**Electronic Transactions on Artificial Intelligence**
Vol. 4 (2000), Section B: pp. *141-153*
http://www.ep.liu.se/ej/etai/2000/015/



**Refereed Article**

# Stephen Muggleton:

# Learning Stochastic Logic Programs

**Author's affiliation:** University of York, U.K.

**Abstract:** *Stochastic Logic Programs (SLPs) have been shown to be a generalisation of Hidden Markov Models (HMMs), stochastic context-free grammars, and directed Bayes' nets. A stochastic logic program consists of a set of labelled clauses p:C where p is in the interval [0,1] and C is a first-order range-restricted definite clause. The paper first summarises the syntax, distributional semantics and proof techniques for SLPs. L-model semantics of SLPs are introduced. This differs from the semantics of SLPs given by Cussens in that it allows a natural extension of the notion of logical entailment (*$\models$*). Logical entailment is central to both the basic definitions of Inductive Logic Programming (ILP), as well as various ILP techniques such as inverse entailment. L-models provide a method of extending the foundations of ILP to allow for the learning of SLPs. The paper discusses how a standard ILP system, Progol, has been modified to support learning of SLPs. The resulting system 1) finds an SLP with uniform probability labels on each definition and near-maximal Bayes posterior probability and then 2) alters the probability labels to further increase the posterior probability. Stage 1) is implemented within CProgol4.5, which differs from previous versions of Progol by allowing user-defined evaluation functions written in Prolog. It is shown that maximising the Bayesian posterior function involves finding SLPs with short derivations of the examples. Search pruning with the Bayesian evaluation function is carried out in the same way as in previous versions of CProgol. The system is demonstrated with worked examples involving the learning of probability distributions over sequences as well as the learning of simple forms of uncertain knowledge.*

## Publication and review history

This work was first presented at the Machine Intelligence 17 Workshop, held on July 19-21, 2000 at Bury St Edmunds, Suffolk, UK. Attendance at this workshop was based on invitations. Speakers at the workshop were invited to submit their articles for consideration in the forthcoming workshop volume. The subsequent publication and review history for the present article was as follows.

1. First version *published* by Linköping University Electronic Press on 21.12.2000 and permanently available at
   http://www.ep.liu.se/ea/cis/2000/041/
2. First version *accepted* after due refereeing and according to scientific journal standards by the Electronic Transactions on Artificial Intelligence (ETAI) on 27.3.2001. Authors were invited to revise their articles, if they so desired, based on comments by the reviewers.
3. Revised version *accepted* on 24.12.2001.
4. Revised version *published* by Linköping University Electronic Press on 31.3.2002 and permanently available at the same URL as mentioned above.
5. Revised version appears in Electronic Transactions on Artificial Intellligence, Volume 4 (2000), section B, pages 141–153. The section and the annual volume are made permanently available at
   http://www.ep.liu.se/ej/etai/
6. Paper editions of the ETAI issue and the ETAI volume containing this artice *republished* by the Royal Swedish Academy of Sciences.

The review policy and the quality requirements for acceptance are documented at http://www.etaij.org/info/

## Article maintenance

The Electronic Transactions on Artificial Intelligence maintains an Article Interaction Page for this article at
http://www.etaij.org/ra/mi/017/
Besides the publication and review history, it contains links for contacting the author(s), as well as to amendments and other related information for the article. It is intended to keep these links up-to-date in the future.