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Proactive modeling of goals and elaboration of computerized solutions

Modelação proativa de metas e elaboração de soluções informatizadas

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ABSTRACT: Computerized solutions for solving concrete everyday problems are structured through deductive algorithms. However, even before designing algorithms, there is an abductive step guided by the goal to be achieved, which is usually neglected. Following Rauen's (2014) Goal Conciliation Theory, I intend in this study to describe and explain the process of formulation, execution and checking of ante-factual abductive hypotheses in developing a computerized solution.

Keywords: Goal Conciliation Theory; Relevance Theory; Proactive Modeling of Goals; Ante-factual Abductive Hypotheses; Algorithms.

RESUMO: Soluções informatizadas para resolução de problemas que emergem de necessidades cotidianas concretas são estruturadas através de algoritmos dedutivos. Todavia, antes mesmo de elaborar algoritmos, há uma etapa abdutiva que é geralmente negligenciada. Seguindo a Teoria da Conciliação de Metas proposta por Rauen (2014), pretende-se descrever e explicar neste estudo como ocorre o processo de elaboração, execução e checagem de hipóteses abdutivas antefactuais na elaboração de uma solução informatizada.

Palavras-chave: Teoria de Conciliação de Metas; Teoria da Relevância; Modelação Proativa de Metas; Hipóteses Abdutivas Antefactuais; Algoritmos.

1 Algorithms and computerized solutions[1]

Algorithms are sequences of steps followed in a default order, leading to the solution of a problem or demand. In a broader sense, an algorithm can also be used as a synonym of recipe, process, method, procedure or routine. Technically, algorithms "consist in a logical, orderly and finite sequence of executable instructions, which solve a given problem" (BORATTI, 1990).

The development of an algorithm is based on programming logic[2] in a process that essentially consists in the generation of conclusions from a list of premises. The algorithm is the starting point for the achievement of a program and, consequently, is the basis of a computerized solution. In other words, all computerized solutions are generated from algorithms.

The quality of an algorithm determines the quality of the computerized solution. If the algorithm is inconsistent or is faulty, then the program will also be inconsistent or contain failures[3]. That said, knowing how to properly build an algorithm is as important as building the program. As Fernandes and Botini (1998, p. 5) argue, "if the algorithm is of high quality, it will not matter what the programming language is in which it will be developed, because the outcome (the program itself) will consequently be of high quality."

A recipe to make a cake can be an example of algorithm: Mix the ingredients; Beat them for 5 minutes; Lightly grease the baking pan with butter; Pour the batter into the pan; Bring the pan to the oven; Bake for 30 minutes; Remove the cake from the pan while still warm; Serve. In this example, it is possible to realize that the syntactic order of actions is important for the achievement of the cake. If this order is not followed, the cake could be placed in the oven for baking before the ingredients were mixed, for example.

Viewing algorithms as a logical sequence of ordered, finite and unambiguous steps – with beginning, middle and end – can lead us to the assumption that it is a completely deductive process, formed from sequences of propositions (premises) that lead to a particular conclusion.

The internal structure of the algorithms shows that they actually follow a logical deductive path where: *P* being the antecedent and *Q* being the consequent, given *P*, we always have *Q*. Exposing a more detailed form we would have.

$P \rightarrow Q$	A true *P* implies a true *Q*
P	Given a true *P*
Q	Then, *Q* is true

However, when analyzing the elaboration of an algorithm as a whole, we can realize that a substantial part of the task, perhaps the most important one, is omitted, i.e., the structure of the algorithms little or nothing reveals about how these assumptions were previously chosen.

Given this context, this study aims to describe and explain, in accordance with the Goal Conciliation Theory (RAUEN, 2013, 2014), a common situation in informatics: the elaboration of a computerized solution based on an algorithm. The study assumes that the search for a computerized solution seems to be rather an abductive process. So, this hypothetical process triggers the various steps based on deductive reasoning.

Before dealing with the example, I present the theoretical proposal.

[1] I acknowledge Dr. Fábio José Rauen's essential contributions to this study.

[2] John McCarthy (1958) was the one who first proposed the use of mathematical logic for computer programming. Many artificial languages were developed from this concept in programming.

[3] Acording to Teixeira (2004), a survey conducted by consulting firm American Cutter, with 150 software makers, pointed out that a third of them admitted launching on the market software with defects. In addition, the American economy spends approximately 60 billion dollars per year with defective software. In Brazil, experts believe that this value may reach 8 billion reais, i.e. 0.6% of PIB.

