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

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 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. 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.

\[ P \rightarrow Q \quad \text{A true } P \text{ implies a true } Q \]

\[ P \quad \text{Given a true } P \]

\[ Q \quad \text{Then, } Q \text{ is true} \]

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 According 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 model 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.

**2.3 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.

\[
\text{[2]} \quad \text{The individual } i \text{ abducts an ante-factual hypothesis } H_a \text{ to achieve the goal } Q \text{ at time } t_2.
\]

The output of this step can be represented as follows:

\[
\text{[1]} \quad Q \\
\text{[2]} \quad P \quad Q
\]

**2.4 Checking**

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

\[
\text{[4a]} \quad \text{The individual } i, \text{ considering [2] } \text{“If } P, \text{ then } Q' \text{” and [3a]} \quad P, \text{ achieves } Q' \text{ at the time } t_3, \text{ or } \\
\text{[4b]} \quad \text{The individual } i, \text{ considering [2] } \text{“If } P, \text{ then } Q' \text{” and [3b]} \quad \neg P, \text{ achieves } \neg Q' \text{ at the time } t_3.
\]

The fourth stage involves the evaluation of the antecedent action \( P \) or inaction \( \neg P \) into the deductive scope of the hypothetical formulation “If \( P \),

\[^{1}\text{According to Rauen (2013, p. 9), the expression } Q' \text{ represents the fact that the achievement of the goal is always to some extent different from their projection.} \]
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:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>( Q )</td>
</tr>
<tr>
<td>2</td>
<td>( P ) ( Q )</td>
</tr>
<tr>
<td>3</td>
<td>( P )</td>
</tr>
<tr>
<td>4</td>
<td>( Q' )</td>
</tr>
</tbody>
</table>

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 \((P \Rightarrow Q)\) 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 \((P \land Q)\).

### 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 an 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](image)

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:

\[ Q_p \quad \text{yield the report, programmer} \]

Schematically, the output of this stage is as follows:

\[ Q_p \]

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 \( Q \).

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.

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

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 \( f \).

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 \( f \) are executed, then the report will be yielded.

The output of this stage is as follows.

\[ 2b \quad \text{If the programmer } I \text{ runs the sequence } f, \text{ then the report } Q \text{ will be yielded at } t_2. \]

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

\[ 1 \quad Q_p \quad \text{yield the report, programmer} \]

\[ 2 \quad P_p Q_p \quad \text{run the sequence } f, \text{ programmer yield the report, programmer} \]

\(^7\) 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 _P_ to achieve the goal _Q_ of yielding a report at _t_e.

The output of this third step is as follows:

[1] _Q_p yield the report, programmer
[2] _P_p _Q_p run the sequence, programmer yield the report, programmer
[3] _P_p run the sequence, 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:


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’_. 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 _P_. This stage is represented as follows:

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 _P_p_ and gets a report _Q_p’_ at _t_f_ 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 _P_) 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_e.
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:

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

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:

$$[2b] \text{If the user } u \text{ hires a programmer } P_u \text{ then he/she will get the report } Q_u \text{ at } t_2.$$

Or, in a more schematic way:

$$[1] Q_u \quad \text{get the report, user}$$
$$[2] P_u Q_u \quad \text{hire the programmer, user} \quad \text{get the report, user}$$

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:

$$[3] \text{The user } u \text{ hires a programmer } P_u \text{ to achieve the goal of getting a report } Q_u \text{ at time } t_3.$$

The output of this third step is the following:

$$[1] Q_u \quad \text{get the report, user}$$
$$[2] P_u Q_u \quad \text{hire the programmer, user} \quad \text{get the report, user}$$
$$[3] P_u \quad \text{hire the programmer, user}$$

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:

$$[1] Q_u \quad \text{get the report, user}$$
$$[2] P_u Q_u \quad \text{hire the programmer, user} \quad \text{get the report, user}$$
$$[3] O_u P_u \quad \text{communicate, user} \quad \text{hire the programmer, user}$$
$$[4] O_u \quad \text{communicate, user}$$
$$[5] P'_u \quad \text{hire the programmer, user}$$

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.

$$[1] Q_p \quad \text{yield the report, programmer}$$
$$[2] P_p Q_p \quad \text{run the sequence, programmer} \quad \text{yield the report, programmer}$$
$$[3] P_p \quad \text{run the sequence, programmer}$$
$$[4] Q'_p \quad \text{yield the report, programmer}$$

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:

\[
\begin{align*}
1 & \quad Q_u & \text{get the report, user} \\
2 & \quad P_u, Q_u & \text{hire the programmer, user} \\
3 & \quad O_u, P_u & \text{communicate, user} \\
4 & \quad O_u, Q_u & \text{hire the programmer, user} \\
5 & \quad P'_u & \text{communicate, user} \\
6 & \quad Q'_u & \text{get the report, user}
\end{align*}
\]

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**

![Figure 2](image-url)

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 $P \rightarrow Q$, the antecedent action $P_\pi$ of running sequence, was necessary to achieve the consequent state $Q_p$ of the report generation, but it was not sufficient to achieve $Q_\pi$. Similarly, from the point of view of the user, we face an active self non-conciliation because the antecedent action $P_\pi$ of hiring a programmer was necessary but not sufficient to achieve the consequent state $Q_\pi$ 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 $P_\pi$ abduced 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 $H_\pi$ 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 $Q_\pi$; or, as described by Rauen (2013, p. 11), that the state $Q_p'$ answers to, matches or corresponds with the goal $Q_\pi$, and therefore the result of $P_\pi$ action is similar to or congruent with the result designed by the user’s $Q_\pi$. 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:

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

References

BORATTI, I. C. Basics of programming logic. Florianopolis, UFSC, 2 August 1990. Classroom instruction to students of computer science.


