

A Visual Agentic Multimodal Deductive System

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Abstract: -Visual analytics based on a visual virtual tree-based functional deductive system called Morph Gentzen that was developed by the author since 1997. Context abstractions with categorical linguistics, agent languages, and Meta-Contextual Reasoning are newer areas encompassed since the Morph Gentzen computing logic by this author since 1997. Reflecting on what was accomplished over the years, this brief is a glimpse on the techniques that bring forth computable AI world knowledge representable with generic model diagrams, characterized with a minimal family of generalized Skolem functions. The functions may correspond to objects defining shapes and depicting pictures. The process is instantiated on tableau sequents with logical deductive completeness on the sequent models that are proved to have compactness properties. There are applications to multimodal foundation models (LLM) to be explored.

Key-Words: Model Diagrams, Morph Gentzen, virtual tree computing, visual nonmonotonic logic, neuromorphic computing, Visual LLM, Context Abstraction, Language Categories, Agent computing Linguistics, Meta-Contextual Reasoning, VR computing, Haptic logic, IM, Multiagent AI Computing, Intelligent Multimedia Databases

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1. Introduction

Agent and objects are what Hybrid pictures represented with virtual agent trees is a novel computing and cognitive AI paradigm encompassing visual agent computing. The term "agent" has been applied to refer to AI constructs that enable computation on behalf of an AI activity. It also refers to computations that take place in an autonomous and continuous fashion, while considered a high-level activity, in the sense that its definition is software and hardware implementation, independent. For example, in mission planning (Genesereth-Nilsson 1987, Nourani-1991) or space exploration, an agent might be assigned by a designed flight system to compute the next docking time and location, with a known orbiting spacecraft. Intelligent agents are software entities that assist people and act on their behalf. Intelligent agents can automate the retrieval and processing of information. Software agents are specific agents designed by a language that carry out specified

tasks and define software functionality. Most agents defined by our examples are software agents. In the space applications we have, towards neuromorphic computing, of course, hardware functionality is specified for chip agents. Hence there are computing models with which agents might be applied the software counterpart to transistors and microchips. The example depicted by figure 1 is from our double vision (Nourani 1995c) and spatial computing projects. The visual field is represented by visual objects connected with agents carrying information amongst objects about the field and carried onto intelligent trees for computation. Intelligent trees compute the spatial field information with the diagram functions. The trees defined have function names corresponding to computing agents. The computing agent functions have a specified module defining their functionality. Basic Gentzen systems attributed to the German logician Gerhard Gentzen since 1943, is a variant form of a deductive system. Like a deductive system, a Gentzen system has axioms and inference rules. But, unlike a deductive system, the basic building blocks in a

Gentzen system are expressions called sequents, not formulas.

2. A technical overview to Morph Gentzen

The concept of Hybrid Picture is the start to define intelligent multimedia (IM) objects. Hybrid Pictures are IM Hyper-pictures, as in marked up web-pages, or JAVA JSP pages which can be automatically transformed based on computing, images, or rules defining events. Hybrid pictures are context and content sensitive hyper-pictures. A transition is the consequence of single application of the Morph Gentzen inference rules: Transitions are with automatic hybrid picture transformation, is defined and illustrated by a multimedia language. A term we invented to define automatic event driven or otherwise, hyper picture transformation. Trans-Morphing is the basic visual computing event defined for hybrid multimedia computing.

A deductive system is comprised of a set of axioms augmented with inference rules. The rules of inference are usually written in the form $\alpha, \alpha \rightarrow \beta / \beta$. That is the premises the hybrid pictures α , and $\alpha \rightarrow \beta$ the hybrid picture β is a Morph Gentzen consequent.

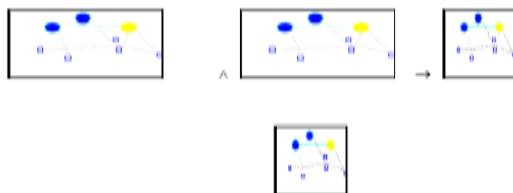


Figure 1 A Morph Gentzen Sequent

The Morph Gentzen system (the author 1997) augments the basic appropriate deductive calculus with Morph Gentzen deduction rules as follows. The deduction rules are a Gentzen system augmented by Morphing, and Trans morphing. The logical language has function names for hybrid pictures. The Morph Rule - An object defined by the functional n-tuple $\langle f_1, \dots, f_n \rangle$ can be morphed to an object defined by the functional n-tuple $\langle h(f_1), \dots, h(f_n) \rangle$, provided h is a homomorphism of intelligent objects as abstract algebras. (Nourani 2005). The TransMorph Rules- A set of rules whereby combining hybrid pictures $p_1, \dots, p_n$ defines an Event $\{p_1, p_2, \dots, p_n\}$ with a consequent hybrid picture p . Thus, the combination is a trigger event.