2 Proactive modeling of goals from abductive hypotheses

Rauen (2014) presents an abductive/deductive approach to proactive modeling of goals, which connect the notions of relevance and goal. He argues that the expansion of the cognitive context for the processing of goals is abductive, so the cognition is moved rather by a presumed conclusion (goal) than by the emergence of premises. His proposal does not rule out the deductive module proposed by Relevance Theory, but integrates this module to check these abductive hypotheses.

Rauen's model is especially based on the cognitive principle of relevance that the human mind tends to maximize the relevance (SPERBER; WILSON, 1995). The term *relevance* defines a property of inputs directed to cognition. It is by processing an input that modifications and rearrangements of cognitive assumptions can happen. An input is relevant when it is worth being processed, i.e., when the cognitive effects compensate the efforts of its processing. Thus, in the same context, the larger the cognitive effects and/or the smaller the processing efforts, the larger is the relevance.

Moreover, Rauen agrees with Lindsay and Gorayska's notion of relevance as a *goal-dependent predicate* (2004, p. 69). Based on this approach, the individuals assign relevance to inputs based on purposes or plans they are involved in. So, an event is relevant when it is competing for any plan that is thought to be sufficient to achieve a given goal. This converges with Silveira and Feltes (1999, p. 37), when they state that individuals pay attention to stimuli that, in some way, comes to meet their interests or fit the circumstances of the moment. Thus, the individuals can be reacting to stimuli or can be proactively acting by previous interests or purposes.

The proactive modeling of goals as proposed by Rauen (2014) consists of four stages: goal formulation, and formulation, execution and checking of an ante-factual abductive hypothesis.

2.1 Formulation of the goal

The first stage of the model is formulating a goal. According to Rauen, this step can be formalized as follow:

[1] The individual *i* formulates a goal *Q* at the time t_1,

The model exposes that the process starts at t_1, which represents the time of the emergence of the demand to achieve the goal *Q*, and the goal *Q* is a future possibility not yet existing at the time t_1 (the time of the goal formulation *Q*).

The output of this stage can be represented as follows.

[1] *Q*

2.2 Formulation of an ante-factual abductive hypothesis

The second stage of the modeling consists in proposing at least one ante-factual abductive hypothesis.

Considering the case of any goal *Q* and an individual *i* that realizes being in this state of goal *Q* in the future. So, *x is Q* is equivalent to any state *x* that will satisfy the expectation of achieving the goal *Q*. Therefore, the individual *i* formulates at least one abductive hypothesis that there is a nomological connection between *P* and *Q*, and considers an antecedent action *P* as at least sufficient to achieve the consequent state *Q*. It Follows that *x is P*, and the individual *i* performs the action *P* in expectation of achieving *Q*.

In this stage, the agent abducts a *hypothesis* or *inference to the best solution*, *principle of plausibility*, which simultaneously is the lowest cost solution faced with the fixed effect of the goal, *principle of relevance*. At this point, the modeling converges with Harman's (1965) *inference to the best explanation*. The best solution would be connected with a principle of plausibility. Thus, if an explanatory abductive hypothesis H_e is accepted when it explains the evidence and no other rival hypothesis does as well as H_e does, then an ante-factual abductive hypothesis H_a is adopted when it suggests being able to achieve a goal with more efficiency and no other rival hypothesis does this as well as H_a does.

Simultaneously, Rauen argues that the principle of relevance assumes the role of a cut line for the emergence of rival hypotheses such that the first abductive hypothesis considered consistent with this principle is the hypothesis that demands lower processing cost faced with the fixed effect of achieving the goal. In other words, in the second stage of the modeling, the agent formulates an ante-factual abductive hypothesis that best contributes to achieving the goal and that is probably the first hypothesis that has emerged in the context. This stage can be formulated as follows.

[2] The individual *i* abducts an ante-factual hypothesis H_a to achieve the goal *Q* at time t_2.

The output of this step can be represented as follows:

[1] *Q*
[2] *P* *Q*

2.3 Execution

In the third stage, the agent performs the antecedent action *P* for achieving the consequent state *Q*. This stage can be formulated as follows.

[3a] The individual *i* performs *P* to achieve *Q* at the time t_3, or
[3b] The individual *i* does not perform *P* to achieve *Q* at the time t_3.

This description considers that there is a proper time t_3 of the execution of the antecedent action, which follows the formulation of the ante-factual abductive hypothesis H_a. There is a positive model in which action *P* is carried out; and, by definition, there is the negative model in which action *P* is not carried out. So, despite the plausibility of the hypothesis, there are contexts where the action is not possible or even being possible, it is not performed.

The output of the third stage can be formulated as follows.

[1] *Q*
[2] *P* *Q*
[3] *P*

2.4 Checking

Finally, in the fourth stage, the individual evaluates the hypothetical deductive formulation.

