Discussion 1:

What new areas of mathematics have been spawned by computer experimentation?

One new area of mathematics which I am intimately familiar with through my background in mechanical engineering that has been greatly aided by computer experimentation is the area of finite element analysis. Basic mechanics equations have been developed for simple objects like beams, blocks, etc. However, for predicting the behavior of more complex shapes like airplanes, cars, etc. would require integrations that are more complex than can generally be handled. Finite element analysis is a mathematical model used to predict the behavior of objects with complex shapes by chopping the complex shape into many smaller, simple blocks. Since equations for computing the behavior of each block is relatively simple, the behavior of the complex shape will mirror the behavior of the many smaller blocks that make a representative model. In my work we regularly use models which have hundreds of thousands of blocks to make a predictive model for a single part. Before computers, such a complex system of equations would not have been feasible to solve, however due to the computing speed of computers it is now relatively routine.

Why bother using neural networks when one can develop and use computer algorithms to solve problems?

This is an interesting question considering that neural networks in general are a computer algorithm which can be used to solve a problem. The reason that neural networks are so broadly appealing is that they are flexible enough to learn arbitrary systems (meaning that they can be applied to a wide variety of problems). Neural network also do not require much supervision to learn, thus non-experts can use the networks as “black boxes” to learn the problem that they are trying to solve. While they have some limitations, such as the amount of data and time it takes to train them, the benefits often outweigh the costs, thus they have found a wide variety of applications in industry.