Section 2.1
Leonardo of Pisa (Fibonacci)

Who: um....

What: The Transitional Period

When: 1085 - 1453

Background

Until this point, the Western world was in some ways one enormous civilization, comprising the Romans, Egyptians, Persians, and Greeks. Trade between nations was prevalent, and knowledge, goods, and services were easily disseminated throughout the "known world". However, with the fall of Rome in 476, the intellectual achievements of the West slowed to a trickle. The Chinese, Indians/Hindus, and Persians/Arabians took up the mantle of preserving and fostering academic pursuits. Of primary interest at the beginning this section are the Persians.

After the rise of Islam following Mohammed's flight to Medina in 622, the myriad Arabian and Persian tribes united under a single nation and purpose. This new culture quickly spread throughout the Middle East as the Moslems set out to conquer and convert the known world. At its apex, the Persian Empire reached as far east as the borders of India and as far west as Spain.

Meanwhile in Europe, the political, economic, and cultural power began a slow migration to the north. Empires ceased to exist in the way they had previously. In 1085, the Christians conquered Toledo (in present day Spain) from the Moors (Persians). This was followed by an influx of Christian scholars to the city to acquire Moslem learning.

Leonardo of Pisa

Easily the preeminent mathematician of the Middle Ages, Leonardo was born in 1175 in Pisa where his father was involved with the mercantile business. It

was in his famous work *Liber abaci* that Hindu-Arabic numerals received their strongest support to date. In fact, the text opens with the following passage:

> These are the nice figures of the Indians
>
> 9 8 7 6 5 4 3 2 1
>
> With these nine figures, and with the sign 0...any number can be written as will below be demonstrated.

In the fifteen chapters that follow, Fibonacci explains the reading and writing of these new numerals, methods of calculation, computation of square and cube roots, and the solution of linear and quadratic equations. Despite the advantages of the Hindu-Arabic numerals over their more common Roman competitors, their acceptance was not immediate. But in the fifteenth century, with the advent of printing, their forms became standardized and their use became commonplace.

While *Liber abaci* is essentially an independent investigation of arithmetic and algebra, the influence of al-Khwarizmi and Abu Kamil is unmistakable. The algebra is rhetorical and applications deal primarily with barter, partnerships, and geometrical mensuration.

Probably Fibonacci's most famous contribution to mathematics as a whole, aside from his advocacy of Hindu-Arabic numerals, is the sequence that bears his name. The sequence of numbers 1, 1, 2, 3, 5, 8, ... is perhaps the most important and most studied sequence of all time. It is formed by beginning with two consecutive ones (or in more generality any two integers), and then each successive term is the sum of the two previous terms. The sequence is produced from the following problem in *Liber abaci*:

> How many pairs of rabbits can be produced from a single pair in a year if every month each pair begets a new pair, which from the second month on, becomes reproductive?

If this origin were the only "application" of the Fibonacci sequence, it would not have endured such popularity. Quite the contrary, there are numerous demonstrations and applications of the sequence in nature, the arts, and of course mathematics. In mathematics, the sequence appears in Pascal's triangle, the

binomial formula, probability, the golden ratio, magic squares, and many other topics.