[4a] The individual *i*, considering [2] "If *P*, then *Q*" and [3a] *P*, achieves *Q'*[4] at the time t_4, or
[4b] The individual *i*, considering [2] "If *P*, then *Q*" and [3b] –*P*, achieves –*Q'* at the time t_4.

The fourth stage involves the evaluation of the antecedent action *P* or inaction –*P* into the deductive scope of the hypothetical formulation "If *P*,

[4] According to Rauen (2013, p. 9), the expression *Q'* represents the fact that the achievement of the goal is always to some extent different from their projection.

then *Q*", which merges with Sperber and Wilson's (1995) deductive module[5]. Thus, whether the individual chooses to carry out the antecedent action *P* or not, the consequences will be deductively evaluated within the domain of the abductive hypothesis.

The output of the fourth stage in [4] can be seen below:

[1] Q
[2] P Q
[3] P
[4] Q'

Considering the checking stage, the author proposes four types of achievement as the results conciliate with the goals and the hypothesis is confirmed or not: active conciliation, active non-conciliation, passive conciliation and passive non-conciliation.

In simple terms: in active conciliation (1a), the individual *i* performs *P* and the goal *Q* is achieved; in active non-conciliation (1b), the individual *i* performs *P*, but the goal *Q* is not achieved; in passive conciliation (1c), the individual *i* does not perform *P*, and, even so, the goal *Q* is achieved; and in passive non-conciliation (1d), the individual *i* does not perform *P* and the goal *Q* is not achieved.

In addition, these types of achievement led the author to offer an ordination of hypothetical utterances "If *P*, then *Q*." Rauen argues that abductive hypotheses emerge as categorical ($P \Leftrightarrow Q$) and model active conciliations by default. Faced with problems or dilemmas, this formulation becomes biconditional ($P \leftrightarrow Q$), admitting passive non-conciliations. When *P* is only sufficient, the formulation becomes conditional ($P \rightarrow Q$), admitting passive conciliations. When *P* is necessary, but does not guarantee *Q*, the formulation becomes enabling ($P \leftarrow Q$), admitting active non-conciliations. Finally, when all possibilities are plausible the formulation becomes tautological ($P – Q$).

2.5 Goal hetero conciliations

When two or more individuals engage in a process of goal conciliation (hetero conciliation), we face a more complex situation than when the individual herself[6] provides and checks her own personal goal (self conciliation). In collaborative situations, it is crucial to communicate the goal. This can be an obstacle, because there are no guarantees for the success of any communicative process. Thus, an essential sub-goal is the very elaboration of communicative ostensive stimulus allowing the speaker to explain to the listener what the goal is. This seamlessly merges with Sperber and Wilson's (1995) relevance-theoretic modeling.

In sum, when the process involves more than one individual, we face a more complex situation where self and hetero conciliations coexist. Each individual has her internal goal *Q* and goal achievements *Q*'. Apart from the individual check, whether the achievements *Q'* are consistent with their goals *Q* (self conciliations), there is also a need to check common higher level goals (hetero conciliations).

Situations with goal conciliations involving more than one individual are very common in computer science. Upon detecting a problem requiring

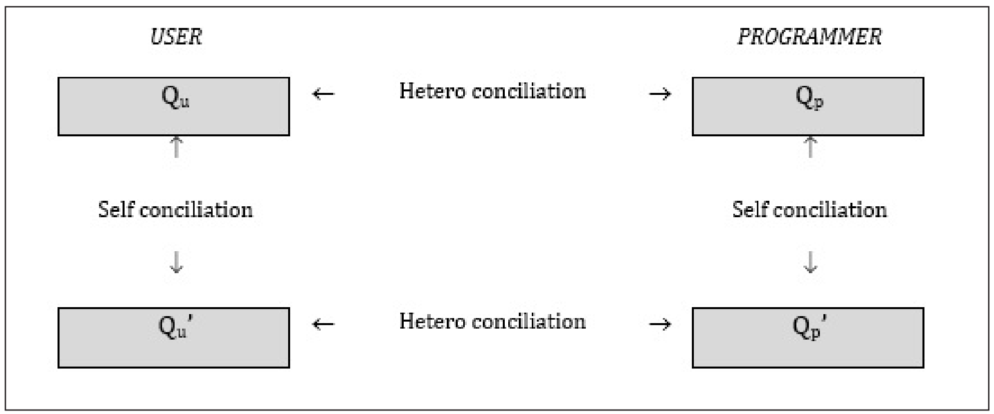
[5] In the understanding procedure guided by the concept of relevance, it stands out the deductive module proposed by Sperber and Wilson (1995). It is a module that captures assumptions obtained from perception or memory and not trivially and not demonstratively deduces conclusions by rules of elimination like *elimination-and*, *elimination-or* and *modus ponens*. According to Rauen (2013), this mechanism has been shown to be effective in modeling cognitive processes involved in the interpretation of verbal inputs. For him, this is due by the fact that the individual, seeking an interpretation that satisfies their expectation of optimal relevance, follows a route of minimum effort and, based on linguistic encoding, in an attempt to get a explicit meaning (explicature), he enriches these inputs and, eventually, get an implicit meaning from this explicit meaning (implicature). The process ends when the interpretation conforms to his/her expectation of relevance.

