Every "proper-Hypergeometric" multiscum/integral identity with a fixed number of summation or integration signs, possesses a short, computer-constructed proof. We present the theory behind these algorithms and proof methods with some applications. In particular, we will discuss the following problems as a showcase.

Prove the identity

\[ \sum_{k=0}^{n} \binom{n}{k}^3 = \sum_{k=0}^{n} \binom{n}{k}^2 \binom{2k}{n}. \]

Find the diagonal coefficients (i.e. coefficient of $x^n y^n z^n$), in the Taylor expansion of

\[ \frac{1}{\sqrt{(1 - x)^2 + (1 - y)^2 + (1 - z)^2 - 2}}. \]

Find the number of permutations of length $n$ that avoid the patterns 1234 and 2341.

For the DM seminar schedule, see:

http://www.people.vcu.edu/~clarson/DM-seminar.html