Is the universe a simulation?

The question has been changed since I wrote this answer (in 2010), making the question much narrower!

This answer is to the original question:

Is the Universe a Simulation?

I will first explain the difference in scope of these questions. Simulation is the general situation whereby information processes result in virtual systems that experience virtual worlds. The information processes do not need to be associated with a physical 'computer', i.e. there does not need to be any physical substrate underlying and implementing those information processes, (as is implied by the reference to the movie The Matrix). It is naïve realism that causes us to assume that there must be an underlying physical substrate. See What is naive realism?

However that assumption is known to lead to numerous paradoxes and explanatory gaps that can be overcome by overcoming that assumption. For example, see:

- Can it ever be said that Scientific realism takes off from the springboard of commonsense or naive realism?
- Has science become too dogmatic?
- Is light a wave or a particle?
- Will we ever be able to truly understand Quantum Mechanics?

Of particular note, quantum information processes enable observers to experience observables, which portray a classical universe. This is an example of a simulation process that operates at the level of the quantum field, prior to space, time, and all seemingly physical systems. There is no need for an underlying physical computer to implement the quantum field, instead the quantum field underlies all apparent physicality.

Thus, most of the information in the answer below is not about the narrow context of "computer simulation" like in "The Matrix", although some of it could be applied to that. Instead it is about a deep metaphysical enquiry into the information theoretic foundations of what seems to be a physical universe but may in fact be virtual.

For a detailed explanation of this broader context see The Objective Information Process & Virtual Subjective Experiences Hypothesis

Now for the original answer:

I will not attempt to answer this question here, but merely provide some links to instances where the idea has been discussed. This idea is becoming increasingly popular within the scientific debate because it provides an explanatory framework that allows us to comprehend quantum phenomena that were previously incomprehensible...

Whilst it is impossible to comprehend the quantum mechanical description of the universe in terms of 'physical' phenomena, at the same time we are finding that thinking in terms of information processes allows us to understand quantum phenomena, not as something bizarre and paradoxical, but as the natural & necessary properties of a simulated virtual reality.

Simulated reality – Wikipedia http://bit.ly/cecMCS
Simulated reality is the proposition that reality could be simulated—often computer simulated—to a degree indistinguishable from "true" reality. It could contain conscious minds which may or may not know that they are living inside a simulation. In its strongest form, the "simulation hypothesis" claims it is probable that we are actually living in such a simulation.
This is different from the current, technologically achievable concept of virtual reality. Virtual reality is easily distinguished from the experience of "true" reality; participants are never in doubt about the nature of what they experience. Simulated reality, by contrast, would be hard or impossible to distinguish from "true" reality.
The idea of a simulated reality raises several questions:

- Is it possible, even in principle, to tell whether we are in a simulated reality?
- Is there any difference between a simulated reality and a "real" one?
- How should we behave if we knew that we were living in a simulated reality?

Digital Physics – Wikipedia http://bit.ly/cX4wQJ
In physics and cosmology, digital physics is a collection of theoretical perspectives based on the premise that the universe is, at heart, describable by information, and is therefore computable. Therefore , the universe can be conceived as either the output of a computer program or as a vast, digital computation device (or, at least, mathematically isomorphic to such a device).
Digital physics is grounded in one or more of the following hypotheses, listed in order of increasing boldness. The universe, or reality, is:

- Essentially informational (although not every informational ontology need be digital);
- Essentially digital;
- Itself a colossal computer;
- The output of a simulated reality exercise.

Ross Rhodes http://bit.ly/akhqh6
Quotes from "A Cybernetic Interpretation of Quantum Mechanics", which explores the parallels between quantum mechanics and the properties of a virtual reality.
"Many of the phenomena observed in the laboratory are puzzling because they are difficult to conceptualize as physical phenomena, yet they can be modeled exactly by mathematical manipulations. When we analogize to the operations of a digital computer, these same phenomena can be understood as logical and, in some cases, necessary features of computer programming designed to produce a virtual reality simulation" (Ross Rhodes)

Edwin Fredkin http://bit.ly/arxLrg

Finite Nature Hypothesis of Edwin Fredkin, which proposes that reality is finite and discrete in all ways and that there exists an iterative cellular automata computational process that underlies, manifests and 'computes' the phenomenon of existence.

Cognitive Theoretic Model of the Universe CTMU http://bit.ly/aTEvNp
The Cognitive Theoretic Model of the Universe proposes that the universe is an 'utterance' within an abstract virtual-reality generative grammar.

Process Physics http://bit.ly/dwnvQW
proposes that reality is a self-referential information process producing fractal topological defects that form space and time.