[6] In this text, whenever you read "she-her-herself", please understand "he/she-his/her-himself/herself."

a computerized solution (a program, a system, a website, etc.), it is common that the individual, hereafter *user*, contact someone who is an expert in computer technology, hereafter *programmer*, in order to try to solve her problem. So, we face an everyday situation involving two characters, the user and the programmer.

Let us borrow the basic scheme for self and hetero conciliations, as proposed by Rauen (2014, p. 19), to explain this process in our example:

Figure 1 – Goal self and hetero conciliations



Source: Adapted from Rauen's (2014, p. 19) goal hetero conciliation scheme.

According to the scheme, the programmer's self conciliation corresponds to only one part of a more complex situation where two characters are involved, the *programmer*, which is responsible for developing the solution from his/her earlier knowledge; and the *user*, which is responsible for requesting the development of a solution. In this case, checking her positive *Q'*, the programmer is actually checking the execution of a sub-goal, which is inserted into a larger goal whose source was provided by user, when she requested the service.

Situations like this make the checking process more complex, because self and hetero conciliations coexist. In addition to checking the balance between his/her internal goal Q_p and her external goal Q_p', the programmer must also worry about checking if what was written by her as Q_p' solution answers to the first user's demand Q_u'.

So, to cover the whole complexity of the situation and to identify whether the user's goal has been met, it is essential to find whether Q_p' conciliates with Q_u', or, as described by Rauen (2013, p. 11), the state Q_p' answers to, matches or corresponds with the goal Q_u', and thus the result of action P_p is similar or congruent with the result designed by the user Q_u. This is indispensable, because it is a situation that involves the individuals' goals and sub-goals.

The hetero conciliation process converges with the notion of *shared intentionality or intentionality "we,"* as proposed by Tomasello and colleagues (2005). For them, we are facing a situation defined by collaborative social interactions of at least two individuals, which are able to understand each other as intentional agents, and to share not only a common goal or commitment, but also coordinated action roles to achieve it. These collaborative activities themselves have a higher level of complexity compared to self conciliations. They demand that the individual aligns herself with others to shape a common goal; moreover, the individual distinguishes herself from others to understand and coordinate different, but complementary roles in the common intention. In this process, the individual's goals and intentions intertwine with another's goals and intentions, and the cognitive representation of the shared goal comprises this complex whole.

3 Modelling of a proactive program

As an example of Rauen's (2013, 2014) proposal, we take a situation which involves the development of a computerized solution in two steps. Initially, we will model the notion of self conciliation. In this case, the programmer decides and evaluates herself her own goal. Below, we will model the notion of hetero conciliation. In this case, the user hires a programmer to develop a computerized solution that complies with her demands. In order to illustrate this case, let us consider the demand for yielding a printed report that lists in alphabetical order the name and telephone number of all suppliers of a company.

3.1 Modeling goal self conciliation

In the event that the programmer herself knows the demand and yields a computerized solution, the first stage consists in formulating a goal. In this situation, the goal could be formulated as follows:

[1] The programmer *I* formulates the goal *Q* of yielding a report at t_1.

Schematically, the output of this stage is as follows:

[1]	Q_p	yield the report, programmer

In the second stage, she chooses the best way to develop the solution. According to Rauen (2013, 2014), we are facing an election process of at least one relevant and plausible ante-factual abductive hypothesis to achieve the goal *Q*.[7]

In the example, the programmer chooses the algorithmic sequence, antecedent action *P*, which appears as an inference to the best solution. So, this solution emerges as an at least sufficient proposal to achieve the consequent result *Q* of yielding the requested report.[8] This implies that this hypothesis will be considered by the programmer *I* as the most likely to yield the report and, simultaneously, the way to lower processing cost when the programmer *I* is faced with the fixed effect of yielding it.

[2a] The programmer *I* abducts the best ante-factual abductive hypothesis H_a to achieve the goal *Q* of yielding the report at t_2.

Consider here that the programmer *I* has inferred that the best way to achieve the goal *Q* of yielding the report is an algorithmic sequence of data reading, data sorting, report viewing and printing – from now on, $sequence_1$. Thus, since the hypothesis H_a can be mapped by a hypothetical formulation "If *P*, then *Q*," according to which, if an antecedent action *P* is executed, then a consequent state *Q* can be achieved, the ante-factual abductive hypothesis (H_a) will be one that provides that if all steps of $sequence_1$ are executed, then the report will be yielded.

