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CS549 – ST/Scalable Querying & ML – Spring 2022

Topic: SATNet Bridging deep learning and logical reasoning using a differentiable satisfiability solver

https://arxiv.org/pdf/1905.12149.pdf

What is the problem discussed in the paper?

Deep learning problems are applicable with no constraints on the output, are differentiable and solved via gradient optimizers. Logical inference has rich constraints on the output, are discrete in both input and output, solved via tree search.

The paper talks about the introduction of a new layer that enables end to end learning of both the constraints and solutions of logic problems within deep networks. They talk a smoothed differential satisfiability solver than can be integrated into the loop of deep learning systems. This layer employs block coordinate descent methods to efficiently compute the forward and backward passes.

Why is it important?

To solve deep learning problems with logic, with most of the methods have to hard code relationships between the variables. Many differential logical reasoning systems were in place where most of them still require fairly hand specified logical rules and groundings which makes them with limitations to operate fully.

So, this approach is important to show that learning logical structures is possible with their approach of SATNet architecture. This SATNet provides a step towards integrating symbolic reasoning and deep learning which is one of the most important long-standing goals in the field of artificial intelligence.

What are the main ideas of the proposed solution for the problem?

The paper presented SATNet as the first differentiable MAXSAT solver as a layer. In a typical SAT clause matrix is given and we find the satisfying assignment. In this approach, clause matrix is parameters of the layer which is to be learned. MAXSAT is the optimization variant of SAT solving. It will maximize the number of satisfiable clauses. Primal-dual interior point method is used for SDP to optimize, which has very high complexity and is expensive. The solution for this problem is to efficiently solve via low-rank factorization. The paper also talks about the back propagation through the optimization proc. The auxiliary variables are used in SATNet, where only SDP are with diagonal constraints, limiting representation. Also, adding auxiliary variable increases representation power. Learning sudoku is exampled with normal input and MNIST as well. Later the idea is extended to the virtual sudoku.

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