A Morph Gentzen rule applies the encoding in figure 1 with functions corresponding to objects with agent functions deploying the rules in the top box in figure 2 and the standard logical and knowledge-based rules in box on the right side of figure 2 to carry out an inference on a hybrid picture. The rule knowledge-based stores pictorial similarity rules encoded with agents and functions in addition to what is usually stored in an automated and AI reasoning system, e.g., logical deduction rules. The inference can be either allowed to be even driven, i.e. when object agent conditions occur, or simply be considered as a specific inference that can be carried out when desired. For example, the following is a depiction that from the hybrid pictures α , and $\alpha \rightarrow \beta$ the hybrid picture β is a Morph Gentzen consequent.

3. A preview on a Visual Nonmonotonic

The author's publications (Nourani, 2003) have proved that a set of first-order observations ϕ is reconcilable with the model iff there exists a predictive diagram for the logical consequences

to ϕ . Here Morph Gentzen deductions are applied to explain a Tableaux consequent.

An explanation problem can be stated formally as given:

Facts Φ : Consistent formulas, known to be true;
Defaults Δ : Possible hypotheses, that we accept as part of an explanation.

Observations G : Which are to be explained.

An observation g in G is explainable, if there exists ground hypotheses $\Omega \subseteq \Delta$ such that:

1. $\Phi \cup \Omega \models g$; and
2. $\Phi \cup \Omega$ is consistent.

To state-specific applications, let us state the compactness theorem from standard logic and model theory. Let us say that a prediction is minimal iff the predictive hypothesis are based on a minimal subsets of Δ . Let us present a basic for interactive analytics that is entailed from the above, however, with Morph Gentzen sequent.

Considering sequent on the tableau model theorem A set of formula Λ 's validity is preserved by an arbitrary morph sequent with functions appearing in Λ iff Λ is provable on the tableaux for the respective language. Every picture p_i on a sequent has an agent and object presentation algebra (e.g., Nourani, 1996, 2018: Chapter 12). Let us call that the virtual presentation algebra for a morph Gentzen sequent. By the tableau sequent theorem above, we can state a Morph Gentzen compactness theorem as follows. The Morph Gentzen computing structures are algebraic agent signature tree structures admitting initial models (e.g., Nourani, 1996). The ordinary signature tree structures were first presented 1977 ADJ IBM Watson Research Mathematical Sciences. The agent structure algebras are due to the present author (e.g., Nourani, 1996).

Definition 2.1: Let $(M, a)c$ in C be defined such that M is a structure for a language L and each constant c in C has the interpretation a in M . The mapping $c \rightarrow ac$ is an assignment of C in M . We say that $(M, a)c$ in C is canonical model for a presentation P on language L , iff the assignment $c \rightarrow a$ maps C onto M , i.e., $M = (a:c \text{ in } C)$. Generic diagrams allow us to define canonical models with specific functions.

How we present agent structures with agent signature trees allows us to morph sequent on the structure while preserving the basic initial morphic properties based on well-behaved infinitary language fragments. Therefore, we have sequent compactness. properties as follows.

Proposition (Morph compactness) a morph Gentzen sequent $p_1, \dots, p_n, n \text{ in } \square$ has a tableau model iff every finite sequent on p_i has tableau sequent model.

Proof: Follows from theorem 6.1, the canonical ISL algebra theorem (this author 1996) and the compactness theorem from standard model theory..

The above proposition is the basis for explaining an interactive analytic process.

Theorem A Morph Gentzen sequent MG is explainable iff there exists a predictive model diagram for the logical consequences to MG .

Proof (Nourani 2018, 2005).

➤ Remark: That says we can have an explanation for a visual analytics picture based on comprehensive logical consequences. A model diagram for a sequence is essentially a

generic encoding for the sequent Tableaux model (theorem 6.1 above)

3. Application Examples

The followins is a brief forward on the applications to Analytics, Predictive Modeling, Spatial Navigation, planning, decision systems, visual Data bases and Haptic Neurocognitive AI Example I Spacecraft Navigation (the author 1999)

An example IM planning mission (Nourani 1999) is as follows.

Hybrid picture 1- Spacecraft

"Spacecraft"

A Navigation Window

"Navigation Window"

Agents: A1 Computes available docking times based on the visual field on the window.

