

Programming Bits and Getting Its

My first thoughts when looking over the questions for the FQXi essay contest were:

Question 1. What IS information?

Well, you got.... um, it's like... OK. Next question.

Question 2. What is its relation to “Reality”?

Whew. I was afraid this was going to be impossible.

But, if we can start with “Reality” it's actually an easily approachable topic. (To make “Reality” less scary let's get rid of the quotes and the uppercase R.)

Some people have gotten the idea into their minds that reality is kind of like soup. You've got a big pot filled with broth and vegetables and meat and spices and it's all stirred and mixed up together. That's reality, a big pot of soup.

The funny thing about that notion is that there's a long list of folks throughout the history of humanity that have written about the ultimate nature of reality, and none have advocated the view that reality is a monolithic pot of soup. That list includes Newton and Einstein.

Newton wrote in the Definitions of the Principia that in order for space and time to be understood they should be split into absolute and relative.^[1] “Relative time”, he writes “is a measurement of duration by the means of motion.” Einstein evolved our understanding of relative time and relative space in physics. He argued, according to Heisenberg, absolute time isn't in the mathematics and isn't observed, but it's still “in the theory”^[2].

Understanding what he means is to understand reality as it has been understood by that long list of history's “perennial philosophers”, and (this essay argues) as it will be understood by future generations of physicists.

So what does he mean?

Relative time exists in a relative sense. Absolute time exists in an absolute sense. Relative and absolute don't exist the same way.

They are not like ingredients mixed into a pot of soup.

Which is important to keep in mind when asking questions like “it from bit, or bit from it?”

It might sound trivial, but the greatest insight wrapped up in the phrase “it from bit” is not that we have “it”, and not that we have “bit”, but that we have “**from**”.

“**From**” means “it” and “bit” are different. Fundamentally different. They exist in a different sense at different levels of reality.

Reality isn't a single set of ingredients mixed together like soup. It's more like lasagna. (Or a cake. Or bean dip. Or... I'm going to lay off the food analogies or I'll never finish this essay.)

“It from bit”'s most significant meaning is the transition between one type of existing to a profoundly different type of existing. Whether one says “it from bit” or “bit from it” or “it from dit” or “dis from dat”, it's the transition that matters.

So let's examine that. What is that?

It's **measurement**.

Ok, big scary topic, let's back up.

Let's start with some bits.

Listing 1.

```
// make an array called bits
var bits = [];

//put 10K bits in the array
for (var i = 0; i < 10000; i++) {
    bits[i] = { x: Math.random(),
               y: Math.random(),
               z: Math.random(),
               charge: Math.random() > 0.5
             };
}
```

A little JavaScript. Nothing to be afraid of.

It creates an array of ten thousand bits, with random values in the x, y, and z properties.

Now. How would we go about getting some “its” in there?

One thing we **can't** do is add a new array named “its”, like this:

```
// new “its” array
var its = [];
var bits = [];

for (var i = 0; i < 10000; i++) {
    bits[i] = { ... }; // truncated

    //Now make a duplicate “it”
    its[i] = {x:bits[i].x, y:bits[i].y,
             z:bits[i].z, charge:bits[i].charge};

    //Or make “it” something different
    its[i + 10000] = [1, false, Math.random()];
}
```

This program might have variables called “its” and “bits” but it does not represent “it **from** bit”

because even if `its` has a different value than `bits`, they exist the same way, as variables in the program. In this case they would be just like ingredients in a pot of soup, both variables existing the same way; they are both of a common set of **information**.

Basically, starting with variables in a computer program, our goal is to get something *fundamentally different* than a variable in a computer program.

The way to do that is **measurement**.

Now, you may be thinking, 'I can measure the distance between two bits like this':

```
var d = Math.sqrt(Math.pow(bit[50].x - bit[51].x, 2) +  
                  Math.pow(bit[50].y - bit[51].y, 2) +  
                  Math.pow(bit[50].z - bit[51].z, 2));
```

And you also may be thinking, 'measurement `d` is just a variable in the program, and therefore it isn't fundamentally different than `bits` either.'

You would be 100% correct.

Let's back up again.

How do we measure? For example, how would you and I measure the distance between two trees?

I would get a measuring tape. Sounds simple, right? But there are a few details we take for granted. Such as there being light. If it was night and you had no lights and the clouds and trees blocked out the moon and stars so it was completely dark out, this measuring tape idea wouldn't work.

