

**Scientific Report for the STSM,  
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During the period of 24<sup>th</sup> – 31<sup>st</sup> August I have visited King's College, working with Dr. Nir Oren on the problem of graph based explanation of norms in multi-agent systems. Our work has been aimed at the ability to provide users with justifications of why certain norms are either applicable, violated or in some other similar state.

Norm aware agents make use of concepts such as obligations, permissions, and prohibitions, to represent and reason about socially imposed goals and capabilities. Such agents are able to decide whether to act in a manner consistent with norms, or whether to ignore them. Typically, norms are imposed on a set of agents in order to increase the overall utility of the system (often at the cost of individual utility), reduce computational or communication overhead, or provide robustness in the case of unexpected situations.

While a norm aware agent is typically able to reason about what norms are applicable to it, or some other agent in the system given some situation, the problem of *explaining* why a norm is applicable, or violated, or in some other similar state, has not been investigated in depth. The ability to provide such an explanation has multiple benefits. For example, a designer would be better able to understand the interactions between different norms, allowing them to avoid creating redundant norms, and specify their norms more precisely. A user would be able to get a more intuitive understanding of the system by understanding the reason why certain norms were assigned a certain status in response to system events.

Norms are typically specified using logical concepts which are, especially for end users, are often difficult to understand. Our work focused on a novel graphical norm representation, based on conceptual graphs. Conceptual graphs (CGs) provide a graphical approach to knowledge representation, and have the advantage of ease of understanding over traditional knowledge representation approaches. Furthermore, their graph based semantics allow for various problem solving techniques to be applied that are not natural for standard logic based approaches.

In the joint work carried out with Dr. Nir Oren, we provided a CG based semantics to a normative framework designed with a number of purposes in mind: the ability to implement it in an efficient manner, and the ability to monitor the changing status of norms. The semantics we proposed allows one to graphically represent the changes in norms over time, and to determine their status using graph based operations such as projection.

Thus, we are now able to provide a visual explanation of certain aspects of normative reasoning. Furthermore, we make use of graph operations to detect redundancy in norms, that is, to identify whether some portions of a norm can be removed without changing the situations in which a norm is deemed violated by the semantics of the normative system.