The output of this stage is as follows.

(2b) If the programmer *I* runs the $sequence_1$ *P*, then the report *Q* will be yielded at t_2.

The result of processing [2b] can be represented in this way.

[1]		Q_p		yield the report, programmer
[2]	P_p	Q_p	run the $sequence_1$, programmer	yield the report, programmer

[7] It is a fact that there are many ways to develop the solution. According to Psillos (2002, p. 7), if many rival hypotheses can explain the same event, a goal can also be achieved by various solutions, and the abductive logic does not have tools to restrict them. However, the success with which individuals abduct explanations suggests that there are mechanisms to rank hypotheses by their explanatory virtues: encyclopedic knowledge, previous experience, common sense, all contribute to the classification of hypotheses or the emergence of a single hypothesis taken as the more plausible one, since it emerges as the strongest one.

[8] According to Harman (1969), a principle of plausibility is working here. This principle yields some algorithmic alternative at least sufficient to achieve the goal. Note that choosing a path that is sufficient to achieve a goal does not guarantee that the conclusion will be true even though they derive from true premises.

Abducted the best hypothesis, the third stage consists of the probably implementation of the antecedent action P. So, the programmer formulates an algorithm comprising: data reading, data sorting, report viewing and printing. Let us see the positive version of that formulation.

[3] The individual *I* runs the sequence$_1$ *P* to achieve the goal *Q* of yielding a report at t_3.

The output of this third step is as follows:

[1]		Q_p		yield the report, programmer
[2]	P_p	Q_p	run the sequence$_1$, programmer	yield the report, programmer
[3]	P_p		run the sequence$_1$, programmer	

Once executed the action, which characterizes the active version of the third stage of the modeling, it begins the fourth stage. This stage consists in checking the hypothetical deductive formulation. See:

[4] The programmer *I*, considering [2] "If *P*, then *Q*", and
[3] *P*, achieves *Q'* at t_4

In the fourth stage, the programmer gets a concrete result of the action. So, what was once just an internal goal, now is an external result identified as *Q'*.[9] At this stage, there is a review of the antecedent action *P* into the deductive scope of the hypothetical formulation "If *P*, then *Q*." Thus, in the positive scenario, we evaluate the actual report, which is yielding from the algorithmic formulation based on sequence$_1$. This stage is represented as follows:

[1]		Q_p		yield the report, programmer
[2]	P_p	Q_p	run the sequence$_1$, programmer	yield the report, programmer
[3]	P_p		run the sequence$_1$, programmer	
[4]		Q_p'		yield the report, programmer

The procedure described in this item contemplates what Rauen (2014) has called "goal self conciliation." Thus, the programmer *p* has conciliated the internal goal Q_p with the external goal Q_p'. In addition, the programmer confirms and reinforces the ante-factual abductive hypothesis H_a, because she runs the sequence$_1$ P_p and gets a report Q_p' at t_4, which answers to, coincides or corresponds with the goal Q_p at t_1. In other words, the programmer *p* confirms that the antecedent action *P* (run the sequence$_1$) causes the consequent state *Q* (yielding a satisfying report).

3.2 Modeling goal hetero conciliation

To illustrate the process of goal hetero conciliation, let us consider a situation that involves an interaction between user and programmer. In this case, the user *u* hires the programmer *p* to develop a computerized solution that attends his/her demand: again, to yield a printed report that lists in alphabetical order the names and telephone numbers of all suppliers of a company.

In the first step, we have the formulation of the user *u's* internal goal, which could be represented as follows:

[1] The user *u* formulates the goal Q_u to get a report at t_1.

Schematically we have the representation of the output of this stage:

[1]	Q_u	get the report, user

[9] The presentation of the results as *Q'* is explained by the fact that the actual result of a process will always be somewhat different than was mentally deliberated, despite the accuracy of the implementation of the steps. Furthermore, *Q* and *Q'* belong to different processing times, respectively, t_1 and t_4.

In the second stage the user chooses the most plausible relevant ante-factual abductive hypothesis to achieve the goal Q_u. In general, the modeling of this stage could be represented as follows:

[2a] The user *u*, abducts the best ante-factual hypothesis H_a to achieve the goal Q_u of getting the report at t_2.

Let us consider that the user *u* has inferred that the path of least effort to achieve his/her goal Q_u of getting a report was to hire the services of a professional. Thus, since the hypothesis H_a can be mapped by a hypothetical formulation "If *P*, then *Q*," hiring the services of a professional – the antecedent action P_u – arises as the minimally effective proposed solution to achieve the consequent result Q_u of getting the requested report.

