

A MATHEMATICAL THEOREM ABOUT NORTHERN EUROPE AND ITS PROOF

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ABSTRACT. In this paper, we present a mathematical theorem about Northern Europe and its proof. The four color theorem is used in our proof.

1. INTRODUCTION

The four color theorem is that: for any plane made of contiguous regions, constructing a figure and terming it a map, at most four colors are required to color all the regions of the map so that any two neighbor regions have different colors. A formal description of the proof of the four color theorem is detailed in [1]. In this paper, we present a mathematical theorem about Northern Europe and its proof. The four color theorem is used in our proof.

2. THEOREM AND PROOF

Norway, Sweden, Finland and Russia all border the sea. The sea is connected. Norway borders all the other nations. Finland borders all the other nations. If we only consider the largest areas of nations, then we have:

Theorem 2.1. *Sweden does not border Russia.*

Proof. Considering that the problem can be a coloring problem, we prove with the four color theorem. Since any of two in $\{Norway, Finland, Russia\}$ border each other, we need 3 colors to color them. The sea also needs one other color. We have used 4 colors now. Due to the four color theorem, Sweden can be colored using one of these 4 colors.

Since the sea, Norway and Finland border Sweden, they should have different colors from the color of Sweden. Hence, within the used 4 colors, only the color of Russia can color Sweden. This is equivalent to the statement that Sweden does not border Russia. This completes the proof. □

REFERENCES

- [1] Georges Gonthier. Formal proof—the four-color theorem. *Notices of the AMS*, 55(11):1382–1393, 2008.

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