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Highlights

- Shannon-Neumann Logic
- Unbalanced Assignment Problems
- Estimation of Loss of Estimators
- Parameter of Binomial Distribution

Discovering Thoughts, Inventing Future

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Boosting Human Insight by Cooperative AI: Foundations of Shannon-Neumann Logic

By Edouard Siregar

Abstract- We present the logical foundation of an artificial intelligence (AI) capable of dealing with complex dynamic challenges, that would be very hard to handle using traditional approaches (e.g. predicate logic and deep learning). The AI is based on a cooperative questioning game, to boost insight. Insight gains are measured by information, probability, uncertainty (Shannon), as well as utility (von Neumann).

The framework is a two-person cooperative iterated Q&A game, in which both players (human, AI agent) benefit (positive-sum): the human player gains insight and the AI player learns to improve its suggestions. Generally speaking, valuable insight is typically gained by asking 'good' questions about the 'right' topic, at the 'appropriate' time and place: by posing insightful questions. In this study, we propose a logical and mathematical framework, for the meanings of 'good, right, appropriate', within clearly-defined classes of human intentions.

Keywords: artificial general intelligence, complexity, cooperative learning games, frame drift problem, information entropy, insight problems, predicate logic, renormalization, utility, value-alignment problem.

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Ref

1. Leon Sterling L. and Ehud Shapiro E. (1986) *The Art of Prolog: Advanced Programming Techniques* (MIT Press Series in Logic Programming), MIT Press; First Ed., ISBN-10: 0262192500 ISBN-13: 978-0262192507

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AI based on this Shannon-Neumann Logic, combines symbolic AI with cooperative learning. It is transparent (no hidden layers), explainable (no unjustifiable moves), and remains human-aligned (no AI vs human contradictions) because of continuous cooperation (positive-sum game). In this paper, we focus uniquely on logical validity, and leave the complex topic scientific soundness for future research.

Keywords: artificial general intelligence, complexity, cooperative learning games, frame drift problem, information entropy, insight problems, predicate logic, renormalization, utility, value-alignment problem.

I. Introduction & Motivation

Purely algorithmic AI, from Predicate Logic [1] to Deep Learning neural nets [2–4], have proven highly effective for static, well-defined, narrow problems [5]. For *dynamic, complex challenges*, traditional AI becomes too 'brittle' (fails due to inappropriate application), and human *insight* is necessary to guarantee sound, human-aligned solutions. Solutions built on insufficient insight, can have deep long-lasting, human and economic consequences (e.g. conflict avoidance, war on drugs, pandemics or climate ill-preparedness).

Insight is usually gained (besides randomness and serendipity), by knowing *when/where* to pose *which* types of questions, about *what* topic: that is, by posing *'insightful questions'*. This ability thus requires a precise logical and mathematical meaning for the variables $\{when, where, what, which\}$, within well-defined contexts C, of human *cognitive mindsets*.

In this paper, the task of generating insightful questions, uses a framework we call Shannon-Neumann or SN-Logic, to cope with the fundamental concepts in

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insight-gains (see paper I [8]): built by combining information, probability, uncertainty [6] and utility [7]. This paper is structured as follows:

- In section 1, we discussed algorithmic vs human intelligence, and the purpose of SN-Logic.
- In section 2, we present the two-person (human H, AI agent A_{SN}) cooperative Iterated Questioning (IQ) game's role, from both H's and A_{SN}'s perspectives
- In section 2.3, we discuss the dynamic drift problem: coping with the changing human understanding of a given complex challenge, using a dynamic optimization process. It's impossible to clearly define a single problem, in complex challenges (e.g. war on drugs) so that they can last for decades
- In sections 3.1-3.2, we discuss SN-Logic's requirements to cope with insight (which involves causality, information, logic, probability, uncertainty and utility) and the spaces over which SN-Logic operates
- In sections 3.3-3.4, we introduce SN-Logic's grammar: semantics + syntax The syntax is used by *question generators*, to build millions of possible questions
- In section 3.5, we present SN-Logic predicates of two classes: problem difficulty-minimizing, and solution quality-maximizing, used in all inferences
- In section 3.6, we discuss the complexity and scope of SN-Logic, and section 3.7 highlights the distinction between knowledge acquisition (symbolic AI) and cooperative (machine) learning, both present in our AI
- In section 3.8, we introduce the *normal form* for making *SN-inferences*, about a question's insightfulness
- In section 4, we introduce the *Insight Gain Tensor* $\mu(when, where, what, which)$ to select *sound* inferences, from the many *valid* normal-form inferences, and measures of insight gains associated to these questions
- In section 5, we illustrate the use of SN-Logic, and we perform a validation test, to show how SN-Logic/IQ-game helps finding a solution path, to a component of a hard real-world solved case (quantum field theory research topic)

II. Two-Person Cooperative IQ-Game

a) IQ-game: Human player perspective

The Iterated Questioning or IQ game, is described in paper I. During a game session, the AI-agent, A_{SN}, poses the human player H, a question $q \in Q$, it thinks is most insightful, given H's current cognitive mindset $C(t)$. H then explores it, and reports if it was insightful. These are the game's *cooperative policies*, both players agree to adopt for each Q&A episode. The game serves several purposes which benefits both players (positive-sum game) [7, 9]

For the human player, H, the IQ-game has the following main roles:

- The IQ-game is a Q&A process that reduces uncertainty and increases information about a specific problem, via a sequence of Q&As. It provides an *effective tool*, to gain insight on the many aspects of a complex challenge.
- The IQ-game drives a sequential (mostly left-hemispheric) conscious reasoning for solving well-defined (narrow) tasks. This process is mirrored by algorithmic AI. For complex tasks, this process alone fails to deliver full solutions. Conceptual solutions to such problems require the next process: insight-gaining.

Ref

7. Von Neumann, J. and Morgenstern O. (1944) *Theory of Games and Economic Behavior*, Princeton University Press: Princeton, NJ.

- The IQ-game drives a parallel (mostly right-hemispheric) non-conscious process, for gaining insights leading to an 'aha' moment. Largely non-conscious processing can be used, where the first process proves too slow or impossible (task is too broad, ill-defined and complex).
- The IQ-game is driven by dual goals: minimizing obstacles and maximizing solution qualities. The *minimizing questions* guide H to eliminate or reduce difficulties in the problem, when possible. The *maximizing questions* guide H to boost specific solution qualities, when constraints allow it. It is a dynamic optimization (changes with H's understanding). We discuss this process in section 3.4.
- The IQ-game provides a non-brittle reasoning *framework*, which continuously adapts to the human player H's cognitive *intentions* C. This mindset C evolves as H's understanding of the challenge progresses. The IQ-game copes with the framework drift problem (section 2.3).

Ref

10. Russell S. (2019) *Human Compatible: Artificial Intelligence and the Problem of Control*, Viking, New York.

b) IQ-game: AI player perspective

For the AI-agent, A_{SN}, the IQ-game has these roles:

- The IQ game produces game session episodes, from which the agent A_{SN} can learn via cooperative learning.
- The IQ game ensures the agent remains *human-aligned* [10], because of the continuous human judgments. What is useful, informative, insightful for a human player H, does not necessarily mean the same for A_{SN}, even if it starts that way. In the learning process, these values can drift apart, due to many factors. In the IQ game, human valuation is the *ultimate arbiter*, for the insight value of a question (since any AI short of a full AGI super-intelligence, will fail miserably at this task), while SN-Logic estimates the insight values, given $C(t)$.
- The IQ game taps into a most valuable human resource: our collective evidence-based knowledge, undeniably our greatest accomplishment (culture, science, technology).

Note that our collective *belief-based* human selections are often poor (e.g. who we put in power as our leader). The forces here are complex and evolutionary: desire for control, cognitive biases and herd mentality from the fear of social isolation (e.g. [11]).

These factors are absent in the IQ procedure, since decisions are individual, and based *directly* on one's own *experience* of a question's insight, within a very specific cognitive context $C(t)$. It uses *direct evidence-based* judgment, where H's main incentive is to make life easier for herself. There are, of course individual variations in the experienced insightfulness of questions, but only stable patterns (across many individuals) are retained in cooperative learning (not presented in this paper).

c) Framework drift problem

A *complex challenge* is typically time-evolving, multi-objective, multi-solution, multi-discipline, multi-level and open-ended, making it hard from the start, to clearly define a single problem, even when it is *urgent* (e.g. a crisis) or *critical* (e.g. sustainability), or both (e.g. a pandemic)

Instead, there is a drift in the framing of problem and its solutions, as we accumulate new insights about a challenge: a framework drift problem. The drift cannot be handled with a static AI/ML system, focused on a given narrow problem.

The IQ-game, copes with the framework drift, by using an *adaptive* reasoning *framework*, and an *adaptive* cognitive intention $C = \{framework, where, when, what\}$

(section 3.3-3.4) which tracks the human player H's current understanding of the conceptual framework. It follows H's evolving understanding of the challenge, helping the SN-logic suggest the insightful questions, within each context C. The IQ-game doesn't define a problem from the start, but instead, let's H describe the

III. Predicate SN-Logic

a) SN-Logic requirements

Standard Logic Programming (predicate logic) is very effective when making strict deductions, but it cannot cope with the cooperative 2-person IQ-game. The purpose of SN-Logic is to provide an inference engine with the following requirements: it has to be ...

- *precise* (ambiguity-free) semantics axioms
- *consistent* (contradiction-free) framework within which, all SN-inferences can be made (normal-form inferencing)
- *transparent* (natural language, no hidden layers)
- *explainable* (no unjustifiable moves)
- *human-aligned* (no conflicts of with human cognitive intentions)
- *non-brittle* able to cope with fundamental concepts related to human-insight: causality (causes of insight), time-dependence (evolving understanding), information, probability, uncertainty (Shannon), utility (von Neumann), and insight (paper I). Brittleness is a common cause of AI failures.

To satisfy these requirements, we need a consistent set of SN-Logic definitions, axioms and rules, to which we now turn.

b) SN-Logic Spaces

To reason using a predicate logic (such as SN-Logic), the variables x need *spaces* X, to *scope* the *quantification*: $\forall x \in X$, $\exists x \in X$. SN-Logic's concepts are partitioned in six compact concept spaces, over which we can perform inferences (see appendices A-F):

Five *vector* spaces $\{T, S_D, S_C, S_G, S_S\}$, are used to describe the human player H's changing cognitive mindset $C(t)$, during the IQ-game. The AI agent, A_{SN}, needs to know $C(t)$, because the insightfulness of a question, depends on H's increasing understanding of the challenge and its possible solutions, as insight is accumulated.