A2 carrysout docking sequence based on messages to Spacecraft B Hybrid picture 2 Spacecraft B Navigation Window

Agents: B1 carries on course based on its visual field window B2 Accepts and carries out docking maneuvers from external hovering craft agents

Plan Goal

"Plan Goal"

Engage docking between A and B at appropriate A and B field windows. Morph Gentzen

"Morph Gentzen"

Computing can be applied to the hybrid pictures to satisfy a plan goal. Thus, morphing is applied with precise fluidity to plan computation. The auhor's Double Vision Spacecrafts and Spatial Navigation. A version appeared at the AA99, Seattle, Autonomy Track.

Decision-Theoretic Control of Reasoning

Premises are Problem Instances, Solver, World, Context, Run time Structural evidence Execution, Bayesian Learner, Contextual

evidence, Predictive Model, Feature refinement, insights Design, real-time control, insights The techniques seek to learn predictive models to refine and from a set of runs, a Bayesian model is learned that predicts the future behavior of the control computational procedures as well as to gain insights about problem structure and hardness. A focus is automatically adapting reasoning engines to problem and applying machine learning and decision-theoretic control of computation to reasoning algorithms, e.g. (Nourani-Fähndrich 2018). After generating feature streams solver given any new state description. The predictive model is then used to help guide the solver on future problem instances by making choices that minimize the expected time to solution.

Classical Planning applied to visual cognitive processes.

The classical AI planning problem is to find a sequence of actions that transforms an initial state into a goal state. Actions are deterministic, and the initial state of the world is fully described. Under these conditions the state of the world after each action is known in advance, so sensing is not often unnecessary, and planning can be performed in a fully open-loop fashion. Nourani, Cyrus F, A Haptic computing logic, in Pivec, M., (2005). Affective and Emotional Aspects of Human-Computer Interaction. IOS Press, Amsterdam. Or the author's Planning and Plausible Reasoning in AI. In: Proc. Scandinavian Conference in AI, May 1991, Denmark,

Model Discovery, Intelligent W-Interfaces, and Business Intelligence with Multitier Designs

Intelligent business interfaces are designed with intelligent multi-tiers applying agents and intelligent business objects with applications to intelligent WWW interfaces. Basic intelligent content management with multi-tier designs for interfaces are peresented. The field of automated learning and discovery has obvious financial and

organizational memory applications. There are basic applications to data discovery techniques with intelligence multimedia databases. The computing model is based on a novel competitive learning with agent multiplayer game tree planning. The computing techniques, the Morph Gentzen deductive system and its models are applied towards an active multimedia database warehousing, model discovery, and customizing interface design. Intelligent visual computing paradigms are applied to define the multimedia computing paradigm and active databases. The Intelligent Multimedia paradigms can be applied to databases and query processing applications to stock trading platforms since the authors 2017 on publications.

Applications to Multimedia Databases

Defining compatibility and visual effects relations, allows objects to be selected and applied to design and compare customized views. Multimedia programming is combined with visual multiagent objects to define specific visual compatibility for customized active databases. Active databases deploy certain computing which lend themselves naturally to the Intelligent Multimedia principles, this author, e.g. since 2001- TAIM. The concept of an active objects are embedded by intelligent objects and "events" are embedded by the computing defined by IM as a basic principle an embedded by intelligent trees, intelligent objects, and hybrid pictures. The characteristics of an Active DMBS, or ADMBS, supports definition and management of ECA-rules, e.g. Event, Condition, and Action. Hence an ADMBS must have means to define ECA's. An ADBMS must support rule management and rule base updates.

4. Visual Nonmonotonic Reasoning

Minimal prediction is an artificial intelligence technique defined since the author's model-theoretic planning project. It is a cumulative nonmonotonic approximation attained with

completing model diagrams on what might be true in a model or knowledge base. A predictive diagram for a theory T is a diagram $D(M)$, where M is a model for T , and for any formula q in M , either the function $f: q \in \{0,1\}$ is defined, or there exists a formula p in $D(M)$, such that $T \cup \{p\}$ proves q ; or that T proves q by minimal prediction. A generalized predictive diagram is a predictive diagram with $D(M)$ defined from a minimal set of functions. The predictive diagram could be minimally represented by a set of functions $\{f_1, \dots, f_n\}$ that inductively define the model. The free trees we had defined by the notion of provability implied by the definition, could consist of some extra Skolem functions $\{g_1, \dots, g_l\}$ that appear at free trees. The f terms and g terms, tree congruences, and predictive diagrams then characterize partial deduction with free trees. Morph Gentzen computing visual nonmonotonic logic is the most recent development for our research with applications to visual predictive computing and explainable AI, e.g. (Nourani 2020).