Digital Philosophy http://bit.ly/9RDKx4
Digital Philosophy (DP) is a new way of thinking about the fundamental workings of processes in nature. DP is an atomic theory carried to a logical extreme where all quantities in nature are finite and discrete. Further, DP implies that nature harbors no infinities, infinitesimals, continuities, or locally determined random variables. At the most fundamental levels of physics, DP implies a totally discrete process called Digital Mechanics. Digital Mechanics (DM) must be a substrate for Quantum Mechanics.

Zuse's Thesis: The Universe is a Computer http://bit.ly/cNc5An
Konrad Zuse (1910-1995; pronounce: "Conrud Tsoosay") not only built the first programmable computers (1935-1941) and devised the first higher-level programming language (1945), but also was the first to suggest (in 1967) that the entire universe is being computed on a computer, possibly a cellular automaton (CA). He referred to this as "Rechnender Raum" or Computing Space or Computing Cosmos. Many years later similar ideas were also published / popularized / extended by Edward Fredkin (1980s), Jürgen Schmidhuber (1990s - see overview), and more recently Stephen Wolfram (2002) (see comments and Edwin Clark's review page)

Jürgen Schmidhuber's Computable Universes & Algorithmic Theory of Everything http://bit.ly/bgDcvZ
Various articles exploring the issue: Is our universe just the output of a deterministic computer program?

System Science of Virtual Reality: Toward the Unification of Empirical and Subjective Science http://bit.ly/9XhElB
A book that describes the core mathematical and conceptual principles of information system theory, virtual reality and a re-derivation of quantum mechanics. Also discusses naïve realism and the hard problem of consciousness.

Stephen Wolfram: A New Kind of Science http://bit.ly/9feS4u (read online)
This long-awaited work from one of the world's most respected scientists presents a series of dramatic discoveries never before made public. Starting from a collection of simple computer experiments--illustrated in the book by striking computer graphics--Stephen Wolfram shows how their unexpected results force a whole new way of looking at the operation of our universe. Wolfram uses his approach to tackle a remarkable array of fundamental problems in science, from the origins of apparent randomness in physical systems, to the development of complexity in biology, the ultimate scope and limitations of mathematics, the possibility of a truly fundamental theory of physics, the interplay between free will and determinism, and the character of intelligence in the universe.
In this book he advances the hypothesis that the universe and everything is being computed by a simple program.

A review of "A New Kind of Science" http://bit.ly/ayPmdi
Wolfram claims in his book that the universe and everything is being computed by a simple program. This review illustrates that this idea is certainly not new to science, and it gives links to the prior work of Zuse.

God Is the Machine – Article on Wired http://bit.ly/9KIRIj
In the beginning there was 0 and then there was 1. A mind-bending meditation on the transcendent power of digital computation.

John Wheeler "It from bit" google search http://bit.ly/aEjjxL

Anton Zeilinger – Quantum Centenial http://bit.ly/aMuYmd
"we are gaining new insight into quantum mechanics itself by viewing it as an advanced theory of information."

Many quotes from scientific sources related to this issue http://bit.ly/bi9sc5

- "Quantum theory is a method of representing quantumstuff mathematically: a model of the world executed in symbols." (N. Herbert)
- "In contrast to the mechanistic Cartesian view of the world, the world-view emerging from modern physics can be characterized by words like organic, holistic, and ecological. It might also be called a systems view, in the sense of general systems theory. The universe is no longer seen as a machine, made up of a multitude of objects, but has to be pictured as one indivisible dynamic whole whose parts are essentially interrelated and can be understood only as patterns of a cosmic process." (Fritjof Capra)
- "The process metaphysics elaborated in Process and Reality (Whitehead) proposes that the fundamental elements of the universe are occasions of experience. According to this notion, what people commonly think of as concrete objects are actually successions of occasions of experience. Occasions of experience can be collected into groupings; something complex such as a human being is thus a grouping of many smaller occasions of experience. According to Whitehead, everything in the universe is characterized by experience (which is not to be confused with consciousness); there is no mind-body duality under this system, because "mind" is simply seen as a very developed kind of experiencing." (Process Philosophy)

Epistemological Problems of Perception (Stanford Encyclopedia of Philosophy)
http://bit.ly/aZcY7T
The historically most central epistemological issue concerning perception, to which this article will be almost entirely devoted, is whether and how beliefs about physical objects and about the physical world generally can be justified or warranted on the basis of sensory or perceptual experience — where it is internalist justification, roughly having a reason to think that the belief in question is true, that is mainly in question. This issue, commonly referred to as "the problem of the external world," divides into two closely related sub-issues, which correspond to the first two main sections below. The first of these issues has to do with the nature of sensory experience and its relation to the physical world; it is typically formulated as the question of what are the immediate objects of awareness in sensory experience or, in a variant but essentially equivalent terminology, of what is given in such experience. The second issue has to do with the way in which beliefs about the physical world are justified on the basis of such sensory experience.