The (tensor product) space S_A, of possible *conceptual actions* (operation x object) provide the raw material to build conceptual solutions.

Notes

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- *Vector space T of exploration stages*: vector variable $[when \in T]$ describe the current stage $when$ of the exploration cycle. The vector $[when]$ rotates in T over time (appendix A).
- *Vector space S_D of mental obstacles*: vector variable $[where \in S_D]$ describes *where* the human player's H difficulties reside. The vector $[where]$ rotates in S_D over time while exploring the challenge (appendix B).
- *Vector space S_C of difficulty causes*: vector variable $[what \in S_C]$ describes *what* in the reasoning's framework, is causing H difficulty. The vector $[what]$ rotates in S_C over time while exploring the challenge (appendix C).
- *Vector space S_G of mental goals*: vector variable $[where \in S_G]$ describes the solution quality, H intends to improve. The vector $[where]$ rotates in S_G over time while exploring the challenge (appendix D)
- *Vector space S_S of solution elements*: vector variable $[what \in S_S]$ describe *what* aspect of the solution, H intends to improve. The vector $[what]$ rotates in S_S over time while exploring the challenge (appendix E)
- *Tensor space of conceptual actions $S_A = O_p \times O_b$*: action variable $[which \equiv action \in S_A]$ is composed of a mental operation (verb $\in O_p$) attached to a target object (noun $\in O_b$)). Space S_A provides the *building-blocks* of conceptual solutions. (appendix F).

c) SN-Grammar: Axioms of Semantics

SN-Logic's role, is to provide guidance for insight-building via a Q&A process: suggesting *when/where* to pose *which* questions about *what* topic. To be used in inferences, the meanings of the parts of speech (variables $\{when, where, what, which\}$), and the sentence structure (questions $which \equiv q \in Q$), have to be both *consistent* and *precise*.

A_{SN} needs a basic grammar (syntax, semantics, vocabulary) to communicate effectively with the human player H, in a consistent and precise manner. SN-Logic is based on four consistent (contradiction-free) axioms, to define its semantics precisely (ambiguity-free).

Let the human-player H's cognitive mindset $C(framework, p)$ be defined by the current reasoning $framework$ (next section), and three (intention) parameters: $p = \{when = p_1, where = p_2, what = p_3\}$, then:

(Sem 1) *Shannon-informative* questions: a question (which) $q(p, action)$, that *reduces uncertainty* (Shannon entropy) for H, who's mindset is $C(framework, p)$

(Sem 2) *Neumann-useful* questions: a question (which) $q(p, action)$, that has a *human-aligned* (via the 2-person IQ-game) *utility*, within a mindset $C(framework, p)$. It helps H make progress towards a solution.

(Sem 3) *SN-insightful* questions: question (which) $q(p, action)$ satisfying (Sem 1, Sem 2) is *SN-insightful*, within a mindset $C(framework, p)$, otherwise it is *SN-insightless*.

(Sem 4) *SN-Valid* inferences: an inference is SN-valid, if and only if it has the *SN normal form* (section 3.6)

These SN axioms of semantics, allow the AI to cope with core concepts of causality (causes of insight), dynamics (changing reasoning frames) information, probability, uncertainty [6], utility [7] and insight (paper I). These are necessary components of an insight-boosting AI. The axioms Sem1, Sem2 restrict the form of allowed questions. This constraint is used by a *Q-generator* of questions $q \in Q$, to which we now turn.

d) SN-Grammar: Syntax for Dual-Optimization

The cooperative IQ-game is driven by *dual-objectives*: to *minimize* the problem's *causes of difficulty*, and to *maximize* the solution's *quality*. The optimization must continuously adapt to H's understanding of the challenge, over an IQ-game session).

The SN-grammar has a simple syntax, specified for each question class Q. All questions $q \in Q$ will fall into two classes $Q = \{Q_{min}, Q_{max}\}$, from two complementary (dual) perspectives: (a) causes of cognitive *difficulty* (to *minimize*), (b) *qualities* of solution (to *maximize*). Each question class *generates* many of specific questions, aimed at making insight-gains.

The purpose of SN-Logic is to incrementally boost our insight about solutions, by suggesting *when/where* to pose *which* types of questions about *what* topic, while adapting to a moving target: our *current* understanding the *obstacles* in a challenge

The question generator, or *Q-gen*, of *difficulty-minimizing* questions, uses a specific syntax for an evolving cognitive mindset $C_{min}(frame, topic, p_1, p_2, p_3)$. There is a lot of freedom in which questions to pose, even at a specific place and time, within a well-defined framework. We select a set of six commonly useful problem-solving questions, to illustrate the procedure.

Q-Gen Syntax: difficulty-minimizing questions $q(p, action) \in Q_{min}$

q_{min1}: at what exploration stage are we in now? (specifies $when = p_1 \in \ T$)
q_{min2}: what reasoning *frame* are we operating in, now? (specifies [frame])
q_{min3}: what *topic* in [frame] are we focusing on, now? (specifies [topic])
q_{min4}: where does the main difficulty reside? (specifies $where = p_2 \in S_D$)
q_{min5}: what, more specifically, causes this difficulty? (specifies $what = p_3 \in S_C$)
q_{min6}: can you *reduce* the difficulty (*where*) and *avoid* its causes (*what*), by using these actions? (specifies $action \in S_A$ and $which = q_{min6} \in Q_{min}$)

The variable [*action*] ($\in S_A \equiv O_P \ \times \ O_b$), is a product [*verb operation*] ($\in O_p$) x [*noun object*] ($\in O_b$) (appendices and section 5).

The [frame] variable, labels the reasoning framework *currently* being used (e.g. a discipline, a subject, a specialty, a model, a system, a theory, a technology etc.). This framework can change from one exploration stage to the next. It is a moving target, which mirrors our current understanding of a complex challenge.

The [topic] variable, labels a set of items we're focusing on, within [frame] (e.g. agents, assumptions, bounds, properties, qualities, relations, statements, strategies, tactics, techniques etc.). Typically, [topic] is a tool we use within [frame], to make progress. For a concrete example, see section 5.

Questions $q \in Q_{min}$ are *SN-insightful*, only if they are *SN-informative* (axiom Sem 1): they attempt to reduce a maximum possible amount of uncertainty (alternatives, ignorance, options, possibilities), within the context C_{min}.

The generator of *quality-maximizing* questions, uses a specific syntax for an evolving cognitive mindset $C_{max}(frame, topic, p_1, p_2, p_3)$:

Ref

6. Shannon C. and Weaver W. (1949) *The mathematical theory of communications,* Univ. Illinois Press.

Q-Gen Syntax: quality-maximizing questions $q(p, action) \in Q_{max}$

q_{max1}: at what exploration stage are we in now? (specifies $when = p_1 \in\ T$)
q_{max2}: what reasoning *frame* are we operating in, now? (specifies [frame])
q_{max3}: what *topic* in [frame] are we focusing on, now? (specifies [topic])
q_{max4}: where do you need a boost (goal)? (specifies $where = p_2 \in S_G$)
q_{max5}: what solution aspect, do you want to focus on? (specifies $what = p_3 \in S_S$)
q_{max6}: can you *boost* your goal ($where$) and the solution's quality ($what$), by using these *actions*? (specifies $action \in S_A$ and $which = q_{max6} \in Q_{max}$)

Questions in Q_{max} are *SN-insightful*, only if they are *SN-informative* (axiom Sem 1): they attempt to reduce a maximum amount of uncertainty (alternatives, ignorance, options, possibilities), within the context C_{max}. They are *specificity-boosting* questions which reduce uncertainty (Shannon entropy) to increase the solution's quality.

e) SN-Logic predicates q(x)

The SN concept of *insight* involves notions in information, logic, probability, uncertainty and utility (see paper I). To cope with these, we need a logic with quantifiers for scoping the variables x to specific spaces X. In standard predicate logic, a predicate is a *function* p of a variable x, which maps a variable $x \in X$, into the predicate's truth values $\{T, F\}$ [12].

$$X \rightarrow \{T, F\} \text{ and } x \in X \rightarrow p(x) = T \text{ } or \text{ } F$$

In SN-Logic, an SN-predicate is a *function* q of a variable x, which maps a variable $x \in X$, into the predicate's insight values $\{insightful\ I^+, insightless\ I^0\}$.

$$X \rightarrow \{I^+, I^0\} \text{ and } x \in X \rightarrow q(x) = I^+ \text{ } or \text{ } I^0$$

In SN-Logic we define the two classes (minimizing, maximizing) of predicates $q(x)$, the mindset parameter $p \in P \equiv \{when, where, what\}$ and the predicate variable 'cognitive *action*':

- SN-predicate questions $q(p, action) \in Q_{min}$, where $p \in P$, $action \in S_A$
- SN-predicate questions $q(p, action) \in Q_{max}$, where $p \in P$, $action \in S_A$

The parameter $p \in P$ is in the space P of *cognitive mindsets* $C_{min}(framework, p)$: the set of H's *intentions*, during the IQ-game. The AI needs to know this intent, to make useful cooperative suggestions. The mindset parameter p, encodes the type of insight, H wants to boost, at any given time.

f) SN-Logic Complexity & Scope

SN-Logic only requires concept spaces $(\{T, S_D, S_C, S_G, S_Q, O_p, O_b\}$ of very small size $N = Card(Space) \approx 10^2$ (see appendices).

- Number of distinct *cognitive mindsets*: $N_{cogn} = O(Card(P)) = O(Card(T) \times Card(S_D) \times Card(S_C) = 10 \times 10 \times 10 = 10^3$
- Number of possible *conceptual actions*: $N_{acts} = O(Card(S_A)) = O(Card(O_p) \times O(Card(O_b)) = 10^2 \times 10^2 = 10^4$
- Number of possible *distinct questions*: $N_{ques} = Card(Q) = N_{cogn} \times N_{acts} = 10^7$ minimizing questions, posed by the Q_{min}-generator (same for maximizing questions).

Ref

12. Andrews P. B. (2002) *An Introduction to Mathematical Logic and Type Theory: To Truth Through Proof,* 2nd ed., Berlin: Kluwer Academic Pub. and Springer.

