family of transcendental functions include the exponential, sine and cosine functions. The exponential function, represented by e to some power x, is familiar to anyone who has dealt with compounded growth, whether in populations or in accumulated interest in a savings account at a bank. The technique for studying the behavior of these functions is equivalent to entering a number into the display of a scientific calculator, locating the appropriate key, then repeatedly pressing that button, all the time observing what happens to the successive numbers displayed.

The most interesting results are seen when the investigator deals with complex numbers rather than with the ordinary real numbers that a calculator uses. Complex numbers make it possible to wander across a broad plane rather than along a narrow road. Each iteration represents a step along a path that hops from one complex number, z, to the next. The collection of all such points along a path constitutes an orbit. The basic goal is to understand the ultimate fate of all orbits for a given system.

Depending on the value of z chosen as a starting point, the orbit may behave in one of several different ways. It may rapidly converge to a single point and stay there; in other words, the same number comes up again and again. Alternatively, it may always return to a certain value after a fixed number of iterations. Or the numbers may get steadily larger.

In fact, the starting points of orbits can be color-coded to indicate how quickly the points escape along their orbits to infinity. In contrast, points that tend to stay close to their starting values are usually shown in black. The colored area for the iteration of a particular mathematical expression is known as a Julia set. These sets often look spectacular.

Pickover's contribution to the study of the dynamical behavior of transcendental functions was examination of the behavior of the hyberbolic cosine (cosh) function in the complex plane. His graphics experiments, he says, "are good ways to show the complexity of the transition region between convergence and divergence."

"The process of iteration," says Pickover, "can be likened to pulling layers from a fruit whose center contains a hard kernel." That kernel is what's left after an infinite number of iterations and has an extremely convoluted and complex boundary. As pictured on a computer screen, points that fall within black regions (that is, within the kernel) have different fates upon iteration than those on the outside.

Says Pickover, "Computers with graphics have played a critical role in the study of iterated sets and in helping mathematicians form the intuitions needed to prove new theorems about convergence of points in the complex plane." □

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