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Abstract

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Titolo:
Building bricks with bricks, with Mathematica

Abstract:
In this work we solve a special case of the problem of building an *n*-dimensional parallelepiped using a given set of smaller *n*-dimensional parallelepipeds. Consider the identity :

$$x^3 = x(x-1)(x-2) + 3x(x-1) + x$$

For sufficiently large x, we associate with the term x^3 a cube of size x, with the term x (x - 1) (x - 2) a parallelepiped of edges x, x - 1, x - 2, with 3x (x - 1) three parallelepipeds of edges x, x - 1, 1, and with x a parallelepiped of edges x, 1, 1.
The problem is the actual construction of the cube with the given parallelepipeds.
In [DDNP90] the problem was solved with respect to a basis whose elements are polynomials of degrees 0, 1,…,*n*.
Here, after [Fil10], we deal with a multivariate version of the problem with respect to a basis all of whose elements have the same degree (binomial basis). We show that it is possible to construct the parallelepiped associated with a multivariate polynomial
$P(x_1, \ldots, x_n) = (x_1 - S_1)(x_n - S_n)$, with $S_1, \ldots, S_n \in \mathbb{Z}$ using the parallelepipeds described by the elements of the basis.
We provide an algorithm in Mathematica to solve the problem for each *n*. Moreover, for *n* = 2, 3, 4 (in the latter case, only when a projection is possible), we use Mathematica to display a step by step construction of the parallelepiped $P(x_1, \ldots, x_n)$

References
[DDNP90] E. Damiani, O. D'Antona, G. Naldi, and L. Pavarino, Tiling bricks with bricks, Stud. Appl. Math. 83 (1990), no. 2, 91{110.
[Fil10] Daniele Filaretti, Costruzione di parallelepipedi con parallelepipedi, Master's thesis, Universita degli Studi di Milano, Italy, 2010.