For it to work, you'd put a measuring tape between the trees, and with enough light to see the measuring tape, that light bounces off the measuring tape into your eyes and to your brain which reads the number where the tree is, and you determine the distance is "*16 feet, 3 inches*".

So at a minimum we need measuring tape, and we need light, and we need eyeballs, and we need a brain with some knowledge of how to read measuring tape.

That's how we measure in reality.

How did we measure in our model?

```
var d = Math.sqrt(Math.pow(bit[50].x - bit[51].x, 2) +  
                  Math.pow(bit[50].y - bit[51].y, 2) +  
                  Math.pow(bit[50].z - bit[51].z, 2));
```

It's a very different process. Can the gap be bridged?

Yes.

There is measuring tape in the real measurement and not in the model measurement. So let's put measuring tape into the model measurement.

How is that done?

Well, what is a measuring tape made of?

Could be metal or fabric, both are made of molecules, which are made of atoms, which are made of charged particles.

In other words, to put measuring tape into the model, can we arrange the bits into atoms, and the atoms into molecules that form a virtual measuring tape.

I propose that:

Given that trees, measuring tape, light, eyeballs, and brains are all made of interacting electrons, protons, neutrons, and photons...

Given that we can make computer models of interacting electrons, protons, neutrons, and photons...

In the future we will make a computer model of trees, measuring tape, light, eyeballs, and brains using only elementary particles, so we will...

Therefore make a model of **measurement** as a physical process.

One of the reasons this has never been done before is the sheer number of particles involved. In **listing 1**, the `bits` array contains ten thousand charged particles. In order to model eyeballs and a brain, we're going to need a lot more `bits` than that.

So, unless you have a cutting edge Big Data supercomputer handy, let's do a thought experiment.

Imagine `bits` is now an array much larger than 10,000. Let's say billions of billions.

And imagine those bits are interacting such that they act like charged particles, forming atoms, molecules, and ultimately, measuring tape and eyeballs and brains.

Now imagine that in the model light bounces off the measuring tape into the eyeballs to the brain, and the brain determines "*16 feet, 3 inches*".

In what variable is "*16 feet, 3 inches*" stored?

It isn't stored in a variable. That measurement is brain activity. It exists in the model, but not in one of the variables the computer is reading and writing to.

The measurement exists in the complex relational data encoded in the brain.

The measurement has transcended the variables of the program. It is fundamentally different. It belongs to a different set of **information**.

Bit has become something else. Bit has become It.

Bits and its now exist differently in the model. They are two different sets of information. They are both real but in different ways.

The computer program deals with the information it assigns to and accesses from variables.

If those variables happen to form eyeballs and a brain that makes measurements (in other words, an observer), then what is real to the modeled observer is the result of its measurements.

Measurement is the “**from**” in “it from bit”.

Let's modify our thought experiment.

If we're on the same page, we should have a hypothetical computer model of bits that look a lot like charged particles, atoms, molecules, trees, measuring tape, eyeballs, and a brain.

Let's replace the trees with single electrons.

And let's direct our observer (the eyeballs and brain) to measure the position of a single electron.

Oh, while we're at it, let's direct the modeled observer to measure the particle's momentum at the same time.

What do you think will happen?

Conclusion

Reality isn't soup. There is a “hierarchy of the real”^[3], where most of what we deal with is of a **relative reality**, of a relative truth, sprouting from an **absolute reality** that is fundamental to it.

Likewise, our future theories and models of quantum mechanics will be layered sets of information: the **absolute information** of the algorithm and its data, and the **relative information** emerging from internal measurements.

That latter information, the measurements the internal observer made of its world, are the model's predictions that we should compare with the measurements we make of our world.

That's never been done before, though in the world of Big Data, it is simply a matter of resources.

In the meantime it serves as an interpretation of quantum mechanics that is different from the rest and truly represents “it from bit”.

References

[1] Newton, Isaac Philosophiae Naturalis Principia Mathematica Second printing, University of California Press, 1946. p. 6

[2] Heisenberg, Werner Physics and Beyond, Harper & Row, 1971. p. 63

[3] Huxley, Aldous The Perennial Philosophy Harper Colophon ed. Harper & Row, 1970. p. 33