These numbers already compare favorably to a typical human problem-solver H, working by herself. But the real power of SN-Logic (its scope of applications), comes from the combinatorial possibilities: the possible *combinations* and *permutations* of insight-boosting questions, needed to solve *each class* of challenges:

- Number of combinations: $N_{comb} = 2^{N_{ques}}$
- Number of permutations: $N_{perm} = N_{ques}!$

Thus, the number of distinct classes of challenges SN-Logic can cope with, is *effectively infinite* ($N = 10^7!$), yet, based on a few small, compact concept spaces (cardinality $\approx 10^2$). In this sense, SN-Logic is *economical* (Occam's razor).

g) Symbolic AI (knowledge acquisition) vs Learning

The computed complexity of SN-Logic is a theoretical *upper bound*, to determine the scope of SN-Logic. In practice the *computational cost* will be much lower, due to *universal* constraints (common to all challenge classes), because they are imposed by (mostly) challenge-independent forces:

- causality: universal root causes of cognitive difficulties (e.g. confusion due to ambiguity, indecision due to missing information) and solution quality (e.g. accuracy, adaptability)
- logic: *valid* inferences with *sound* semantics
- planning: logically *necessary* chronology of solution steps
- problem-solving: *universal tactics* to minimize obstacles (to avoid/reduce), and maximize solution quality (to target/increase/maximize) (e.g. divide-and-conquer, minimize ambiguity, maximize order, simplify)
- information: a question is only informative, if it *reduces uncertainty* by eliminating alternatives, options, outcomes, possibilities, within a cognitive mindset (intention) C, restricting the *insightful* questions to a manageable subset: $q \in Q^*(C) \subset Q$, with $Card(Q^*(C)) << Card(Q)$
- utility: a question is only useful, if it helps H, overcome obstacles, given a cognitive intention C, restricting the *insightful* questions to a manageable subset: $q \in Q^*(C) \subset Q$, with $Card(Q^*(C)) << Card(Q)$

These rules impose a lot of structure on the SN-agent's *insight grain tensor* $\mu(frame, topic, when, where, what, which)$, which is, in its fully general form, a high-dimensional rank-6 tensor, but is in practice, very *sparse* and *decomposable* into simpler tensors and convolution kernels.

The structure imposed by the universal (challenge class-independent) constraints, is sufficient to construct factored ('vanilla') tensors μ^* of much lower dimensions and lower rank: *knowledge acquisition.* A 'flavor' is then learned to *fine-tune* the tensors to each class of challenge, via *cooperative learning* (not described in this paper). Given the complexity upper-bounds of SN-Logic, the fine-tuning possibilities are vast.

h) SN-Logic Normal Form

A_{SN}'s fundamental problem, is to use the IQ-game, to guide a human player H, in *when* and *where*, to pose *which* types of questions about *what* topic, to gain a maximum amount of insight into a complex challenge.

A standard normal form inferencing (analogous to conjunctive and disjunctive normal forms, in digital and predicate logic), is necessary for the AI to cope with the computational complexity of SN-Logic. The AI can efficiently search for predicate variables *action* $\in S_A$, used as building-blocks for conceptual solutions. Given an *evolving* inferencing framework (*frame, topic*), SN-normal forms are the following:

Notes

SN normal-form for minimizing inferences

Given a minimizing mindset $C_{min}(frame, topic, p)$, where $p \in P = \{when, where, what\}$:

if $\exists$ *action* $\in S_A$, such that $\mu_{min}(frame, topic, p, action) > \mu_{crit}$,

then

$q(p, action) \in Q^*_{min}(C_{min}) \subset Q_{min}$, and

$q(p, action)$ is *SN-insightful*, within C_{min}

SN normal-form for maximizing inferences

Given a maximizing mindset $C_{max}(frame, topic, p)$, where $p \in P = \{when, where, what\}$:

if $\exists$ *action* $\in S_A$, such that $\mu_{max}(frame, topic, p, action) > \mu_{crit}$,

then

$q(p, action) \in Q^*_{max}(C_{max}) \subset Q_{max}$, and

$q(p, action)$ is *SN-insightful*, within C_{max}

The sets $Q^*(C)$, are maximum-insight subsets of Q_{min} or Q_{max}, and $\mu(frame, topic, p, action)$ is an *insight-gain tensor* (discussed shortly) whose insight gains are above a minimum *critical cutoff* μ_{crit}. The purpose of an insight-gain cutoff scale is intuitive, but its mathematical justification is outside the scope of this paper, which focuses only on logical *validity*, and ignores scientific *soundness*. The cutoff is related to a scale-invariance due to a conformal symmetry, under the renormalization of probabilities (unitarity). *Scale-separation* is used in quantum field theories [13], but *justified* by the *conformal symmetry* [14] of a renormalization group [15].

To perform successful inferences autonomously, the AI agent needs to possess the means of deciding whether a predicate variable *action* $\in S_A$, leads to insight gains above a minimum lower bound (that is, *action* $\in S^*_A(C) \subset S_A$). The insight-gain tensor provides the SN-agent, the ability to select *sound* inferences, from a vast number of merely, *valid* ones (that is, of SN normal-form).

IV. Insight Gain Tensors μ

a) Need for Insight-Gain Tensors

The AI performs SN normal-form inferences, to suggest insightful questions to explore, given human-targeted insight gains $C(p)$. These 'most insightful' questions, lie in a restricted subspace $Q^*(C) = \{Q^*_{min}(C_{min}),\ Q^*_{max}(C_{max})\}$, within a large space Q, of possible questions ($Card(Q) = 10^7$). Given a current mindset $C(p)$, A_{SN} must find a subspace of questions $Q^*(C)$. This is where an insight-gain measure $\mu(p, action)$ (convolution tensors and their kernels, used to restrict searches to optimal sub-spaces) are essential, to make *sound* inferences (real-world accurate), rather than merely *valid* ones (SN normal-form inferences). This will be presented elsewhere. For now, we simply discuss general constraints imposed by SN-Logic, on the tensor elements.

Ref

13. Dyson F., (1949) The radiation theories of Tomonaga, Schwinger and Feynman, Phys. Rev. 75, 486.

Notes

b) Constraints on Insight-Gain Tensors μ

The AI's capacity to generate *SN-insightful* I^+ questions, from a vast possibility of *insightless* I^0 ones (with *actions* $\in S_A$), resides in the structure a high-dimensional *insight-gain* tensor $\mu(when, where, what, which) \equiv \mu(p, action)$, for each challenge *class* and reasoning *frame*. So the full rank-7 tensor is actually $\mu(class, frame, topic, p_1, p_2, p_3, action)$. This function outputs the value g of insight gain associated to exploring a question *which* $\equiv q(p, action) \in Q$, where $p \in P$ encodes H's targeted insight gains. To be useful, the tensor μ is required to satisfy the following properties:

- $\mu : Cl \times Fr \times P \times S_A \to [0,1]$, where Cl = set of challenge classes, Fr = set of reasoning frameworks (frame+topic), $P = T \times S_1 \times S_2$, $S_A = O_p \times O_b$, $S_1 = S_D$ *or* S_G, and $S_2 = S_C$ *or* S_Q
- it is a measure of insight gain $\mu(class, frame, topic, p, action) = g \in [0,1]$ (normalized)
- probability of all possible *actions* with a mindset p, must sum to one (unitarity)
- $\mu_{crit} \in]0,1[$ (minimum critical insight-gain value $\mu > \mu_{crit}$)
- $g = 0$ when $q(p, action)$ is *SN-insightless* I^0 , given the mindset p
- $g = 1$ when $q(p, action)$ is maximally *SN-insightful* I^+, given the mindset p
- μ is initialized by satisfying heuristics from causality, information, logic, planning, problem solving and utility. These constraints provide the initial (challenge class-independent) approximation for μ
- μ gets optimized (fine-tuned) for specific classes of challenges, by *cooperative learning*, using the IQ-game's session episodes

V. Validation Test: Post-Doc Researcher's Dilemma

We can now illustrate how SN-Logic is used, on a real challenge. In the IQ-game, both players (human: H, A_{SN}) agree to use simple *cooperative strategies*, given H's current mindset C:

(1) A_{SN} suggests its guess at a most insightful question ($q \in Q^*(C)$)

(2) H reports questions q she actually finds insightful

The game's Q&A session, cycles over each obstacle, encountered within a challenge. Hundreds of such sub-problems may be encountered, to solve a challenge. Usually, the number and nature of these obstacles is unknown ahead of time, in real-world challenges.

For clarity, we use a single, static, not so complex, yet most difficult challenge. The scenario is: a young post-doctoral researcher, H, is trying to find a good quantum field topic, to spend her next ten years on. The first few moves (Q&As) of the two-person IQ-game, could proceed as follows:

Q from A_{SN}: 'Greetings! What *class* of challenge are we exploring today (sample which depends on what SN-Logic is being used for):

To *compose* something	e.g. music, arts, literature, programming
To *compute* something	e.g. any domain
To *construct* something	e.g. any domain
To *design* something	e.g. engineering, technology
To *discover* something	e.g. science, mathematics
To *govern* something	e.g. crisis mitigation, leadership
To *invent* something	e.g. engineering, science, technology
To *manage* something	e.g. corporate, government
To *optimize* something	e.g. any domain
To *predict* something	e.g. any domain
To *reconstruct* something	e.g. intelligence, inverse problems, sensing
To *solve* something	e.g. any domain

A by H: I want to improve on standard quantum field theory, its a *discover* class of challenge ([class] = *discover*).

1. Q from A_{SN}: Which *exploration stage* are we in, now:
(AI is using q_{min1} in Q-gen)

    to specify a current obstacle
    to minimize the obstacle
    to explore solution ideas
    to question a solution idea
    to verify a solution idea

    A by H: 'I want to identify the current obstacle'

2. Q from A_{SN}: 'What is our current *reasoning framework*?
(AI is using q_{min2} in Q-generator)

    The framework is composed of a *topic* and a *frame*

The *topic* can be any useful tool we select, for overcoming the obstacle (select the closest match):

actions	e.g. activities or behaviors
agents	e.g. catalysts or inhibitors
limits	e.g. lower, upper, extremes
computations	e.g. algorithms
equations	e.g. model or representation
laws	e.g. laws of quantum physics
procedures	e.g. protocols or decision
processes	e.g. interactions or communications
properties	e.g. pattern or symmetry
qualities	e.g. strengths or weaknesses
relationships	e.g. hierarchy or priorities
restrictions	e.g. constraints or conditions
rules	e.g. allowed or forbidden
statements	e.g. assumptions, conditions or theorems
states	e.g. equilibrium or criticality
strategies	e.g. divide-and-conquer
structures	e.g. classes, partitions, sets
tactics	e.g. explore special cases
techniques	e.g. calculation or construction
...	

