding of this definition we have understood how God created the idea of "Oneness" inside of his created Universe. But, the Bible says that God did more than just create the World.
It says that he created Man (and also Woman) in His own image and likeness.

1) Most New Age Theologies today[12] subscribe to the axiom/assertion/affirmation that there is "Only One Mind…God the Good Omnipotent".

2)The mental science of Yoga, however, being based on the Sutras of Patanjali teaches in Book IV, "One(ekam… the principal Divine life force) Mind (cittam) directs the many created minds in the variety of their activities". Sutra 5 But, it also says later "An object (vastu) is not dependent (tantram) on One Mind (eka-cittam…the principal mind God), because if it were so (tada), then what (kim) will happen when it is not cognized by that Mind (apramaannakam…no valid, truthful, tenable, assessment is possible)?" sutra 16. Inotherwords the teaching is that an object does not come into being with its perception[13]. Thus, there it follows from this if there is no collective consciousness dwelling in our individualities (eg. a concept of a concept) there is no One first Mind…for otherwise there would be an infinite regress."

3) Standard Christian theology teaches that we each have our own individual minds and God has his mind as something separate. In addition to this there is (has been since the beginning) and ever will be a World with

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How do We Define the number One?

Dr. Andrew W.Harrell, Phd Mathematics UC Berkeley 1974

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This question arises when we consider how we can develop a better understanding of the interrelations of science and faith. At the turn of the last century work on the area of the foundations of mathematical analysis and the beginnings of the development of mathematical logic increased. This happened along with the invention of digital computers. And, a new area of mathematical area of research called set theory was created in order to understand what "a real number" in Calculus means. Leopold Kronecker made his famous statement, "God created the integers and all else is the work of man." But, how did God create the integers? Plato's dialogue Parmenides is perhaps his hardest to understand work and the most important attempt in the classical era to try understand different ways we can answer this question. What is a set? What is an empty set (basically this is determined logically when you know what an element in a set is and what a set is)? This talk will give a short history of some of the progress mathematicians and logicians have made trying to answer these questions since the beginning of the last century. We have shown, that except for some notable gaps, how "real numbers (rational, algebraic, transcendental)", and likewise various other "complex and ideal numbers" can all be constructed logically from the positive integers. The possibility of the "notable gaps" come from the proof of the independence of the continuum hypothesis.

- SOME REASONS FOR THINKING ABOUT THIS QUESTION
- In terms of its relation to metaphysics and epistemology: The Greek philosophers realized this as a fundamental philosophical question too. Plato's dialogue Parmenides is perhaps his hardest and most important attempt in the classical era to try and understand this . And, it deals with just this question, "What is does the Concept of One mean philosophically and mathematically?'
- "Among different languages, even where we cannot suspect the least connexion or communication, it is found, that the words, expressive of ideas, the most compounded, do yet nearly correspond to each other: a certain proof that the simple ideas, comprehended in the compound ones, were bound together by some universal principle, which had an equal influence on all mankind." A Treatise on Human Understanding Book 1 Section III
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- Isn't this Hume saying that he believes in such a thing as a "concept of a concept"?
  - How can we understand what the deeper philosophic question of What a "Concept of a Concept" is if we don't understand what the Concept of One is? This basic question is phrased above as a mathematical question in the logical foundations of the branch of mathematics called set theory. We believe the question of how we can develop a better understanding of science and faith is interconnected to this question. Thus, it is not only its mathematical implications that make this conundrum important for us to solve.
    This question from mathematical research relates to a fundamental theological and spiritual one… If we are to say that the fundamental nature of God is that He is One, what do we mean by this? The standard theological answer to this question is contained in a religion's teaching about the name of God (which is a trinity for Christians and Hindus). Is it possible to be a Father and Mother of God using structures of thinking within His Holy Spirit operating in our own minds and spirits and souls? Elsewhere on an internet prayer website I have posted some thoughts about this (see references). And, an understanding of how our human interest in this question as a mathematical one developed will certainly better help us understand how our different human forms of science and faith are related in us. To do this we need to go back to the turn of the last century when questions of the foundations of the area of mathematical analysis and the beginnings of the development of mathematical logic as it relates to the invention of computers was being developed.

