

From Reasoning to Verification: Logic through the Ages

Speech given by prof.dr. Marko van Eekelen at the occasion of the official opening on September 24, 2015, of the MarsiliusVanInghenPad on the campus of the Radboud University in Nijmegen, The Netherlands

Distinguished guests,

Standing before you, re-enacting Marsilius van Inghen, I consider it a great honour to be able to share with you today what motivated me in taking the initiative for having a campus road named after Marsilius van Inghen.

The underlying motivation came via the brothers Herman, Paul and Johan van Limbourg who created around the year 1400 the world famous miniature illuminations in the Très Riches Heures for the Duke of Berry and Auvergne, the brother of the King of France.

Only a decade ago, it was recognised that these three brothers were born in Nijmegen where they learned the art of painting from their uncle Johan Maelwael who is considered to be the origin of painting in the Netherlands. Since then, every year in Nijmegen a large medieval festival is organised in honour of these achievements. Next year 's event will be very special since it will be celebrating the 600th anniversary of their death.

I got involved in this medieval festival through my wife Lianne Dirven. She is present here. She re-enacts the ancestress of her family, Cornelia Derwyf who lived in the same period as the brothers van Limbourg. I felt inclined to join my wife in these festival activities. So, I went searching for a suited medieval person to re-enact.

Through Google, I learned that in the 14th century only a few universities existed in Europe. Scientists were generalists, often active at the same time in theology, philosophy, and mathematics. Science was not so much experimenting but above all: reasoning. They reasoned about the works of the ancient greeks, mainly Aristotle and Plato. They were referred to as philosophers. The 'Ph.D., the Philosophers Degree' is a remnant of that. By the way, at formal university events the clothing style of today's professors is another remnant from the 14th century.

So, I checked the online Stanford Encyclopedia of Philosophy and typed in the search phrase Nijmegen. First hit was not one of the current professors nor one of their predecessors: it was Marsilius van Inghen. Googling along, I further learned that in 1382 the city of Nijmegen held a banquet in honour of Marsilius van Inghen. It may well be that Johan Maelwael was present at that banquet.

Recall that reasoning was important with hardly any distinction between philosophy, mathematics and religion. It was the time of many examples of informal, logical reasoning resulting e.g. in discussions around logical proofs of the existence of God.

In this context, Marsilius van Inghen used strict logical rules for his reasoning. He advocated making a clear distinction between reasoning based on assumptions that were religious, and natural assumptions that were based on evident observations in nature. But what to do when reasoning with religious assumptions gave a different result than reasoning with natural assumptions? Marsilius had a clever solution: the natural reasoning was not incorrect but one should believe in the religious reasoning. This Salomon's judgment paved the way for natural reasoning to flourish further without dramatic conflicts.

For more than two centuries, Marsilian's method, the Marsilian way, the Via Marsiliana, was cited often, among others by Leonardo da Vinci and Galileo Galilei. It was Galileo Galilei who took a different stand than Marsilius, in a conflict between the logic of science and the faith of religion he made the choice for science. In his turn he paved the way for a further separation between faith and logic. Over the ages, logic reasoning further developed. Hilbert asserted that all mathematics would be formalised via strict deductive reasoning. Russell's paradox and Gödel's incompleteness theorems showed that there are inherent limitations on that. The Dutch mathematician Luitzen Brouwer advocated that logic should be constructive. His intuition told him that there was not so much value in knowing the existence of something without being able to construct it. The resulting constructive logic now plays an important role in reasoning about software and hardware in computer systems.

In 1936, Alonzo Church with the lambda calculus and Alan Turing with the Turing Machine both formalised the notion of computability paving the way for implementing logic reasoning not only in hardware (e.g. in transistors, in logical gates, in micro-chips) but also in software (e.g. in functional programming languages as is shown in my Ph.D. thesis performed under the supervision of Professor Henk Barendregt).

Later in the previous century, the Curry-Howard isomorphism between programs and proofs made it possible to create logical proofs with the computer and verify them with a simple computer program, a proof assistant. This gives ultimate trust in the correctness of the proof.

With such a proof assistant, I have led a project to verify the core of the software of the Maeslantkering: the Rotterdam surge barrier that aims to prevent the flooding of Rotterdam

even when the water levels are very high. It consists of two barriers, each of the size of the Eiffel tower in Paris. We proved that there were several subtle errors in the decision software that could cause the barrier to fail. The software was changed and thanks to this automated verification logic the feet of the Rotterdam people are guaranteed to stay dry.

The way of reasoning of Marsilius, the Via Marsiliana constituted an important step in the scientific developments in logic. Through the ages logic developed from the medieval way of reasoning with words to the current highly advanced computerised logic creating and verifying proofs of properties of mathematics, of hardware and of software.

We are about to open a new path. This path is close to the St. Annastraat, nicknamed Via Gladiola. I want to take the opportunity to suggest as nickname for the Marsilius van Inghen Pad, the Via Marsiliana.

In a few moments we can walk along the Via Marsiliana, the new Marsilius van Inghen Pad. May many professors and many Ph.D candidates follow the path of Marsilius on their personal way to contribute to science with their inaugural lecture or their Ph.D. defence.