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The reasoning *frame* is the clearly-defined context, within which *topic* is being used (select the closest match):

discipline	e.g. molecular biology
subject	e.g. protein folding
context	e.g. social revolution
environment	e.g. location and time
event	e.g. activity or pandemic crisis
model	e.g. just-in-time supply-chains
principle	e.g. quantum computing
method	e.g. optimization
network	e.g. communication or transport
theory	e.g. general relativity
specialty	e.g. programming
system	e.g. quantum communications
technology	e.g. fresh water extractor
...	

Note SN-logic's non-brittleness: at any given time, the reasoning *frame* can adapt to any required abstraction level and scope. Such frame changes are typically *unpredictable* at the start of a real-world challenge.

A by H: For my research direction, I want to identify a weakness in quantum field theory (QFT) (so here, [frame] $\equiv$ *theory*, and [topic] $\equiv$ *qualities*).

3. Q from A_{SN}: 'What's your main difficulty with the [frame], right now? (select the closest match)
(AI is using q_{min4} from Q-generator + an insight-gain tensor/kernel)

inability to *apply*	[topic] in/of [frame]
inability to *compute*	[topic] in/of [frame]
inability to *construct*	[topic] in/of [frame]
inability to *decide*	[topic] in/of [frame]
inability to *evaluate*	[topic] in/of [frame]
inability to *exploit*	[topic] in/of [frame]
inability to *identify*	[topic] in/of [frame]
inability to *select*	[topic] in/of [frame]
inability to *simplify*	[topic] in/of [frame]
inability to *solve*	[topic] in/of [frame]
inability to *understand*	[topic] in/of [frame]

A by H: I can't *evaluate* the weaknesses [topic = qualities] of quantum field theory [frame = theory]

4. Q from A_{SN}: 'More specifically, why can't you *evaluate* the [topic] in [frame]? (select the closest root cause of the difficulty)
(AI is using q_{min5} from Q-generator + an insight-gain tensor/kernel)

missing *comparison for*	[topic] in/of [frame]
missing *constraint on*	[topic] in/of [frame]
missing *criterion for*	[topic] in/of [frame]
missing *direction in*	[topic] in/of [frame]
missing *information about*	[topic] in/of [frame]
missing *intuition for*	[topic] in/of [frame]
missing *knowledge of*	[topic] in/of [frame]
missing *metric for*	[topic] in/of [frame]
missing *ranking of*	[topic] in/of [frame]
missing *standard for*	[topic] in/of [frame]
missing *value of*	[topic] in/of [frame]

A by H: 'I lack an *intuition for* the weaknesses of QFT'

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5. Q from A_{SN}: awesome, so our current obstacle is, our *missing intuition* for the *weaknesses* of QFT. Let's try to eliminate this obstacle.

   A by H: 'Okay, I'm all ears!'

6. Q from A_{SN}: can we gain *intuition* to *evaluate* QFT's weakness, by...
   (explore any question you think is promising, or move-on)
   (AI is using q_{min6} in Q-generator + SN normal-form inferences + insight-gain tensors/kernels)

   by exploring:
   idealized cases of the *theory* (QFT)
   solved cases of the *theory* (QFT)
   simple cases of the *theory* (QFT)

   by outlining:
   consequences (causal) of the *theory* (QFT)
   implications (logical) of the *theory* (QFT)
   predictions (temporal) of the *theory* (QFT)
   tests (experimental) of the *theory* (QFT)

   by identifying:
   inconsistent aspects of the *theory* (QFT)
   limitations of the *theory* (QFT)
   problematic aspects of the *theory* (QFT)
   uncertain aspects of the *theory* (QFT)
   unjustified aspects the of *theory* (QFT)
   untested aspects of the *theory* (QFT)
   by looking for:
   ambiguities (imprecision)
   contradictions (logical, evidence)
   counter-examples (exceptions)
   discrepancies (differences)
   dogma (cognitive traps)
   errors (math, procedures)
   falsehoods (logical)
   flaws (procedure, reasoning)
   gaps (missing pieces)
   implicit assumptions (reasoning)
   impossibilities (logical, physical)
   inaccuracies (scientific, technical)
   incompatibilities (between two items)
   inconsistencies (logical)
   limitations (scope of applicability)
   unexplained items (no explanation)
   unjustified items (lack justification)
   unsupported items (lack evidence)
   violations (law-breaking)
   weaknesses (logical)

   A from H: 'I find some questions quite *insightful*, because
   (click on each insightful one, and note the reasons for your record):

   I outlined the *implications* of QFT (e.g. including matrix unitarity), and QFT's *experimental tests* (e.g. including neutron decay experiments). I found reported *incompatibilities* (e.g. known violations of the CKM matrix's unitarity [16], in neutron decay experiments [17]). That seems like an interesting research area of quantum field theory, for me.

7. Q from A_{SN}: 'Do you want to identify a new obstacle, now? ...
   Note: for a complex challenge, limitless combinations of obstacles can be explored in this manner.

This scenario shows how suggested questions from A_{SN}, can replicate real-world solutions to obstacles, via a *cooperative Q&A* dialog. The researchers do something similar between themselves, early-on, to decide what to work on. But AI's *complementary* strength, is to cover many exploration paths, which are very often overlooked, yet may be key to quality solutions. This dynamic 'human-AI' interaction would be even more fruitful, in a *group brainstorming session*, where each member of the team, can select directions to explore and possible answers.

VI. Discussion

a) Tensor Construction & Cooperative learning

We mentioned (section 3.7), that insight-gain convolution tensors and kernels, form the bridge between the SN normal form inferencing (SN-validity), and measures of insight (SN-soundness); the bridge between logic (validity) and science (soundness). Initially, the tensors μ are the AI's 'vanilla' core, then, learned flavors are added to it, via machine learning to optimize the core AI, to distinct challenge classes.

The AI's core will be initialized by heuristics from causality, information, logic, planning, problem-solving, and utility. These apply to all types of challenges. The tensors' added flavor, needs to be learned using *cooperative learning* via a renormalization procedure, from the IQ-game's episodes. The construction of the insight-gain tensors and cooperative learning will be described in future work.

b) Conclusion

We presented the foundations of SN-Logic, designed to boost human insight, to help overcome challenges that are hard to deal with, using traditional AI (mainly, predicate logic and deep learning neural nets). This required a logic, capable of coping with the concepts necessary to measure insight-gains: causality (causes of insight gains), dynamics (adaptive reasoning frameworks), information, probability, uncertainty (Shannon) and utility (von Neumann).

In this paper, we presented the following:

- The two-person (H, A_{SN}) cooperative IQ-game's role from both H's and A_{SN}'s perspectives
- The *frame drift problem*: coping with the *changing understanding* of a challenge, using a (non-brittle) logic and optimization process, which continuously adapt to the current human understanding and intention
- SN-Logic's requirements to compute insightfulness (which involves causality, information, logic, probability, uncertainty and utility) and the concept spaces over which SN-Logic operates (to scope the quantifiers)
- SN-Logic's *grammar: semantics + syntax* for posing questions $q \in Q$ from a vast space of potential questions. The syntax is used by a dual *question generator* ($q \in Q_{min}, q \in Q_{max}$), from which all questions are built ($N_{ques} = O(10^7)$)
- SN-Logic *predicates* of two question classes: problem difficulty-minimizing, and solution quality-maximizing, used in all inferences
- The *complexity* of SN-Logic, and show it's broad scope and capability of coping with a large number of distinct challenge classes.
- The SN *normal-form* for making *valid* inferences, about a question's insightfulness, efficiently within a vast space of possibilities

Ref

17. Zyla, P.A et al (2020) Review of Particle Physics: CKM quark-mixing matrix, *Progress of Theoretical and Experimental Physics.* 2020 (8): 083C01. doi: 10.1093/ptep/ptaa104.

Notes

- *Insight Gain Tensors* $\mu(when, where, what, which)$ are necessary to select *sound* inferences (real-world accurate), from a vast (effectively infinite) number of *valid* ones (those with SN normal-form). μ measures the human insight gains, associated to questions posed, within their cognitive mindsets (C_{min}, C_{max})
- A validation test, to show that SN-Logic can replicate the solution steps, to a real-world solved case (discovery in quantum field theory)

This paper focused solely on logic and validity of SN-inferences. It has not dealt with the equally important issue of scientific soundness and accuracy. We will present the construction of the insight-gain convolution tensors and kernels, and the learned structure (cooperative learning), in future papers.

VII. Appendices

A: Vector Space of Exploration Steps T (sample)

Time basis vector: $when \equiv p_1 \in T)$
to identify an obstacle
to minimize the obstacle
to explore solution ideas
to question a solution idea
to verify a solution idea

B: Vector Space of Cognitive Difficulties S_D (sample)

Basis vectors of cognitive obstacles: $where \equiv p_2 \in S_D$	
inability to *classify*	[frame]
inability to *compute*	[frame]
inability to *connect*	[frame]
inability to *construct*	[frame]
inability to *count*	[frame]
inability to *decide*	[frame]
inability to *design*	[frame]
inability to *eliminate*	[frame]
inability to *evaluate*	[frame]
inability to *exploit*	[frame]
inability to *extract*	[frame]
inability to *identify*	[frame]
inability to *interpret*	[frame]
inability to *organize*	[frame]
inability to *perform*	[frame]
inability to *plan*	[frame]
inability to *predict*	[frame]
inability to *rank*	[frame]
inability to *relate*	[frame]
inability to *select*	[frame]
inability to *simplify*	[frame]
inability to *solve*	[frame]
inability to *transform*	[frame]
inability to *verify*	[frame]
etc.	

C: Vector Space of Difficulty Causes S_C (sample)

Basis vectors of causes: $what \equiv p_3 \in S_C$	
level of *abstraction of*	[item]
level of *ambiguity of*	[item]
level of *complexity of*	[item]
level of *dependencies in*	[item]
level of *flaws in*	[item]
level of *fragmentation of*	[item]
level of *implicitness in*	[item]
level of *impracticality of*	[item]
level of *imprecision of*	[item]
level of *incompleteness of*	[item]
level of *inconsistency in*	[item]
level of *indecision about*	[item]
level of *indetermination in*	[item]
level of *inefficiency of*	[item]
level of *insufficiency of*	[item]
level of *uncertainty in*	[item]
level of *unpredictability of*	[item]
level of *weakness of*	[item]
etc.	
missing *assumption about*	[item]
missing *bounds on*	[item]
missing *capacity for*	[item]
missing *classification of*	[item]
missing *confidence in*	[item]
missing *connections in*	[item]
missing *constraints on*	[item]
missing *evidence for*	[item]
missing *explanation for*	[item]
missing *freedom to*	[item]
missing *information about*	[item]
missing *interpretation of*	[item]
missing *intuition for*	[item]
missing *justification for*	[item]
missing *motivation for*	[item]
missing *organization of*	[item]
missing *representation of*	[item]
missing *restriction on*	[item]
missing *scales in*	[item]
missing *statements in*	[item]
missing *tools for*	[item]
missing *verification of*	[item]
etc.	

