An Algorithm for Generating Magic Squares

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Abstract

In this paper an efficient algorithm for generating $n \times n$ magic squares, for $n = 4k+2$, is presented.

Keywords : Magic squares, combinatorics.

Introduction

Magic squares have been studied since antiquity. The earliest recorded appearance dates back to BCE 2200 [1,2] in China. Babylonian mathematicians used a modification of magic squares in their arithmetical calculations. In the ninth century CE Iranian and other Moslem mathematicians used magic squares in astrology and for calculations related to horoscopes. By the fourteenth century magic squares were well-known to European scientists. A famous engraving by the German artist Albrecht Dürer includes a magic square and is shown below.

There are well-known algorithms for generating $n \times n$ magic squares for $n = 4k$ or an odd integer [3,4,5,6], but as far ass this writer knows no general and efficient algorithm without human intervention is known for $n = 4k + 2$. In this paper we present a simple algorithm for generating magic squares for $n = 4k + 2$. The algorithm was also experimentally tested for integers $n < 10^{12}$. The exe-file for the algorithm is available at [http://math.ipm.ac.ir/danoosh/].

1 The Algorithm

To describe the algorithm it is necessary to introduce some notation. (i, j) refers to the $(i, j)^{\text{th}}$ spot in an $n \times n$ matrix and the corresponding entry is denoted by $b(i, j)$.

For clarity of exposition the description of the algorithm is demonstrated by examples for the special case of $n = 10 = 4 \times 2 + 2$. The algorithm consists of nine steps as follows:

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