The result of this step can be seen below:

(2b) If the user *u* hires a programmer P_u, then he/she will get the report Q_u at t_2.

Or, in a more schematic way:

[1]		Q_u		get the report, user
[2]	P_u	Q_u	hire the programmer, user	get the report, user

The abduction of the best hypothesis triggers the third stage consisting of the probable implementation of the antecedent action P_u of hiring the services of a programmer. Let us consider the positive version of this formulation:

[3] The user *u* hires a programmer P_u to achieve the goal of getting a report Q_u at time t_3.

The output of this third step is the following:

[1]		Q_u		get the report, user
[2]	P_u	Q_u	hire the programmer, user	get the report, user
[3]	P_u		hire the programmer, user	

It is just at this point that the communication process is essential. The user must inform the programmer her intention to get a report by way of a computerized solution as precisely as possible. So, a plausible ante-factual abductive hypothesis is producing an ostensive stimulus that allows the programmer to set as her own goal to get this report. The action *O* of the user of communicating her needs to the programmer is, therefore, an essential sub-goal for the user to engage the services of the programmer. See:

[1]			Q_u			get the report, user
[2]		P_u	Q_u		hire the programmer, user	get the report, user
[3]	O_u	P_u		communicate, user	hire the programmer, user	
[4]	O_u			communicate, user		
[5]		P'_u			hire the programmer, user	

Additionally, if the user is fully successful in hetero conciliate his/her plan with the programmer, both must share the same goal *Q* at the end of the communication process. Let us take, then, the case in which the programmer yields the same solution described in the earlier subsection.

[1]		Q_p		yield the report, programmer
[2]	P_p	Q_p	run the sequence$_1$, programmer	yield the report, programmer
[3]	P_p		run the sequence$_1$, programmer	
[4]		Q'_p		yield the report, programmer

Then, the programmer should present the solution to the user – the answer process. It follows that in the answer process the solution Q'_p must be accepted as the user's Q'_u solution, and be integrated into the user's self conciliation scheme. See the formula:

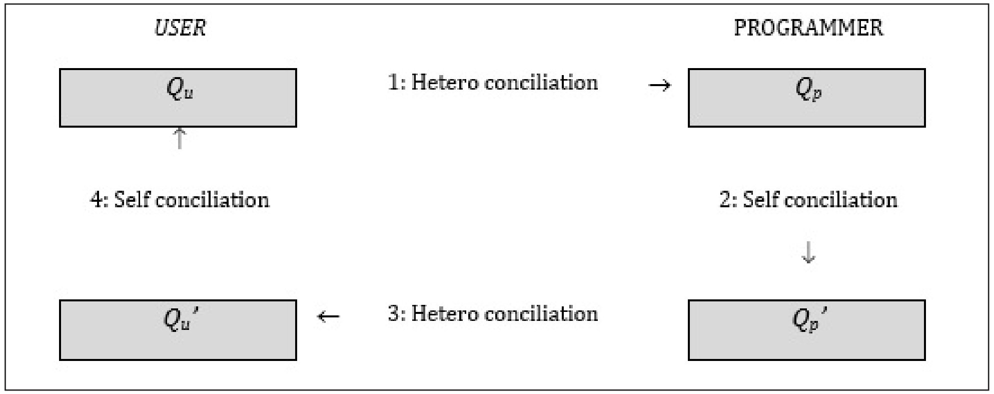
[1]			Q_u			get the report, user
[2]		P_u	Q_u		hire the programmer, user	get the report, user
[3]	O_u	P_u		communicate, user	hire the programmer, user	
[4]	O_u			communicate, user		
[5]		P'_u			hire the programmer, user	
[6]			Q'_u			get the report, user

This simulation describes the complex process of self and hetero conciliation. The user tackles a problem that demands a computerized solution. The solution of this problem is her goal Q_u. As the user does not know how to solve this problem, he abducts the hypothesis of hiring the services of a programmer P_u, and produces ostensive stimuli that aim to communicate her demand O_u. The programmer establishes a goal Q_p, supposedly mirroring the user's goal Q_u. Then, she abducts a best solution P_p to the case, yielding the program Q_p'. It follows the delivery of the product. In this case, the user should assume the solution Q_p' *as* Q_u'. If everything is right, then the solution Q_u' will be self conciliated with the user's first goal Q_u, and the process ends.

That said, first, there is a goal hetero conciliation between Q_u and Q_p in the communication process between user and programmer, when the user contracts the programmer's services. Then there is a programmer's goal self conciliation between the goal Q_p and the achievement Q_p', when he/she designs the supposedly correct computerized solution. Furthermore, there is a goal hetero conciliation, when the programmer presents his/her solution to the user, and the user assumes Q_p'as Q_u'. Finally, a user's goal self conciliation happens, when the user compares Q_u' solution with her initial goal Q_u.