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D: Vector Space of Mental Goals S_G (sample)

Basis vectors of cognitive goals: $where \equiv p_2 \in S_G$	
clarity about the	[solution item]
confidence in the	[solution item]
construction of the	[solution item]
criticism of the	[solution item]
exploitation of the	[solution item]
imagination for the	[solution item]
intuition for the	[solution item]
understanding of the	[solution item]
etc.	

Note: mental goals [*where*] are intentions one tries to maximize, under constraints. The vector $where \in S_G$ rotates in S_G, with the mindset C about the challenge.

E: Vector Space of Solution Elements S_S (sample)

Basis vectors of solution elements: $what \equiv p_3 \in S_S$
solution's *agents*
solution's *cases*
solution's *components*
solution's *consequences*
solution's *constraints*
solution's *dimensions*
solution's *economy*
solution's *efficiency*
solution's *effectiveness*
solution's *ethics*
solution's *form*
solution's *framework*
solution's *information*
solution's *justification*
solution's *methods*
solution's *plan*
solution's *properties*
solution's *qualities*
solution's *relationships*
solution's *requirements*
solution's *resources*
solution's *restrictions*
solution's *space*
solution's *statements*
solution's *sustainability*
solution's *utility*
solution's *value*
etc.

F: Space of Actions $S_A = O_p \times O_b$ (tiny sample)

Conceptual Action Space: $operation \in O_p \times object \in O_b$
Actions to minimize indecision: avoiding, comparing, demanding, imposing, evaluating, excluding, justifying, maximizing, minimizing, optimizing, prioritizing, ranking, requiring, selecting, weighing items etc. Actions to minimize incomprehension: classifying, collecting, defining, explaining, exploring, exploiting, decomposing, grouping, imposing, interpreting, isolating, reconstructing, relating, removing, separating items etc. Actions to minimize inexperience: exploring cases, exploring examples, exploring idealisations, exploring simplifications etc. Actions to minimize skepticism: comparing, demanding, excluding, explaining, gathering, imposing, justifying, reasoning, refuting, rejecting, requiring, searching for, testing, verifying items etc. Actions to minimize unfamiliarity: building an analogy, building a model, defining concepts, looking for items, outlining facts Actions to maximize ability: training to abstract, training to eliminate, training to exploit, training to organize, training to perform, training to relate, training to select, training to simplify, training to solve, training to transform etc. Actions to maximize clarity: classifying, connecting, defining, idealizing, ordering, organizing, outlining, reducing, relating, removing, separating, simplifying, summarizing items etc. Actions to maximize criticism: questioning an assumption, questioning a premise, questioning the framework, questioning a representation, questioning the necessity, questioning the sufficiency, questioning a method, questioning a path, questioning a solution, questioning the value etc. Actions to maximize exploitation: using an assumption, using a fact, using a given, using a constraint, using a property, using a relationship, using a restriction, using a statement, using a theorem etc. Actions to maximize imagination: weakening an assumption, weakening a bound, weakening a condition, weakening a constraint, weakening a requirement, weakening a restriction, weakening a rule, weakening a statement etc. Actions to maximize intuition: exploring an analogy, exploring a case, exploring an example, exploring a diagram, exploring a metaphor, exploring a model, exploring a story, exploring a simplification etc.

Notes

Notes

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Computational Thinking and the Curriculum of Mathematics in Portugal

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Abstract- The emphasis on the importance of programming and computational thinking has been a constant in recent pedagogical trends (Wing, 2006, 2010; NRC, 2011).

In the same perspective Pollock et al. (2019) characterize computational thinking as decomposition, algorithms, data and abstraction.

According to Selby & Woolard (2013) and Tabesh (2017), computational thinking, in addition to being associated with decomposition, pattern recognition, algorithms and abstraction, identifies the importance of debugging, that is, the ability to test and evaluate the effectiveness of the solution , correct errors and seek to refine and optimize the solution.

Keywords: *teaching and learning of mathematics, computacional thinking, problem solving.*

GJSFR-F Classification: *DDC Code: 005.1 LCC Code: QA76.6*

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Computational Thinking and the Curriculum of Mathematics in Portugal

O Pensamento Computacional e o Currículo da Matemática em Portugal

Sandra dos Anjos Canário Custódio Ribeiro

Abstract- The emphasis on the importance of programming and computational thinking has been a constant in recent pedagogical trends (Wing, 2006, 2010; NRC, 2011).

In the same perspective Pollock et al. (2019) characterize computational thinking as decomposition, algorithms, data and abstraction.

According to Selby & Woolard (2013) and Tabesh (2017), computational thinking, in addition to being associated with decomposition, pattern recognition, algorithms and abstraction, identifies the importance of debugging, that is, the ability to test and evaluate the effectiveness of the solution , correct errors and seek to refine and optimize the solution.

This was the framework that was taken into account for the start of the MatemaTIC pilot project, promoted by the Directorate-General for Education (DGE), with the joint organization of the Association of Mathematics Teachers (APM), University of Coimbra (UC) and of the CCTIC of the University of Évora (CCTIC UE).

This project, started in 2019, involved teachers of the 1st Cycle of Basic Education from 30 Groups of Schools in Portugal and its main objective was to create resources and training contexts for teachers of this level of education, to support the development of their skills. professional skills in the fields of mathematics and ICT, so that they are able to work on issues of computational thinking, algorithms and computing, in the classroom, with students.

The final considerations point to the importance of the theme in the awareness of the learning that they intend to consolidate in the students; the importance of the contents to be developed; in the process of supporting students with gradually more complex tasks, helping to build reasoning and develop mathematical language; the importance of generalizing and transferring the problem-solving process to a wide variety of similar tasks; the importance of collaborative work; in the active role of the student in the construction of knowledge; and in the importance of involving the student in the evaluation process in the sense of self-assessment and self-correction.

Keywords: teaching and learning of mathematics, computacional thinking, problem solving.

Resumo- A ênfase na importância da programação e pensamento computacional tem sido uma constante nas correntes pedagógicas recentes (Wing, 2006, 2010; NRC, 2011).

Na mesma óptica Pollock et al. (2019) caracterizam o pensamento computacional como a decomposição, algoritmos, dados e abstração.

Segundo Selby & Woolard (2013) e Tabesh (2017) o pensamento computacional para além de estar associado à decomposição, reconhecimento de padrões, algoritmia e abstração, identificam a importância da depuração, ou seja, a capacidade para testar e avaliar a eficácia da solução, corrigir erros e procurar refinar e optimizar a solução.

Desta forma, há uma convergência de várias áreas que promovem o desenvolvimento da literacia matemática, ou seja, a capacidade de utilizar conhecimentos matemáticos na resolução de problemas da vida quotidiana (Ponte, 2003).

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Foi este o enquadramento que foi tido em conta para o início do projeto piloto MatemaTIC, promovido pela Direção-Geral da Educação (DGE), com a organização conjunta da Associação de Professores de Matemática (APM), da Universidade de Coimbra (UC) e do CCTIC da Universidade de Évora (CCTIC UE).

Este projeto, iniciado em 2019, envolveu professores do 1.º Ciclo do Ensino Básico de 30 Agrupamentos de Escolas de Portugal continental e teve como objetivo principal criar recursos e contextos de formação para professores deste nível de ensino, para dar suporte ao desenvolvimento das suas competências profissionais nos domínios da matemática e das TIC, para que fiquem habilitados a trabalhar as questões do pensamento computacional, da algoritmia e da computação, em sala de aula, com os alunos.

As considerações finais apontam para a importância da temática na tomada de consciência das aprendizagens que pretendem consolidar nos alunos; na importância dos conteúdos a desenvolver; no processo de apoio aos alunos com tarefas gradualmente mais complexas, ajudando a construir raciocínios e a desenvolver linguagem matemática; na importância da generalização e transferência do processo de resolução de problemas para uma ampla variedade de tarefas semelhantes; na importância do trabalho colaborativo; no papel ativo do aluno na construção do conhecimento; e na importância de envolver o aluno no processo de avaliação no sentido de se autoavaliar e de se autocorrigir.

Palavras–Chave: ensino e aprendizagem da matemática, pensamento computacional; resolução de problemas.

Artigo

Em contexto educativo, numa sociedade marcada por rápidas mudanças sociais, decorrentes da evolução científica e tecnológica, torna-se premente que os alunos passem de meros consumidores tecnológicos a produtores de conteúdos. Os alunos de hoje têm de ser preparados para profissões que não existem, pelo que, mais do que conhecimentos, necessitam de adquirir competências para o século XXI, que lhes vão permitir reconstruir o conhecimento à medida das necessidades das novas profissões. O Pensamento Computacional surge, assim, como uma das competências-chave dentro do quadro das 21st Century Skills, de acordo com o referido no *DigiCompEdu* - Quadro Europeu de Competência Digital para Educadores.

A ênfase na importância da programação e pensamento computacional tem sido uma constante nas correntes pedagógicas recentes (Wing, 2006, 2010; NRC, 2011). Nas áreas das Ciências, Tecnologias, Engenharias, Artes, Matemática (STEAM), a programação e a robótica revestem-se de particular importância, sendo reconhecidas como indispensáveis no desenvolvimento de competências, tais como a resolução de problemas e o aumento da eficiência através da automação (Wing, 2010).

Desta forma, afigura-se necessário o desenvolvimento do pensamento computacional porque envolve a resolução de problemas, o que enfatiza a ideia de Polya (2004), que definiu a abstração (definida como a combinação de analogia, generalização e especialização) e a decomposição de problemas como cruciais para o sucesso na resolução de problemas.

Na mesma óptica Pollock et al. (2019) caracterizam o pensamento computacional como a decomposição (divide um problema em sub-problemas), algoritmos (cria uma série de etapas ordenadas para resolver um problema ou alcançar uma meta), dados (analisa um conjunto de dados para garantir que facilita a descoberta de padrões e relações) e abstração (reduz a complexidade para criar uma representação geral de um

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processo ou grupo de objetos para que não seja apenas apropriado para o objeto imediato, mas também para que possa ser usado em diferentes contextos).