The Scientific Case Against Materialism http://bit.ly/9uDhXt
A story told through quotes, comments and links related to commonsense (naive) realism,

epistemology, materialism, information theoretic metaphysics, consciousness, empirical science, mysticism, holistic science and also system theory. There's some fascinating links to profound experiments into the nature of consciousness if you don't already know about them... (The PEAR REG/GCP experiments)

Metaphysics of Virtual Reality http://bit.ly/9Z12Ch
If a computer creates a virtual reality within which artificially intelligent beings contemplate their situation, how would such a world seem to them? What metaphysical concepts would they arive at? What would it be like to be an AI being in a virtual world? I propose this hypothetical situation as an adjunct to direct metaphysical discussion regarding our reality. It provides a neatly defined context for analysis that has some interesting parallels with our own context.

Computational Paradigm http://bit.ly/9Ktr5d
Computation is a fundamental principle, it is not simply a high level phenomenon that electronic computers engage in. Because information is *discernible* difference and the difference relies upon discernment to become information, the act of perception is inherently implied within the very concept of information. From out of a field of variation a perceptual system recognises certain variations, which become information that *informs* the system and the remainder becomes entropy, which still effects the system although in subtler ways such as noise or heat. Information is one of the most abstract and general *substances* that there is; but the concept of information is meaningless without the concept of perception (i.e. the receipt, interpretation, experience and assimilation of information). Perception is an inherently computational process so computation is itself fundamental.

Cartesian Dualism and an Information Theoretic Metaphysics http://bit.ly/b6ZiWi
Cartesian dualism has been much abused as a concept but it does contain some truth, that systems have a distinct inner and outer aspect. The misuse arises because we only ever experience ourselves from within and external objects from without, hence our limited experience led people to postulate that they were "alive and conscious" whereas external objects were "inanimate". Materialism or Cartesian dualism proposes that the inner and outer aspects are separated, but this is true only from a perspective embedded within the simulation. ALL manifest systems have both inner and outer aspects, there are no purely inner or conscious entities and no purely outer or inanimate entities, all have both aspects.

Contexts of Understanding http://bit.ly/dyIUrk
In relation to any 'reality' there are always two apparent contexts. A few examples are that one cannot have a story without a book being read, or a movie without a movie reel in a projector, or a virtual reality without a computational process. In each of these examples the first is an empirical context (objects, places and events) and the second is a transcendent context (that which creates and sustains the empirical context).

Mathematical Analysis http://bit.ly/dvGAE7
Mathematical analyses of various aspects of general systems, general information processes, virtual reality simulation and virtual universes.

There are many other instances, however these links provide a starting point from which to explore further.

Whilst the metaphor of "simulation by computers" is very modern, the underlying ideas have been proposed for many thousands of years using various metaphors. This has not gone unnoticed by some scientists...

"The concepts of science show strong similarities to the concepts of the mystics... The philosophy of mystical traditions, the perennial philosophy, is the most consistent philosophical background to modern science." (Fritjof Capra)

The underlying idea is that there exists non-physical processes that permeate the physical realm and that have not only a causative role, but also a formative and animating role. Thus the innermost animating essence within ourselves (pure awareness) is the cosmic process that animates all things.

For example, in Vedanta the metaphor of a snake and a rope has been used. The point of this metaphor is that the rope only seems to become a snake due to our interpretations, it doesn't actually turn into a snake. Thus the snake is a virtual phenomenon. They further claim that the universe is likewise a virtual phenomenon.

