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CSC 790: Graduate Seminar

Assignment 02

1) Discuss the following (paper 1):

Inductive Logic Programming for Symbol Recognition

a. Motivation
The motivation behind this paper is to present a proof of concept for an approach to automatically learn nontrivial descriptions of symbols based on a formal description by using Inductive Logic Programming (ILP). The paper aims to deduce nonobvious characteristics by feeding an ILP solver a representation that includes graphic symbols expressed by a number of primitives that may be of any complexity and connecting relationships that can be deduced from straightforward image treatment and analysis tools.

b. Problem
The problem that the paper is trying to address is the challenge of finding a way to describe an image that combines expressiveness and high flexibility. The existing approach constructs a chain of syntactic rule triggering using more and more complex “vocabulary” to eventually express terminal concepts and lacks quantitative spatial assessment.

c. Methodology
The paper proposes the following methodology to solve the challenge of expressing visual information:
   i. Extract complex structures using specific and specialized detectors and express symbols as a set of elementary items.
   ii. Make use of reduced version of the force histogram based approach to position all the items relative to one another using a quantitative assessment of directional spatial relationships.
   iii. Feed the inductive logic programming process the three main sets:
      1. Information set: a set of known vocabulary, rules, axioms or predicates, describing the domain knowledge base K;
      2. The automatic solving set: a set of positive examples E^+ the system is supposed to describe or characterize with the set of predicates of K;
      3. Deduction theory set: a set of negative examples E^- that should be excluded from the deducted description or characterization.
   iv. The ILP solver then finds the set of properties P, expressed with the predicates and terminal vocabulary of K such that the largest possible

subset of E^+ verifies P, and the largest possible subset of E^- does not verify P.

v. The output of the ILP solver consists of à [theory] section, containing the rules that define the positive example set.

vi. For each rule of the theory, the solver gives matching statistics, indicating the precision of the rules (how many positive examples covered, and how many negative examples). For a perfect match, the theory section should consist of one single rule covering all positive examples and no negative examples.

d. Data and results

This paper use the datasets of electrical graphical symbols, expressed using the first order logic vocabulary, and coming from an electric wiring component dataset.

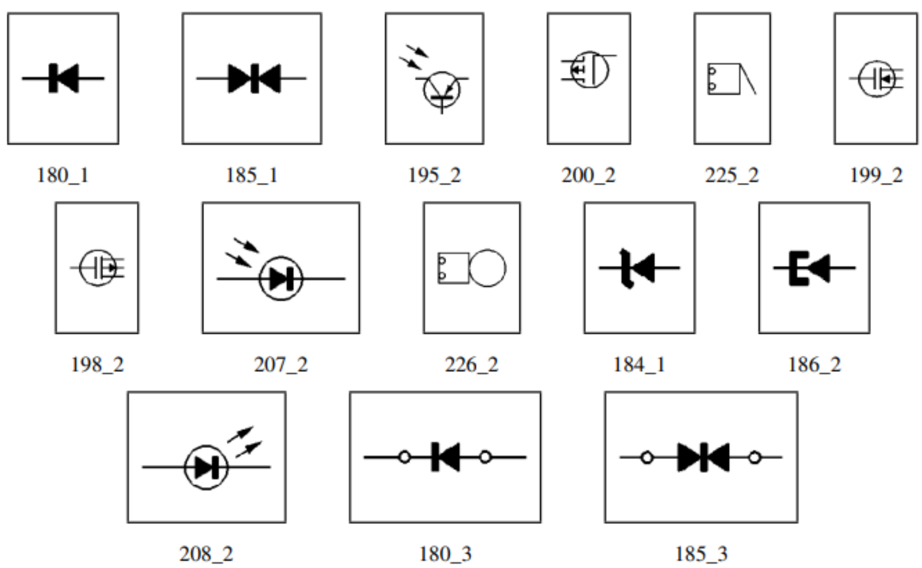

Figure 1: Sample graphical symbols from the dataset

A set of rules (theory) that describes the provided symbol is obtained as result. For example, Let images {195_2, 198_2, 199_2, 200_2, 207_2, 208_2} from Figure 1 be positive examples, representing the symbol of which the representation is to be learnt, and all others be counter examples. The ILP solver gives the following result:

symbol(A):-
has_element(A,B), type(B,circle),
has_element(A,C), inside(C,B),
type(C,cornernw).

This experiment, translated into natural language, means that the chosen examples all have circles containing a northwest corner element. With this rule, all positive examples are perfectly classified with respect to the negative ones.

e. <u>Take home message</u>
The paper presents a proof of concept for the first step of the proposed approach for visual information expression, symbol recognition and representation, by combining robust elementary form detectors that compose a predefined, but extensive vocabulary. The description of symbols can be easily mixed with other more context related information giving the advantage of not needing to visually represent information.

f. <u>Scalability and generalizability of the method</u>
The method is limited by the expressive power of the used vocabulary. Since, a set of specific rules has to be defined for this method, this method might be scaled to some extent for specific tasks but not truly scalable in a real world scenario. This method relies on the locally extracted features based on a set of predefined rules, hence, is not generalizable.

2) Write abstracts from both papers (paper 1 and paper 2)

Paper 1: Inductive Logic Programming for Symbol Representation *(Abstract)*

This paper attempts to present a proof of concept for using Inductive Logic Programming (ILP) in the recognition of symbols. The proposed method aims to automatically learn non-trivial descriptions of symbols by representing them using primitives and connecting relationships, as derived from image treatment and analysis. The representations are fed into ILP solver to uncover hidden characteristics that can improve the semantic-related recognition process. This work represents a first step towards using ILP in symbol recognition.

Paper 2: RSILC: Rotation- and Scale-Invariant, Line-based Color-aware descriptor *(Abstract)*

This paper introduces a new approach for appearance-based object recognition that focuses on the distinctive features of line-rich color scenes and objects. Our proposed method, RSILC, is a rotation- and scale-invariant, line-based color-aware descriptor that extracts and matches key-lines, line region properties, and line spatial arrangements for robust object recognition. The method is especially well-suited for face matching, as facial characteristics are best captured by lines and curves. Our experiments on public datasets show that RSILC outperforms other well-known generic object descriptors in line-rich object recognition.