Selby & Woolard (2013) e Tabesh (2017) mencionam que o pensamento computacional para além de estar associado à decomposição, reconhecimento de padrões, algoritmia e abstração, identificam a importância da depuração, ou seja, a capacidade para testar e avaliar a eficácia da solução, corrigir erros e procurar refinar e otimizar a solução.

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Desta forma, há uma convergência de várias áreas que promovem o desenvolvimento da literacia matemática, ou seja, a capacidade de utilizar conhecimentos matemáticos na resolução de problemas da vida quotidiana (Ponte, 2003).

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Para além das referências anteriormente mencionadas tivemos em consideração os documentos curriculares, atualmente em vigor, nomeadamente: o Perfil dos Alunos à Saída da Escolaridade Obrigatória, as Orientações curriculares para as TIC no 1.° CEB e as Aprendizagens Essenciais da Matemática.

Estes documentos curriculares têm um carácter central, enquanto conteúdos de aprendizagem na área curricular de Matemática, tanto nas transversais, como conhecimentos matemáticos, assim como nas atitudes face à matemática.

Este projeto surgiu tendo como referência os autores de renome na área do pensamento computacional e por outro lado como uma necessidade de dar resposta às necessidades dos alunos do século XXI. Salientamos que o pensamento computacional já fazia parte do currículo de 11 países, tais como Œustria, República Checa, Dinamarca, Finlândia, França, Grécia, Hungria, Itália, Lituânia, Suíça e Turquia.

Este projeto, que contribuiu para a reflexão do Grupo Trabalho de Matemática, criado no âmbito do Despacho n.° 12530/2018, alterado pelo Despacho n.° 7269/2019, quereconheceu como necessidade futura relativa à educação matemática o pensamento computacional e as diferentes áreas a ele associadas.

Este projeto, iniciado em 2019, envolveu professores do 1.° Ciclo do Ensino Básico de 30 Agrupamentos de Escolas de Portugal continental e teve como objetivo principal a criação de recursos e contextos de formação para professores deste nível de ensino, para dar suporte ao desenvolvimento das suas competências profissionais, nos domínios da matemática e das TIC, para os habilitar para trabalhar as questões do pensamento computacional, da algoritmia e da computação, em sala de aula, com os alunos.

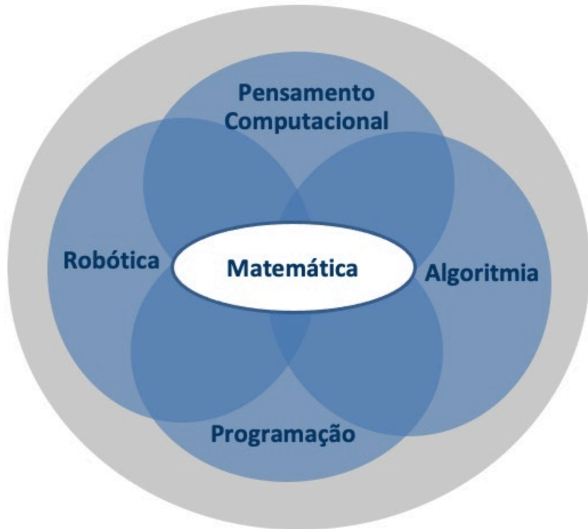

Figura 1: A literacia matemática como ponto de convergência

Os objetivos gerais deste projeto foram: (1) Sensibilizar para a importância destes conteúdos na formação dos alunos do século XXI; (2) Preparar e realizar uma formação para professores em que se mobilizem conceitos do currículo da matemática, de algoritmia, pensamento computacional e programação e se preparem atividades práticas para a sala de aula; (3) Identificar e avaliar as potencialidades do recurso a tarefas que relacionem a Matemática com as TIC; (4) Criar um conjunto de recursos educativos que sirvam de suporte ao trabalho de outros docentes deste nível de ensino.

Integradas na fase de implementação do projeto MatemaTIC, as formações de formadores e de professores decorreram ao longo do ano letivo 2020/21 em regime de *e-learning*. No processo de formação participaram 11 formadores e 107 professores, distribuídos por 9 turmas de norte a sul do país.

Estas formações, na modalidade de curso, realizaram-se de forma articulada, permitindo a existência de tempo, por um lado, para que os formadores discutissem conceitos e dinâmicas de formação e, por outro, para que os professores se apropriassem dos conceitos trabalhados nas tarefas propostas e, deste modo, tivessem condições para as implementar com os seus alunos. Foram, ainda, criadas condições para que os professores pudessem desenhar e/ou adaptar tarefas matemáticas com a intencionalidade de integração e desenvolvimento de práticas do pensamento computacional.

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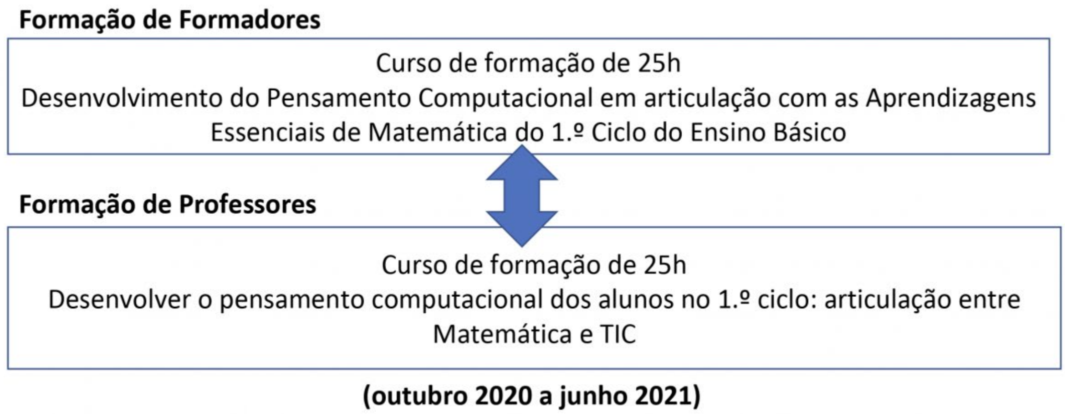

Figura 2: Esquema com organização da formação de formadores e com a formação de professores

No âmbito da formação, foram trabalhadas tarefas matemáticas, que contemplam o uso de recursos muito diversos (desde o papel e lápis, às linguagens de programação por blocos) e as respetivas práticas de sala de aula, tendo sido planificadas com a intencionalidade de desenvolver o pensamento computacional, através da explicitação de práticas como a abstração, a decomposição, o reconhecimento de padrões e a depuração. Os recursos educativos trabalhados, discutidos e implementados, serão tornados públicos, sob a forma de *e-portfolio*, para serem utilizados por outros professores deste nível de ensino.

Ao longo do projeto, foram organizadas reuniões de acompanhamento, para as quais foram envolvidos elementos da DGE, da APM, bem como da Universidade de Coimbra e do CCTIC da Universidade de Évora. Paralelamente, foi criada uma comunidade de prática, que serviu de apoio e suporte à formação, facilitando o processo de comunicação entre os formadores e professores, através da interação em fóruns de diálogo e partilha de ideias/materiais.

Deste projeto será elaborado um relatório, pela equipa da Universidade de Coimbra, que será tornado público, com dados relativos a:

- Metodologias de Ensino;
- Processos e métodos de implementação de práticas inovadoras;
- Impacto dessas práticas no desenvolvimento profissional dos professores;
- Outros dados considerados pertinentes.

Ainda no âmbito do projeto, decorreu, nos dias 7 e 8 de maio de 2021, o Evento Nacional MatemaTIC, com o título: "O Pensamento Computacional e o Currículo da Matemática em Portugal".

Na 1.Ψ parte do evento, concretizou-se uma discussão em torno dos fundamentos de diversas áreas das Ciências da Computação, em articulação com o currículo da Matemática e, na 2.Ψ parte, foram apresentadas algumas das atividades práticas desenvolvidas com professores e alunos. Participaram 1330 professores, formadores, especialistas e público em geral.

Deste projeto resultou a reflexão de que as ações de formação tiveram um impacto muito positivo quer nos formandos, quer nos formadores, porque, para além do desenvolvimento de conhecimentos, capacidades e atitudes, se promoveu a ligação entre especialistas e professores e foram sugeridas boas práticas que se assumiram como modelos para a replicação da formação.

Como resultados desta formação sublinhamos uma evolução dos formandos no domínio e na aplicação de práticas do pensamento computacional e foram desenvolvidas aprendizagens e metodologias e estratégias de ensino ativas e motivadoras que levaram os alunos e os professores a desenvolverem competências básicas ao nível da matemática e da prática do pensamento computacional. É ainda de salientar a reflexão que os formandos fazem da formação porque evidenciaram:

- A tomada de consciência das aprendizagens que pretendem consolidar nos alunos;
- A importância dos conteúdos a desenvolver;
- O processo de apoio aos alunos com tarefas gradualmente mais complexas, ajudando a construir raciocínios e a desenvolver linguagem matemática;
- O importância da generalização e transferência do processo de resolução de problemas para uma ampla variedade de tarefas semelhantes;
- A Importância do trabalho colaborativo;
- O papel ativo do aluno na construção do conhecimento; e
- A importância de envolver o aluno no processo de avaliação no sentido de se autoavaliar e de se autocorrigir;

Neste processo destacamos como dificuldades a adaptação da formação na modalidade de oficina, com regime presencial para a modalidade de curso em regime de e-learning uma vez que a manipulação de materiais concretos constituía uma mais-valia da formação. Porém, apesar dos constrangimentos verificou-se uma melhoria gradual da capacidade de explorar e discutir matemática e consequente melhoria das segundas versões das tarefas realizadas nas sessões assíncronas.

Em jeito de síntese, podemos destacar a ênfase crescente nas práticas de pensamento computacional na abordagem das tarefas matemáticas e também é de salientar a importância da discussão de conceitos matemáticos e práticas de sala de aula e do desenvolvimento do pensamento computacional de forma integrada.

Neste contexto, apresentamos como sugestão o desenvolvimento e alargamento das ações a criação de redes de escolas e de formadores que possam replicar a formação, permitindo a construção de uma comunidade de apoio ao trabalho a ser produzido, criando uma estrutura de apoio intermédia.

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An Improved Hungarian Algorithm for a Special Case of Unbalanced Assignment Problems

By Mohammad Shyfur Rahman Chowdhury
International Islamic University Chittagong

Abstract- The current Hungarian approach to solving unbalanced assignment issues is based on the notion that some tasks should be delegated to fictitious or covert components, and those studies should be left unperformed. In real-world scenarios, it may be desirable to carry out all of the tasks on fundamental details. To do this, multiple tasks may be distributed to a single machine. The current research's enhanced Hungarian method for addressing unbalanced assignment challenges results in the ideal work assignment policy. An example using numbers shows how well the suggested strategy works and how effective it is. The acquired result is then likened to other current approaches to demonstrate our algorithm's superiority.