4.2 Tree Morph Sequent Models

4.2.1 Multiagent Visual Planning and Learning

Let us define what Morph Gentzen sequent modeling is.

Definition 4.1 An IM-homomorphism is a homomorphism defined on algebras with intelligent signature IM.

Definition 4.2: Let A and B be IM-algebras with signatures containing an agent signature HA . A HA -homomorphism from A to B is an IM-homomorphism that preserve a designated HA signature trees properties, e.g., HA -terms preserves 1-1 properties on agent signature terms.

Definition 4.3: An IM-algebras is a Model A for a Morph Gentzen sequent p iff:

Every constant symbol a in signature has a corresponding constant in A ;
 Every IM-term $f(t_1, \dots, t_n)$ has a corresponding n -ary function definable at A ;
 Every IM-equation defined at A with terms on A ;
 Every IM-equation is valid in A .

Remark: On the agent process model instantiations: for the agent function symbols on the the I must ensure that the model A has an agent process function welldefined, e.g., as a hysteretic agent according to the agent state machine e.g. (Genesereth-Nilsson 1987), (Nourani 1993) or a comparable assignment for the functions on the agent signature. Essentially each sequent instance is a state on an abstract agent machine that assign values or a Skolem term for the agent signature function in A .

The above remark might be further considered an agent ontology structural characterization (this author 2005).

Theorem 2 An IM-algebra is a model for a Morph Gentzen sequent p iff there is a canonical IM-algebra definable on a generic IM-tree diagram for p .

Proposition 4.1: Morph Gentzen and Intelligent languages provide a sound and complete logical basis to VR.

Proof: (c.f. Nourani, 2005, 2018 volumes intelligent multimedia computing science ASP 2005 and AA Press volume on predictive analytics chapter 12).

4.2.2 A Visual Computing on a Sequent Analytic Tableaux

The project is towards new analytics based on Tableau computable Morph Gentzen sequent roofs. In the papers, diagrams for cognitive modeling are applied and scientific techniques are applied towards discovery and consciousness science (Nourani, 1999). Morph Gentzen comes close to human experience in attaining proofs. At

the base of its empirical intuition lies a pure intuition which is a priori. Frege's basic logical ideas and Hilbert's program separate carrying out pure mathematics from the physical cognition perceptions of what is carried out as an end. Frege's "concept and object" and on "sense and meaning," is where carrying out logic for objects named by a language had started being distinguished from the object sense perception. Hilbert's program, aside from its being left to reconcile with transcendental idealism on concepts, were to aromatize the entire mathematics. Where are we with descriptive computing Heidegger objects We are at the language, model, arithmetization trichotomy.

The objects are described with languages as Frege intended, modeled by structures, which can be examined by Kan't transcendental idealism, and their computability and reducibility areas Hilbert arithmatized. Hence there is a systematic basis to carryout concept-object descriptions for machinediscovery. Beth (1970) and Nourani (2000) on descriptive definability for the Tableau models, we have the following:

Proposition 4.2: (Tableaux Sequent Models) A structure models a morph sequent iff the structure models the initial antecedent to the sequent and (b) the sequent is explicitly definable by $\Phi\{P_1, \dots, P_n\}$, where $\Phi\{P_1, \dots, P_n\}$ is the set of sentences of the language $LU\{P_1, \dots, P_n\}$; and $P_1, \dots, P_n$ are n -placed relation symbols for relations defining the Skolem functions available on the structure, applied by the sequent.

Proof: Follows from the definition for explicit definability, Morph Gentzen

completeness (proved for example on this author, Apple Academic Press 2018 volume chapter 12.

Theorem 3 A set of formula Λ 's validity is preserved by an arbitrary morph sequent with functions appearing in Λ iff Λ is provable on the tableaux for the respective language.

Proof: Follows from the above proposition and the tableaux model descriptive computability (Nourani, 1997).

5. Concluding Directions

The multimodal reasoning processes with abstract models, predictive visual analytics, context abstractions with categorical linguistics, agent languages, and Meta-Contextual Reasoning are newer areas briefed since the Morph Gentzen computing logic (Nourani 1997). The newest AI frontiers with foundation models for LLM are the obvious application areas (MetaAI multitude team). The publication has shown how a formal logical explication of visual, or linguistics contexts have definable models that might be obtained from the techniques presented. Thus, the ability to define automated reasoning systems, which always transcend the context they are in, is embedded within the defined techniques. Generic diagrams are shown to be an encoding for a minimal efficient knowledge representation technique applied to define relevant world models and visual computational linguistics models for analytics applications.

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