A Short History of the Number One

- There is a documentary called "The story of One," made by Terry Jones (a Monty Python member). Quite interesting...
- “ 20,000 years ago the number one exists for the first time.
- This is determined from evidence of human scratchs on bones. Many human societies, like the aboridigines, for example, never and still don’t to this day, use any numbers (or even the number one).
- However, the whole science of measurement depends on having an idea of what the number one means to start out the measurements. We know that the Egyptians were some of the first to develop new methods for measurements (using a ruler) and hence beginning a question of what one means inside of us.” [8]

- “Later in human history, the important Greek philosopher Pythagoras set up a group of vegetarian philosophers and mathematicians. He believed everything, especially including music, was made of numbers. He wanted to understand why certain combinations of notes sound harmonious. He studied ratios of whole number (collections of multiples of one) in order to understand this. He coined the term, “music of the spheres”. If the beauty of music relies on whole numbers then so must everything else. And, since whole numbers are at the heart of music and one is at the heart of whole numbers it must be very important to understand what “one” is. However, the rationale for this belief system was later destroyed by the discovery of “irrational numbers”. Pythagoras could not conceive of numbers unless they represent actual objects. Plato, and later Frege, believed that “numbers” were mental objects.
- Plato in the dialogue Parmenides starts humankind off studying “How to We (or You) Define the Number One.” In this dialogue Socrates and Parmenides discuss the arguments and paradoxes of Zeno and other contemporary Greek Philosophers. It assumes a knowledge of previous dialogues like Phaedrus where Plato has explained his theory of independently existing mental objects called Forms. How do we “know” these independently existing mental objects? Our mind can know them by “participating” in them, not in the sense that through sense experience we collect sense-contents of material objects but in another more directly intuitive sense.

- This dialogue discusses the question, “What is the Form of One” (if indeed such a thing exists… for the method used is to discuss a philosophic problem by both assuming the consequences of believing a logical proposition about Forms to be True and then also believing it to be false. This method of mental analysis anticipated that of Boolean logic functions by several thousand years. So, during the dialogue a series of eight “hypotheses” are put forward. And, the “participants” in the dialogue discuss the consequences of assuming the hypotheses are true or not. The first two hypotheses are that.

- However, after this, Archimedes modified this philosophic assumption somewhat by telling us we could think of numbers as objects (concepts) in themselves. This tended to take “one” away from being the “essence of the universe”. “[8]

- After this. The Philosopher Kant wrote several fascinating books on the relation of science and mathematics to philosophy. Up to this time He defined what he called analytic and synthetic logical propositions. Analytic propositions were defined. A synthetic proposition cannot be established without appeal to something other than the content of the concepts involved. He also distinguished between what he called “a priori” and “ a posteriori” propositions. The question became “what kind of a proposition is “1 +1=2”? Is it a synthetic or analytic one? Some argue is it a third possibility, a “tautology”. A tautology is a proposition true only formally because of variable substitutions. Kant did not believe like Plato and Frege was to later that numbers were “mental objects”. He believed they were “transcendental objects”. If you believe this we have a possibility that “1+1=2 is neither a synthetic proposition or a tautology, but a “logical truth.” With the discovery of the non-Euclidean geometries in the second half of the nineteenth century this question became even more interesting. For we suddently realized that there might be several different ways of giving “definition to the defined” as Pascal said. And, if this could be true in the fields of geometry, what about arithmetic? It wasn’t until Frege brought back the idea from Plato that numbers are “objects” that it was solved in my opinion. As mentioned above, now there are actually three possibilities for this proposition, it can be a synthetically discovered truth from our intuition collectively agree upon (Henri Poincare later wrote a series of books proposing this view).