Quotes from Ancient sources related to this issue http://bit.ly/cRfBHP

- "To Sankara the world is only relatively real (Vyavaharika Satta). He advocated Vivarta-Vada [virtuality] or the theory of appearance or superimposition (Adhyasa). Just as snake is superimposed on the rope in twilight [when one mistakes a rope for a snake], this world and body are superimposed on Brahman or the Supreme Self [computational process]... In Vivarta-Vada, the cause produces the effect without undergoing any change in itself. Snake is only an appearance on the rope. The rope has not transformed itself into a snake, like milk into curd. Brahman is immutable and eternal. Therefore, It cannot change Itself into the world. Brahman becomes the cause of the world through Maya, which is Its inscrutable mysterious power [virtual reality simulation]..." (Sankaracharya)
- "Wisdom is eternal, for it precedes every beginning and all created reality... [It is] everywhere... in every tastable thing... burning in all things... the animating power of things... [Wisdom] tastes us. And there is nothing more delicious to comprehend." (Nicholas of Cusa)
- "I have often said God is creating this entire world full and entire in this present now... There where time never penetrates, where no image shines in, in the innermost and highest aspect of the soul God creates the entire cosmos." (Meister Eckhart)
- "He who sees the Supreme Lord [transcendent process], who is present equally in all creatures, who is not destroyed even when they are, he may be said to have truly perceived. Perceiving the Lord as equally pervading everywhere, he does not let his self-sense [egoic delusion] destroy his true Self [awareness of ones transcendent nature] and, in that way, he attains a state of excellence [true understanding and alignment with reality]. He who perceives that all aspects of actions are performed only through prakriti and also that the self is a non-doer [universal consciousness is the only doer], he may be said to have truly perceived. On perceiving that the multifarious aspect of things is located in one point [the transcendent process], from where it extends severally, he attains the Brahman [union with reality].
  Without beginning, devoid of qualities, the Supreme Self, imperishable, though stationed in the body, neither acts nor is touched in any way... Just as ether, pervading everything, is unsmeared on account of its rarefied nature, in the same way the Self, present in everybody, is not besmirched.
  Just as the Sun, alone, lights up this entire world, so also does the Keeper of the field light up this entire field... those who in this way, through the eye of wisdom, perceive the difference between the field and the one who knows it, and the manner of release of all beings from prakriti [overcoming the world illusion through detachment, transcendent knowledge and unconditioned awareness], they obtain the Supreme." (Bhagavad Gita, chpt 13)

- "The real does not die, the unreal never lived. Once you know that death happens to the body and not to you, you just watch your body falling off like a discarded garment. The real you is timeless and beyond birth and death." (Sri Nisargadatta Maharaj)
- "What is it that had birth? Whom do you call a human being? If, instead of seeking explanations for birth, death and after-death, the question is raised as to who and how you are now, these questions will not arise... The realised one enjoys unbroken consciousness, never broken by birth or death - how can he die?.. There is no incarnation, either now, before or hereafter." (Sri Ramana Maharshi)
- "That which is the subtle essence, in it is the self of all that exists. It is the True. It is the Self, and thou... art it." (Chandogya Upanishad 4:10:1-3)

Correspondences with other Metaphysical Paradigms http://bit.ly/cxZZGn
Quotes showing correspondence between the computational metaphysical paradigm and several ancient metaphysical paradigms.

A Survey of the Transcendent Perspective in Ancient Traditions http://bit.ly/aPRm48
Quotes illustrating metaphors for the transcendent computational process underlying the manifest universe.

Consciousness, Self, World, Virtual Reality and Liberation http://bit.ly/a6QN3g

Also see **What is consciousness?**, which provides further background required in order to understand how it is that the universe may be virtual, yet still seem physical.

All of this shows that there is a long history to these ideas, that there are a growing number who are seriously contemplating them and that the implications are subtle, deep and profound.

This simple idea may also provide a cognitive structure with which to integrate knowledge derived from both quantum mechanics and mystic insight, thus potentially bringing an end to thousands of years of cognitive repression.

The following quote from the article "Cognitive repression in contemporary physics" by Evelyn Fox Keller (1979) http://dx.doi.org/10.1119/1.11911 addresses the issue of quantum mechanics within science, but it also applies equally to mysticism in general society.

"Piaget has invited the comparison between the historical development of scientific thought and the cognitive development of the child. Both, it is suggested, proceed through the emergence of discrete stages of structural organization, each stage brings with it new possibilities of conceptual integration, and concurrently, the possibility of a verbal articulation of the new level of organization perceived. Prior to the establishment of a new conceptual structure, knowledge already present in nonverbal forms (in e.g., sensorimotor rather than representation schemes) finds no avenue of expression, and, to the extent that it jars with the earlier established structures, demands cognitive repression. Piaget [1] tells us that an action schema which "cannot be integrated into the system of conscious concepts is eliminated... (and) repressed from conscious territory before it has penetrated there in any conceptualized form." Caught in a transition between stages, the child, when pressed to articulate perceptions requiring cognitive structures which are not yet available, displays confusion, denial and avoidance - a disequilibrium strikingly reminiscent of the mechanism of affective repression."

With the end of this irrational (but understandable) repression of the issue, now society may be able to rationally explore this issue and even develop a mathematical science that explains it in detail. For example, see **System Science of Virtual Reality: Toward the Unification of Empirical and**

Subjective Science http://bit.ly/9XhElB

Finally, regarding "Is the universe a simulation in someone's computer?" I would answer "No!".
There is no need to hypothesise the existence of some physical computer underlying the cosmic
computational processes. Information and computation are fundamental and give rise to all other
phenomena; space, time, energy, force, particles, planets, people, etc. All of this is computational
and virtual, thus there need not be a single speck of matter involved at any stage.

"When you come to the ultimate particles constituting matter, there seems to be no point in thinking
of them again as consisting of some material. They are as it were, pure shape, nothing but shape;
what turns up again and again in successive observations is this shape, not an individual speck of
material." (Erwin Schrödinger)