THIS EXAMPLE HAS BEEN ADOPTED FROM: Discrete mathematics and its applications" by Kenneth H. Rosen, pg 597, 598:

A computer network has data centers in Boston, Chicago, Denver, Detroit, New York, and San Diego. There are direct, one-way telephone lines from Boston to Chicago, from Boston to Detroit, from Chicago to Detroit, from Detroit to Denver, and from New York to San Diego. Let R be the relation containing (a, b) if there is a telephone line from the data center in a to that in b. How can we determine if there is some (possibly indirect) link composed of one or more telephone lines from one center to another? Because not all links are direct, such as the link from Boston to Denver that goes through Detroit, R cannot be used directly to answer this. In the language of relations, R is not transitive, so it does not contain all the pairs that can be linked. As we will show in this section, we can find all pairs of data centers that have a link by constructing a transitive relation S containing R such that S is a subset of every transitive relation containing R. Here, S is the smallest transitive relation that contains R. This relation is called the transitive closure of R.

In general, let R be a relation on a set A. R may or may not have some property P, such as reflexivity, symmetry, or transitivity. If there is a relation S with property P containing R such that S is a subset of every relation with property P containing R, then S is called the closure of R with respect to P. (Note that the closure of a relation with respect to a property may not exist; see Exercises 15 and 35.)We will show how reflexive, symmetric, and transitive closures of relations can be found.

The relation R = {(1, 1), (1, 2), (2, 1), (3, 2)} on the set A = {1, 2, 3} is not reflexive. How can we produce a reflexive relation containing R that is as small as possible? This can be done by adding (2, 2) and (3, 3) to R, because these are the only pairs of the form (a, a) that are not in R. Clearly, this new relation contains R. Furthermore, any reflexive relation that contains R must also contain (2, 2) and (3, 3). Because this relation contains R, is reflexive, and is contained within every reflexive relation that contains R, it is called the reflexive closure of R.