It could be a tautology (derived only from making formal substitions in the variables in the propositional formula). Or, it could be a logical truth which existed by itself for some reason more than a tautology. In order to have "logical truths" be something more than tautologies we have to start out with objects to subsitute in the formulas that are "real in some sense" and whose existence tells us something more than a tautology does. This is how the mathematical area of "set theory" came to be. Frege was the first to found it using both the logical formulas and syllogisms of Aristotle (see my talk last year on the history of "logic machines") and the philosophical arguments of Kant for its methodological thinking.

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- Frege in his book "Foundations of Arithmetic" ask the question, "How do we define the number one."? Up to this time nobody thought this was necessary. But, if we assume it is an object of thought (not just a concept or a meaning of concept) then it must be possible to have it be an element in a set. What can this element be? For Frege this element was the most fundamental element one could have in a set as an object, other than the element "zero". He had taken the object "zero" to be represented by the set which had no elements. So the next most fundamental element must be this set itself which has as its only element an "empty set".

- It wasn't until later in the 20th century that Dr. John Von Neumann proposed a different way to define the number one, here is a good short explanation from a recent discussion I had on the History and Philosophy of Science division on the Linkedin website of the difference between these two defintions:
- 1) Anatoly Tchoussov • to Harrell: may be I've said not very clear;
  I've meant that:
  Yours expression is not correct, because numbers are defined as classes of equivalencies and not as a sum of sets;

  2) such definition has an intrinsic difficulties, i.e. two non-equal models:
  in former note I will use Z as a symbol of an empty set, and figure brackets {} as symbols of a set;

  there are (at least) two ways to introduce numbers:

  A): {Z}, {{Z}}, {{{Z}}}, {{{{Z}}}}, ...

  B): {Z}; {Z, {Z}}; {Z, {Z}, {Z, {Z}}}; {Z, {Z}, {Z, {Z}}, {Z, {Z}, {Z, {Z}}}}; ...

  in a case A "3" doesn't belong to "5", but in a case B "3" belongs to "5";

- The beating heart of modern day computers is one and zero. As mentioned above Leibnitz and Boole made important conceptual discoveries that helped us do this. Colossus, one of the first computers developed in Britian, the mathematics of one and zero may have helped shorten World War II by as much as two years. So, to conclude, today, Roman numerals have been consigned to the dust bin of history. Pythagoras' idea of one and zero are all we need to create the modern computations that have transformed our world into a new information age and pushed humankind forward up to the edge of discovering how we ourselves are made (by God) genetically out of a coded string of amino acids.

• THE QUESTION'S RELATION TO THE MATHEMATICS OF SET THEORY

- The mathematical area of research called set theory was created in order to understand what "a real number" in Calculus means. This interest developed because in the previous decades techniques were developed in order to solve practical problems in mathematical analysis which made use of what Cauchy and Gauss (and earlier Euler) had called "complex" or "imaginary" numbers. Euler used an algebra of calculation in his trigonometric formulas (which had applications of mapping and geodesy) which made use of the imaginary number "i". Cauchy further developed these algebraic techniques and also showed how it was possible to integrate functions involving complex numbers. Gauss developed the beginnings of the concept of a "manifold" which would later revolutionize thinking in electrodynamics and Einsteinian physics. So the questions then became, "What is this 'real number' which determines how we calibrate or measure the space we are analyzing?" "What is a real function?" "What is a complex function?"