Figure 2 below highlights the ordering of these processes.

Figure 2 – Goal self and hetero conciliation ordering



Source: Adapted from Rauen (2014).

3.3 Problems

In the earlier subsection, an example of goal hetero conciliation was modeled. So, the programmer has self conciliated the achievement with her own goal, and has confirmed her hypothesis, so that sequence$_1$ would account for the problem. The program, in turn, has attended the expectations of the user, as a solution for her demands, and strengthened the user's hypothesis of the programmer's expertise.

However, situations in which users are dissatisfied with computerized solutions are very frequent. These failures can be raised from any of the steps. It may be the case that the user does not have a well defined size of her own goal or, as it usually happens, she is not able to evaluate what the computerized solutions can or cannot do. In this situation, the goal itself is problematic. It may be the case that the user will not be able to properly or sufficiently communicate what she wants, or it may be the case that the programmer is unable to properly understand what the user wants. In this situation, the communication may have seemed clear, but user and programmer design different goals. It may also be the case that the programmer is unable to yield the solution, and the program itself contains errors. It may also be the case that the programmer is unable to explain the features of the program and/or the user does not properly understand it even when the program is properly explained by the programmer. These cases will also imply a false hetero conciliation of the achievements. It may still be the case that the user is unable to evaluate whether the program achieves her initial goal, either because she improperly designed the solution since the beginning, or because she does not have enough information to evaluate the potentials of the product.

Let us consider, for example, the case in which the user had as her internal goal Q_u of producing a report containing certain graphical features such as colors and images that have not been implemented by the programmer, because they had not been explicitly requested. So, it seems that the success of this iterative process is closely related to the quality of the communication process.

When the programmer presents her solution, which complies with what has been explicitly requested by the user, she believes she had fully achieved her goals because the external goal Q_p' attends, matches, or is equivalent to her internal goal Q_p – the self conciliation. But, realizing that the user shows displeasure with the solution as developed, she faces a situation of *active self non-conciliation,* and her ante-factual abductive hypothesis H_a should be weakened from categorical to enabling. As Rauen (2013, p 13.) points out, in an enabling abductive ante-factual hypothesis $P \leftarrow Q$, the antecedent action P_p of running sequence$_1$ was necessary to achieve the consequent state Q_p of the report generation, but it was not sufficient to achieve Q_u. Similarly, from the point of view of the user, we face an *active self non-conciliation* because the antecedent action P_u of hiring a programmer was necessary but not sufficient to achieve the consequent state Q_u of getting the report according to the user's expectations. With regard to the analysis of both the user's and the programmer's goals, the result shows that the programmer's achievement Q_p did not comply with what the user had set as her goal Q_u. Thus, the programmer performed the action P_p, abducted by her as the best hypothesis to achieve the consequent state Q_p', but this was not sufficient to make sure that the result Q_p' would be hetero conciliated with the user's expectations. So, we have here a situation of an *active hetero non-conciliation*, because in order to abduct the best ante-factual abductive hypothesis H_a, the programmer must be clear about her internal goal Q_p which directly depends on the user's internal goal Q_u. By failing to clarify her internal goal, the user initiates a process that is doomed to failure, given the interdependence of all goals involved.

The fact that the user mentally visualizes or imagines what she expected as a solution to her problem or demand does not guarantee its consecution. So, she needs to convey this information to the programmer, who needs to understand it. The success of this process is partly an explanation, as explicit as possible, of what the user's internal goal Q_u is, because all the rest of the process depends on it.

In such complex situations, in order to show that the user *u's* purpose has been addressed, it is essential to show that Q_p' conciliates with Q_u'; or, as described by Rauen (2013, p. 11), that the state Q_p' answers to, matches or corresponds with the goal Q_u', and therefore the result of P_p action is similar to or congruent with the result designed by the user's Q_u. In this case, we are faced with a situation that involves both the user's and the programmer's goals and sub-goals, and where coexist processes of goal self and goal hetero conciliations – that do not always achieve the expected results.

If the programmer does something that eventually does not comply with the user's needs, according to the Goal Conciliation Theory (RAUEN, 2014), we are facing a situation of *active hetero non-conciliation*. In this case, there is a weakening of the certainty that the programmer has about the task, i.e., the hypothesis $H_{a,}$ that at first seemed *categorical*, following the scale proposed by Rauen (2013), is weakened. This change was caused by the initial lack of understanding between programmer and user. Thus, assumptions that seemed to be previously entirely true are further weakened, to the point of yielding substantial doubts as a result of failures in sharing goals by those involved in the process.