GJSFR-F Classification: *DDC Code: 005.1 LCC Code: QA76.6*

ANIMPROVEDHUNGARIANALGORITHMFORASPECIALCASEOFUNBALANCEDASSIGNMENTPROBLEMS

Strictly as per the compliance and regulations of:

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An Improved Hungarian Algorithm for a Special Case of Unbalanced Assignment Problems

Mohammad Shyfur Rahman Chowdhury

Abstract- The current Hungarian approach to solving unbalanced assignment issues is based on the notion that some tasks should be delegated to fictitious or covert components, and those studies should be left unperformed. In real-world scenarios, it may be desirable to carry out all of the tasks on fundamental details. To do this, multiple tasks may be distributed to a single machine. The current research's enhanced Hungarian method for addressing unbalanced assignment challenges results in the ideal work assignment policy. An example using numbers shows how well the suggested strategy works and how effective it is. The acquired result is then likened to other current approaches to demonstrate our algorithm's superiority.

I. Introduction

One of the most significant applications of optimization theory is the Assignment Problem, where various tasks need to be distributed across components to be completed, such as spreding personnel to offices and drivers to buses, among other things. There have been numerous ways of exploring the best policy for assigning jobs to components. The Hungarian approach is the most frequently used method for determining the best assignment policy. The Hungarian Method was named by Kuhn (Kuhn, 1995) and was based in significant part on earlier work by two Hungarian mathematicians, Egervary and D. Konig. When the Hungarian approach is used to address an uneven assignment problem, the technique assigns the jobs to fake components that do not perform them (if the number of jobs is greater than the number of components). It seems impossible to leave jobs unfinished in real-world situations. As a result, rather than assigning extra work to dummy components, it is recommended to do each and every job that may be done by assigning multiple jobs to a single component.

To tackle assignment problems, the Hungarian algorithm (Chen., 2011) (W. B. Lee, 1997) and specific heuristic algorithms (e.g., simulated annealing method (B. Li, 2002) ant colony algorithm (Y. Liang, 2005) (R. K. Yin, 2008) particle swarm algorithm (W. F. Tan, 2007) and genetic algorithm (S. Q. Tao, 2004). Heuristic approaches are frequently employed to solve problems with assignments of high complexity. However, because the search is conducted at random, it cannot guarantee that the optimal result will be obtained. The Hungarian algorithm is an algorithm with a mathematical foundation. The Hungarian algorithm is commonly used to tackle assignment problems because of its simplicity and ability to find the best solution without requiring validation

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(X. Q. Hu, 2006) (M. J. Liu, 2013) (H. Z. Zhang, 2009) (L. W. Huang, 2007) (Y. Wang, 2005).

In (J. L. Du, 2010), an enhanced Hungarian algorithm, the "add zero row approach," was presented to handle the incomplete assignment problem based on a study of the standard Hungarian algorithm. The Hungarian method was first introduced by (T. M. Chang, 2004) and, it was used to solve a common assignment problem, such as a marriage assignment. (Ma., 2014) suggested a new method, the "difference method," for solving the non-standard assignment problem: "tasks more than the number of people." This method is more straightforward than the standard algorithm because it does not require using a new matrix to replace the original coefficient matrix at the beginning and instead solves the problems directly on the old coefficient matrix. (Qiu., 2013) suggested an enhanced Hungarian algorithm for studying multiple maintenance scheduling problems in hostile environments. A quick order reduction optimization approach based on the classical Hungarian algorithm was proposed (J. X. Ren, 2014) to increase the efficiency of the distribution of cloud computing activities. The order of the matrix is quickly lowered and, the computing efficiency is increased by deleting the matrix elements that are determined. Reference (R, 2014) used the Hungarian technique to investigate the dynamic power allocation of weapon-targets by changing it into an assignment issue. Furthermore, the traditional Hungarian algorithm has been used to tackle business and technical challenges in a variety of disciplines (P. Hahn, 1998) (Kuhn., 2012) (E. M. Loiola, 2007) (T. Tassa, 2008) (S. Promparmote, 2006) (M. H. Paul, 2013).

According to many authors, the unbalanced assignment problem has many solutions, all of which assume that all jobs are finished. Kumar (Kumar, 2006) came up with a fresh approach to address the problem of uneven assignments. The decision-maker can allocate several tasks to a single component using his methodology. The Lexi Search Approach, developed by Haragopal and Yadaiah (V. Yadaiah, 2016), is a more effective technique for dealing with imbalanced assignment problems that yield the same outcomes as Kumar (Kumar, 2006). In the same year, Kumar's (Kumar, 2006), Haragopal's and Yadaiah's (V. Yadaiah, 2016) methods were surpassed by an approach provided by Betts and Vasko (Vasko, 2016).

II. Mathematical Formulation

Consider the processing cost of the jth job on the ith component be Cij, where i = 1, 2..., m; j = 1, 2..., n. The challenge is to create an ideal work assignment method that ensures that every task is finished while keeping the overall cost of doing so as low as possible.

Mathematical model of an unbalanced assignment problem can be expressed as,

Minimize: $Z = \sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij} X_{ij}$

Subject to constraints

$$\sum_{j=1}^{n} X_{ij} \geq 1, i = 1,2,\ldots\ldots\ldots, m \quad (1)$$

$$\sum_{j=1}^{n} X_{ij} \geq 1, j = 1,2,\ldots\ldots\ldots, n \quad (2)$$

$X_{ij} = 0 \; or \; 1$

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III. Proposed Algorithm

Think about the issue of distributing a group of "n" jobs. $J = J_1, J_2, \ldots J_n$ to an execution set with "m" components. $C = (C_1, C_2, \ldots, Cm)$. X_{ij}, $i = 1, 2, \ldots, m$; $j = 1, 2, \ldots, n$ (n ¿ m), indicating that there are more tasks than components. In this case, n stands for columns and m for rows.

Step-01: Enter the following values: m, n

Step-02: Each column's lowest cost should be subtracted from the column it belongs. This process results in each column reducing the cost column by having at least a single zero.

Step-03: Determine each row's lowest cost and then deduct it from the associated row.

Step-04: Analyze the feasibility of doing an ideal task so that the smallest number of lines needed to cover each zero is calculated. If the number of lines and rows equals one, proceed to Step 7; if not, proceed to Step 5.
Choose the minimum uncovered cost if the number of lines exceeds the number of rows.

1. Take the least exposed cost in the table and subtract it from each exposed cost.
2. The cost at each intersection point is added by those minimum cost.

Step 06: If the case (the total number of lines and rows is equal) fails, then continue steps 04 and 05.
To assign the work, look for a row with only one zero. Choose that zero and block the other zeros in the relevant columns (the same component can be performed on more than one job, but the same job cannot be assigned more than one component).

Step-08: Assign the value with the lowest cost in the initial problem if there is a tie, that is, if any rows have two or more zeros.

Step-09: Repeat steps 7 and 8 until all positions have been filled, that is, all jobs have been assigned to one or more processing components.

Step-10: End

IV. Parallelism between Proposed Algorithm and Hungarian Algorithm

Table 1

Proposed	Hungarian
• This tactic is employed to address issues with unbalanced assignments. • If the number of jobs exceeds the number of processing components, all jobs must be completed using the available components." • There are no unfinished projects. • Related to at least one job that can be performed by a single component. • A single component can only be assigned to a single job.	• This tactic is employed to address issues with unbalanced assignments. • If the number of jobs exceeds the number of components, the remaining jobs are performed by dummy components. • Some jobs aren't being completed. • A single component can only do one thing. • Only one component can be allocated to a single job.

V. Mathematical Analysis

Let us take a problem of 8 jobs and 5 processing components with associated execution costs as given in Table 2.

Table 2

	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8
C_1	270	260	220	190	300	320	180	250
C_2	210	190	300	200	290	180	190	310
C_3	190	260	230	220	280	190	300	290
C_4	250	210	180	190	290	240	190	300
C_5	160	180	160	140	210	170	180	200

Table 3: Follows steps 1, 2 and, 3

	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8
C_1	50	80	60	90	40	150	0	50
C_2	50	0	130	70	40	0	0	100
C_3	60	60	50	50	10	0	100	70
C_4	40	20	10	70	80	60	0	90
C_5	0	0	0	0	0	0	0	0

Table 4: Follows step 4

	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8
C_1	40	80	60	50	90	150	0	50
C_2	40	0	130	50	70	0	0	100
C_3	10	60	50	60	50	0	100	70
C_4	80	20	10	40	70	60	0	90
C_5	0	0	0	0	0	0	0	0

By step 5; from the uncovered costs, choose the lowest cost (i.e. 10)
i. Deduct 10 from each exposed cost in the matrix above.
ii. To get Table 5, sum up 10 at each of the intersection points.

Table 5

	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8
C_1	30	80	50	40	80	150	0	40
C_2	30	0	120	40	60	0	0	90
C_3	0	60	40	50	40	0	100	60
C_4	70	0	0	30	60	60	0	80
C_5	0	10	0	0	0	10	0	0

Following steps 6 and 7, we allocate job J_3 to component M_1 and cross off the remaining zeros in the row corresponding to J_3; as a result, row four has just one zero. As stated in Table 6, allocate work J_7 to component M_4.

Table 6

	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8
C_1	30	80	50	40	80	150	0	40
C_2	30	0	120	40	60	0	0	90
C_3	0	60	40	50	40	0	100	60
C_4	70	0	0	30	60	60	0	80
C_5	0	10	0	0	0	10	0	0

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According to step 8, there is a tie in the 2nd and 3rd rows (containing two zeros). We allocate J_4 to component M_2 (in Table-7) because the cost associated with this position is the lowest in the original cost matrix.

Table 7

	J_1	**J_2**	**J_3**	**J_4**	**J_5**	**J_6**	**J_7**	**J_8**
C_1	30	80	50	40	80	150	0	40
C_2	30	0	120	40	60	0	0 ×	90
C_3	0	60	40	50	40	0	100	60
C_4	70	20	0	30	60	60	0 ×	80
C_5	0	10	0 ×	0	0	10	10	0

Then following step 9, we get the final table-8.