- Of course, for centuries and millennium philosophers had speculated about various theories of reality and metaphysics. But, in order to answer this question in an scientific and analytic sense people began thinking about what particular logical mathematical foundations that we had up to now assumed as given in the background of our axiomatic system determine its solution. Various theories of generalized algebraic numbers were created and Leopold Kronecker made his famous statement, “God created the integers and all else is the work of man.”. But, how did God create the integers? People noticed that the positive integers formed what was called in set theory a “sequence” and that one of the main ways things were proved in mathematic problems involving sequences of integers was something called the “inductive principle”. If a statement or proposition about integers was true for the next integer, after a given integer (no matter what that integer was) and it was true for the first integer, then it had to be true for all integers. The self-evident truth of this fundamental principle of mathematical proof of course depends on the fact (which is not true for all sets of objects) that there is a least positive integer, “One”. So, how do we define the “number One” using modern propositional logic?
- Here are some more selections from the recent dialogue I had on the Linkedin website where some of the complexities of this question came out.

- Steve Faulkner • The number one is the mathematical object that leaves any number unchanged, under multiplication.
- Andrew Harrell • Steve,
  Yes, it is that, But, does that property define it uniquely? There is an object that belongs to the set of rationals and has this property. There is an object that belongs to the set of real numbers and has this property. There is an object that belongs to the set of integers and has this property. There are also three more objects that have the property of leaving any number unchanged under addition. Each of these objects have to be defined differently because because those different sets and different operations are defined differently. The question is how do we define one object that does all of this and is unique?
- Andrew Harrell • @Steve,
  A question you did not ask, but is pertinent is, 'If we define the Number One as the "set of all sets which have the set of no element in them", then how can it be a mathematical object, an "operator" which leaves any number invariant when multiplied by it? The answer I believe is because we have things called "Functors" from the category of sets to the category of arithmetical operators. Functors were introduced in mathematics alot in the 1950s and 1960s in algebraic topology and algebraic geometry to computer mathematical characteristics of manifolds. However, I don't believe they were used in computer science much until recently with the Haskell computer language which has things called "Monads". ?

- A SHORT MATHEMATICAL ANSWER TO THE QUESTION
- **Here is the most generally accepted mathematic answer, figured out by the mathematician/philosophers Frege, Betrand Russell, and Peano at the turn of the beginning of the last century. In short… The number One is "the cardinality (similarity class of one-one functions) of the set whose only member is the empty set." This definition hides a huge logical complexity of definition. What is a similarity class? What is a one-one function (what is a mapping or function for that matter?). What is a set? What is an empty set (basically this is determined logically when you know what an element in a set is and what a set is)?**

- So what are the philosophical implications of this definitions? First of all in order to understand what the concept of Oneness is we have to understand what logic is. There must be an intellectual component (ie not only intuition to our theory of knowledge). And, we must understand what reality and the reality of an object is or means (for it to be an element in a set) in terms of the aforementioned intellectual component of our theory of knowledge. Then, if we understand this we must still also understand what functional computation (which allows us to create one-one mappings) is. This, in turn, allows us to understand what mathematical and scientific/theological Oneness is. We must understand this in order to understand what these two things are and the important fundamental question to our ethical and philosophical theories of well-being and truth.

- FURTHER POINTS ABOUT ITS THEOLOGICAL AND METAPHYSICAL IMPORTANCE

- But, what about its theological importance? Is it in fact the case as Dr. Kronecker has said, "God created the integers (and the science of nature that depends on using them to count and measure) and all else is the work of man." If an understanding of Oneness in terms of natural science is all that we want, then the definition of One from the above paragraph in set theoretical logical terms: "The number One is the cardinality (similarity class of one-one functions) of the set whose only member is the empty set." Solves the problem. With an understanding of this definition we have understood how God created the idea of "Oneness" inside of his created Universe. But, the Bible says that God did more than just create the World. It says that he created Man (and also Woman) in His own image and likeness. How does this relate to the above proposed set theoretical/logical definition of what "the number One" is? In the time between the beginning of the last century and our new millenium Mathematicians and logicians have shown, except for some notable gaps, how "real numbers (rational, algebraic, transcendental)", and likewise various other "complex and ideal numbers" can all be constructed logically from the positive integers. The possibility of the "notable gaps" come from the proof of the independence of the continuum hypothesis.