Indeterminate Limits Encyclopedia Article

Indeterminate Limits

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Indeterminate Limits

Indeterminate **limits** are mathematical expressions that cannot be assigned a unique value. Although these expressions have no meaning per se, they frequently arise in limit problems in **calculus**. For example, to compute the derivative (**slope**) of the **sine** curve at any point on the curve, one needs to evaluate the limit of sin(*x*)/*x* as *x* approaches 0. Simple substitution of *x* = 0 into this expression does not produce a satisfactory result: It gives the indeterminate limit 0/0. But a more careful approach, using the "sandwich principle" of calculus, shows that the correct value of the limit is actually 1.

Generally speaking, a limit of a quotient of two **functions**, *f*(*x*)/ *g*(*x*), is said to be indeterminate of the form 0/0 if both *f*(*x*) and *g*(*x*) approach 0. The actual limit of *f*(*x*)/ *g*(*x*) in such a case depends on more detailed information about these two functions - intuitively, which one approaches 0 "faster." A powerful tool for evaluating such limits is L'Hospital's Rule, which provides the needed information by comparing the derivatives of *f*(*x*) and *g*(*x*).

Besides 0/0, the other commonly occurring indeterminate limits are (infinity)/(infinity), (**infinity**) - (infinity), $1^{(\text{infinity})}$, $(\text{infinity})^0$, and 0^0. L'Hospital's Rule applies directly to the first of these; the other four generally need to be transformed algebraically before l'Hospital's Rule can be applied.