Table 8

	J_1	**J_2**	**J_3**	**J_4**	**J_5**	**J_6**	**J_7**	**J_8**
C_1	30	80	50	40	80	150	0	40
C_2	30	0	120	40	60	0	0 ×	90
C_3	0	60	40	50	40	0 ×	100	60
C_4	70	20	0	30	60	60	θ	80
C_5	0 ×	10	0 ×	0	0	10	10	0

VI. Results and Discussion

Table 9 shows the work assignment policy that reduces the overall cost.

Component	**Job**	**Cost**
C_1	J_7	180
C_2	J_2,J_6	190,180
C_3	J_1	180
C_4	J_3	190
C_5	J_4, J_5, J_8	140, 210,200
Total Cost1470		

We find the total minimum cost in comparison to the other modified Hungarian methods like Kumar [26], Haragopal and Yadaiah [27], and Betts and Vasko [28].

VII. Conclusion

The study presents an improved Hungarian algorithm to solve a particular case (when the number of jobs is greater than the number of processing components) of an unbalanced assignment problem. Generally, most of the issues regarding assignments occur in the abovementioned case. The primary premise of our strategy is to allocate all tasks to be completed. If the created assignment plan is invalid, the virtual jobs will be changed, and the procedure will be continued until an actual optimal assignment strategy is discovered. We show that the assignment strategy found by the suggested approach is the best using mathematical analysis. It demonstrates that the revised algorithm is capable of determining the best assignment strategy.

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On Baysian Estimation of Loss of Estimators of Unknown Parameter of Binomial Distribution

By Randhir Singh
Ewing Christian College

Summary- This paper aims at the Bayesian estimation for the loss and risk functions of the unknown parameter of the binomial distribution under the loss function which is different from that given by Rukhin(1988). The estimation involves beta distribution, a natural conjugate prior density function for the unknown parameter. Estimators obtained are conservatively biased and have finite frequentist risk.

Keywords: Bayes Estimator, Loss Function, Risk Function, Binomial Distribution.

GJSFR-F Classification: DDC Code: 843.7 LCC Code: PQ2165.C5

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On Baysian Estimation of Loss of Estimators of Unknown Parameter of Binomial Distribution

Randhir Singh

Summary- This paper aims at the Bayesian estimation for the loss and risk functions of the unknown parameter of the binomial distribution under the loss function which is different from that given by Rukhin(1988). The estimation involves beta distribution, a natural conjugate prior density function for the unknown parameter. Estimators obtained are conservatively biased and have finite frequentist risk.

Keywords: Bayes Estimator, Loss Function, Risk Function, Binomial Distribution.

I. Introduction

Rukhin(1988) introduced a loss function given by,

$$L(\theta,\delta,\gamma) = w(\theta,\delta)\gamma^{-\frac{1}{2}} + \gamma^{\frac{1}{2}} \qquad (1.1)$$

Where,γ is an estimator of the loss function $w(\theta,\delta)$,which is non-negative. Guobing(2016) used this loss function and derived estimates of the loss and risk function of the parameter of Maxwell's distribution.Singh (2021) took various forms of $w(\theta,\delta)$ and derived estimates of the loss and risk function of the parameter of a continuous distribution which gives Half-normal distribution,Rayleigh distribution and Maxwell's distribution as particular cases. Rukhin(1988) considered the Bayesian estimation of the unknown parameter θ of the binomial distribution by taking

$$w(\theta,\delta) = (\theta-\delta)^2 \qquad (1.2)$$

In this paper,Bayes estimate of the unknown parameter θ of the binomial distribution has been obtained by replacing $w(\theta,\delta)$ by $w_1(\theta,\delta)$ given by

$$w_1(\theta,\delta) = h(\theta)(\theta-\delta)^2 \qquad (1.3)$$

Where,

$$h(\theta) = \frac{1}{\{\theta(1-\theta)\}} \qquad (1.4)$$

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II. Estimation of Loss and Risk of the Parameter of Binomial Distribution

Let the random variable X follows binomial distribution with parameters n and θ.Where θ is unknown satisfying $0 \leq \theta \leq 1$.The prior p.d.f of θ,denoted by $\pi_1(\theta)$ is as follows:

$$\pi_1(\theta) = \begin{cases} \frac{\theta^{\alpha-1}(1-\theta)^{\beta-1}}{B(\alpha,\beta)} & \text{if } \alpha \geq 0, \beta \geq 0, 0 < \theta < 1 \\ 0 & Otherwise \end{cases} \tag{2.1}$$

Notes

Under the assumption of prior probability density function (p.d.f.) for θ as above,Bayes estimates of θ derived by Rukhin (1988) were as follows: For $\alpha \geq 0, \beta \geq 0$

$$\delta_B(X) = \frac{(X+\alpha)}{(n+\alpha+\beta)} \tag{2.2}$$

$$\gamma_B(X) = \frac{(X+\alpha)(n+\beta-X)}{(n+\alpha+\beta)^2(n+\alpha+\beta+1)} \tag{2.3}$$

and for $\alpha = 0, \beta = 0$

$$\delta_0(X) = \frac{X}{n} \tag{2.4}$$

$$\gamma_0(X) = \frac{X(n-X)}{n^2(n+1)} \tag{2.5}$$

It was shown that

$$E_\theta L(\theta, \delta_0, \gamma_0) = \infty \tag{2.6}$$

Under,$w_1(\theta, \delta)$ as above, the corresponding Bayes estimate is given by, For $\alpha \geq 0, \beta \geq 0$

$$\delta_{1B}(X) = \frac{E\{\theta h(\theta)/X\}}{E\{h(\theta)/X\}} \tag{2.7}$$

Or,

$$\delta_{1B}(X) = \frac{(X+\alpha-1)}{A-2} \tag{2.8}$$

On simplification,provided,$A = n + \alpha + \beta > 2$ and,

$$\gamma_{1B}(X) = E\{\theta h(\theta)/X\} - \{\delta_{1B}(X)\}^2 E\{h(\theta)/X\} \tag{2.9}$$

Notes

Or,

$$\gamma_{1B}(X) = \frac{1}{A-2} \tag{2.10}$$

on simplification,provided,$A = n + \alpha + \beta > 2$.

We,see that, in this case $\gamma_{1B}(X)$ does not depend upon X and is function of n,α and β

$$E_\theta L(\theta, \delta_{1B}, \gamma_{1B}) = E_\theta[h(\theta)(\theta - (X + \alpha - 1)(A-2)^{-1})^2](A-2)^{1/2} + (A-2)^{-1/2} \tag{2.11}$$

Or,

$$E_\theta L(\theta, \delta_{1B}, \gamma_{1B}) = [n + h(\theta)(1 - \alpha + \theta(\alpha + \beta - 2))^2](A-2)^{-3/2} + (A-2)^{-1/2} < \infty \tag{2.12}$$

In this case,

$$R(\theta, \delta_{1B}) = E_\theta\{h(\theta)(\theta - \delta_{1B})\}^2 \tag{2.13}$$

Or,

$$R(\theta, \delta_{1B}) = [n + h(\theta)\{1 - \alpha + \theta(\alpha + \beta - 2)\}^2](A-2)^{-2} \tag{2.14}$$

As mentioned by Keifer (1977),an estimator $\gamma(X)$is said to be conservatively biased if,

$$E_\theta\{\gamma(X)\} \geq R(\theta, \delta) = E_\theta\{w(\theta, \delta)\} \tag{2.15}$$

In the light of this condition,$\gamma_0(X)$ as given by Rukhin (1988) is not conservatively biased. In this case,

$$E_\theta\{\gamma_{1B}(X)\} = \frac{1}{A-2} \tag{2.16}$$

Let $\delta_{0B}(X)$ and $\gamma_{0B}(X)$be values of $\delta_{1B}(X)$ and $\gamma_{1B}(X)$,respectively when,$\alpha = \beta = 0$.If possible let ,

$$E_\theta\{\gamma_{0B}(X)\} \geq R(\theta, \delta_{0B}) \tag{2.17}$$

which holds if,

$$-2\theta^2 + 2\theta - 1 \geq 0 \tag{2.18}$$

which is a contradiction,since $0 < \theta < 1$ and maximum value of $-2\theta^2 + 2\theta - 1$ is$-\frac{1}{2}$ which corresponds to $\theta = \frac{1}{2}$.Moreover,$-2\theta^2 + 2\theta - 1 = -1$ for $\theta = 1$ and $\theta = 0$ Thus,$\gamma_{0B}(X)$ is not conservatively biased.

When $\alpha = \beta = 1$,we have,

$$E_\theta\{\gamma_{1B}(X)\} = R(\theta, \delta_{1B}) = \frac{1}{n} \tag{2.19}$$

When,$\alpha = \beta > 1, \theta = 0.5$,

$$E_\theta\{\gamma_{1B}(X)\} \geq R(\theta, \delta_{1B}) \tag{2.20}$$

When,$\alpha = \beta > 1, \theta \neq 0.5$,

$$E_\theta\{\gamma_{1B}(X)\} \geq R(\theta, \delta_{1B}) \tag{2.21}$$

which holds if

$$\alpha \leq 1 + g(\theta) \tag{2.22}$$

.Where,

$$g(\theta) = \frac{2\theta(1-\theta)}{(2\theta-1)^2} \tag{2.23}$$

$g(\theta)$ is a monotonically increasing function of θ over the set $S = (0,1) - \{0.5\}$.Hence, $\gamma_{1B}(X)$ as above,presents a valid 'frequentist report' as mentioned by Berger(1985).

The results are summerized in the following:

THEOREM.Let $(\delta_{1B}, \gamma_{1B})$ be Bayes estimators of the unknown parameter θ of the binomial distribution under the loss function $L(\theta, \delta, \gamma) = \frac{1}{\{\theta(1-\theta)\}}(\theta-\delta)^2\gamma^{-\frac{1}{2}} + \gamma^{\frac{1}{2}}$ and beta prior density with known parameters α and β.Then,the frequentist risk $E_\theta L(\theta, \delta_{1B}, \gamma_{1B})$ is finite for all values of α and β provided $0 < \theta < 1$.For $\alpha = \beta = 0$, $\gamma_{1B}(X)$ is not conservatively biased. The estimator $\gamma_{1B}(X)$ is conservatively biased for$\alpha = \beta = 1$ and for $\alpha = \beta > 1$ satisfying $\alpha \leq 1 + \frac{2\theta(1-\theta)}{(2\theta-1)^2}, \theta \neq 0.5$.However, if $\alpha = \beta > 1, \theta = 0.5$, $\gamma_{1B}(X)$ is also conservatively biased.

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Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

Authorship Policies

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

Copyright

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Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- o Single section and succinct.
- o An outline of the job done is always written in past tense.
- o Concentrate on shortening results—limit background information to a verdict or two.
- o Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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