Finally, it is worth mentioning that *time* is another factor that must be considered in this interaction process. However, time is a variable of complex treatment because of the asynchronicity of all the procedures and because of the role of memory in recovering all these procedures.

4 Discussion

The algorithms formulation is the basis for the development of computerized solutions. This is a "sequence of reasoning or operations that offer the solution of certain problems" (MICHAELIS, 2013). That said, according to Fernandes and Botini (1998, p. 39), the problem or demand is the starting point in seeking for computer solutions, and to "build computerized algorithms consists in structuring a process of logical manner, precisely defined and always opting for best path".

Based on ante-factual abductive hypotheses and proactive modeling of goals, as modeled by Rauen (2013), we are encouraged to view algorithms from the perspective of a starting point that takes place before their specific formulation, disputing the thesis that there are premises that guide their formulation. Instead, I argue that there is a preliminary process in which the focus is the goal to be achieved. Thus, the programmer has to develop an algorithm that she considers to be the goal Q as a guide for choosing the best path to achieve it. Choosing the best ante-factual abductive hypotheses, which Rauen (2013) called *inference to the best solution*, is precisely the same fundamental process that precedes the sequence of deductive steps.

The example of the collaborative generation of the report describes a common situation that takes place when we are dealing with the development of computer solutions. The demand for a solution does not come from the IT professional (programmer, developer, analyst, and so on), but it comes from the user. Realizing a need or faced with a problem, the user asks the professional to develop a solution – that is, the user knows the demand, but does not how to solve it. To solve the situation, he/she needs to communicate it to a professional who, by definition, can solve it, but does not know it yet. Thus, the success of this solution is related to the development of the communication process that is preliminary to all other stages.

By stating the problem, besides having identified it, the user needs to verbalize what she mentally sees as a possible solution, i.e., she needs to expose this "mental picture of the situation," so that the listener understands what she wants, her goal Q. The person responsible for coming up with the solution must interpret what the demand is in order to develop a possible solution, and this is done through the identification of such a goal.

This is only possible because the human brain is capable of imagining solutions even before they specifically exist. Thus, seeking for solutions is triggered by the imagination of a result, and this creative process is more adequately formalized as abductive. See:

Q	Q is the goal or the conclusion that is sought
$P \rightarrow Q$	True P implies true Q
P	P is true

According to this formulation, the process starts with the consequent *Q*, i.e., the goal to be achieved. This is something that does not yet exist, but it is envisaged in the future. Given that one person realizes the solution and another person develops the solution, the process involves serious communicational obstacles. Certainly, there may be situations when the user's foreseen solution Q_u and the professional's developed solution Q_p' are very close, and the closer they are, the better the result is – case of hetero conciliations. Obviously, this result will be directly proportional to the capacities of the professionals abducting it.

In cases of hetero conciliation, the model covers an even greater complexity, because the process involves at least two individuals who take part in a larger context where one's own goals and results are connected to the other person's goals and results. In this case, the success of the whole process will not only involve goal self conciliation but also goal hetero conciliation whose results completely depend on the quality of the communication between the individuals. More specifically, this process does not merely depend on the ability of the developer to build the solution. It also depends on the whole first process that includes not only the communicative act of the user describing what she expects/imagines as a solution to her problem, but something that precedes it, i.e., the first goal that motivated her interaction with the programmer.

The user's goal must be shared with the programmer. Otherwise, even if the programmer has all the necessary skills to develop the solution, and even if its development is agile in terms of the time required for the process, whatever the chosen plan of action, it is doomed to failure.

According to Rauen's (2014) modeling, we face a situation of *goal hetero conciliation*, covering collaborative social interactions of individuals who are able to understand each other as intentional agents, to share a common goal or commitment, and to coordinate their actions in order to achieve this goal and commitment. Tomasello and colleagues (2005) argue that this is the crucial difference between human cognition and that of other species: the human ability to participate with others in collaborative activities with shared goals and intentions.

In a way, the application of Rauen's (2013) model enhances the finding that, contrary to machines, which operate solely by deduction (hence the need for deductive algorithms), the human brain works both deductively and abductively. Perhaps this is the key reason that makes machines and humans so distinct.

As Searle (1998, p. 87) points out,

> Our understanding surpasses that of any computer. A computer only uses algorithms. Therefore, when a computer corroborates a theorem he has to use an algorithm that proves theorems. However, there are some propositions that we realized that are true, but are not verifiable in the system. They, therefore, are not theorems of the system and, therefore, cannot be refuted by an algorithm that proves theories. It follows that our knowledge of these truths cannot be algorithmic. But, as the computers only use algorithms, it is concluded that we are not computers.

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