Genifer
– an artificial general intelligence

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Preface, executive summary, to-do list

1. This book is a perpetual draft.
2. My personal reason for developing AGI is to achieve life extension.
3. The source code of Genifer is hosted on Google Code, including some very easy tutorial slides. Also feel free to contact me!

— YKY

Executive summary:

Inference: Genifer descended from classical logic-based A.I. Its 3 modes of inference are deduction, abduction (explaining), and induction (learning). This is common to NARS, OpenCog, Cyc.

Logic: Genifer is based on an **algebra of concept composition**, which replaces predicate logic as the internal structure of propositions.

KB: Genifer's KB stores logic formulas, similar to classical A.I. systems such as Cyc, and NARS. OpenCog is an exception in that it stores its knowledge as a hypergraph called AtomSpace.

Uncertainty: Genifer uses fuzzy-probabilistic logic, the probabilistic part is an exact algorithm for belief propagation in Bayesian networks. The fuzzy-probabilistic calculus is created by YKY based on the Beta distribution.

Bootstrapping: Genifer will be written in its own language, which is a **logical-functional** programming language based on Genifer's logic and an existing functional programming language such as Clojure or Haskell.

To-do:

Ch 1 (Introduction) Explain the new ideas that I learned about the relationship between propositional logic and topological logic.

Ch 2 (Architecture) Explain AIXI, algorithmic complexity, Solomonoff induction, etc. Explain distributive architecture. New idea that bootstrapping is possible.

Ch 3 (KR) — ok —

Ch 4 (Logic) New logic of concept composition. Ideas about equational unification and concepts. Explain background notions, eg paradoxes.

Ch 5 (Z) Add new idea on the "Java-girl paradox", which is in draft paper.

Ch 8 (Inference) Copy and paste Bayesian inference and factor graph stuff from the Lisp code to here.

Ch 9 (Pattern recognition) Matrix technique on similarity.

Ch 11 (Learning) A lot of new material is in the slides.

Ch 12 (NL) New idea of semantic parsing. New diagrams from GUI.

Ch 13 (Memory) Explain hierarchical clustering idea, ontology.

Ch 14 (Planning) May need re-think.

Ch 18 (Implementation) Bootstrap Genifer in its own language.

Appendix A Recommend more books for AGI sub-areas. Especially math books.

Contents

0 Introduction

0.1 Chicken-and-egg problem

Part I

Techniques

1 Machine learning basics

1.1 Inductive bias and “no free lunch” theorem

1.2 Structuralism, post-structuralism

2 Logic

2.1 The 3 main modes of human thinking

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2.1.2 Abduction

2.1.3 Induction

2.2 Propositional logic

2.3 Predicate logic / first-order logic

2.4 Inference (classical)

2.4.1 Resolution algorithm

2.4.2 Unification algorithm

2.5 Second-order / higher-order logic

2.6 λ-calculus, combinatory logic

2.7 Algebraic logic, geometrization

2.8 Category theory, categorical logic

2.9 Quantum logic

2.10 Term rewriting systems

2.11 Graph rewriting systems, hypergraphs

3 Uncertainty

3.1 Fuzziness

3.2 Probability

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3.3 Confidence

3.4 Uncertain inference

3.4.1 MCMC (Markov chain Monte Carlo)

4 Neural networks

4.1 Neuroscience

4.1.1 Brain architecture

4.1.2 Neurons

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4.2.1 Non-linear analysis

4.2.2 Degree theory

4.2.3 Homology

4.2.4 Harmonic analysis

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5.1 History of natural evolution

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6.1 Control theory / differential geometry

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Part II

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9 Inductive learning

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10 Natural language

10.1 Syntax theory

10.2 Semantic theory

10.2.1 Abduction as interpretation

10.2.2 Montague grammar

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Part III

Architecture

12 Cognitive architectures

13 Memory systems

13.1 Working memory

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14 Implementation

14.1 Ethical issues

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Symbols

$\mathbb{N}, \mathbb{Z}, \mathbb{Q}, \mathbb{R}, \mathbb{C}$	classical number systems	
$\mathbb{Hyp}$	hypothesis space	§??
$\mathbb{Prop}$	(ground) proposition space	

General logic:

$\exists, \forall$	classical existential and universal quantifiers	
$\wedge, \vee, \neg$	classical binary logic AND, OR, NOT	
$\rightarrow$	(classical) implication	§??
$\vdash$	entailment, syntactic	
$\models$	entailment, semantic	
$=$	equality (logic predicate)	§??
$\approx$	similarity = fuzzy equality (logic predicate)	§??
$\subseteq$	inclusion ("is-a" relation)	§??
$\sim$	association (logic predicate)	
$a \circ b$	composition of concepts	§??
(a, b)	pairing or union	§??
$\lambda x.Mx$	lambda abstraction	
$M : \tau$	(type theory) expression M is of type τ	
$t \overset{R}{\Rightarrow} t'$	t rewrites to t' under rewriting system R	
$t \overset{R}{\rightsquigarrow} t'$	t narrows to t' under rewriting system R	§??
$A \bowtie B$	unify(A,B)	§??
[s_1]: formula	KB stores statement s_1	

Fuzzy and probabilistic logic:

$\#x.Q(x)$	probabilistic quantifier ("for some")	§??
$\twoheadrightarrow$	probabilistic implication (= Bayesian network link)	§??
$\overset{Z}{\wedge}, \overset{Z}{\vee}$	fuzzy AND and OR	§??
$\overset{P}{\wedge}, \overset{P}{\vee}$	probabilistic AND and OR	§??
$\odot$	a (fuzzy or probabilistic) operator that combines AND and OR	§??
$\Gamma(\cdot)$	fuzzy modifier	§??
ξ	point of neutrality (fuzzy logic)	§??
w	total number of support for a hypothesis	§??
w^+, w^-	positive and negative support for a hypothesis	§??

Categories of truth values:

$\mathcal{B}$	binary logic
$\mathcal{P}$	(binary) probabilistic logic
$\mathcal{Z}$	pure fuzzy logic
$\mathcal{P}(\mathcal{B})$	binary-probabilistic logic
$\mathcal{P}(\mathcal{Z})$	fuzzy-probabilistic logic

Miscellaneous:

"text"	texts in English / natural language
`source code`	source code

formula	logic formulas
To do: ...	things to do

Bibliography

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