Abductive Reasoning in New Venture Ideas: Formalizing Abduction in a World with Artificial Intelligence

Massimo Garbuio  
University of Sydney Business School  
International Business  
massimo.garbuio@sydney.edu.au  

Nidthida Lin  
Macquarie University  
Department of Management  
nidthida.lin@mq.edu.au  

Abstract  
Understanding how new venture ideas emerge and how this process can be augmented by the wealth of data and computing power of artificial intelligence (AI) is critical. Here, we explicate how abduction operates in relation to the generation of new venture ideas and how this might be augmented in a world of AI. Compared to deduction and induction, abduction is a more useful form of reasoning and innovative abduction generates more innovative new venture ideas than explanatory abduction. We further posit that AI will become an enabler for more rapid generation of high quality and more numerous new venture ideas.
Abductive Reasoning in New Venture Ideas: Formalizing Abduction in a World with Artificial Intelligence

Abstract

Understanding how new venture ideas emerge and how this process can be augmented by the wealth of data and computing power of artificial intelligence (AI) is critical. Here, we explicate how abduction operates in relation to the generation of new venture ideas and how this might be augmented in a world of AI. Compared to deduction and induction, abduction is a more useful form of reasoning and innovative abduction generates more innovative new venture ideas than explanatory abduction. We further posit that AI will become an enabler for more rapid generation of high quality and more numerous new venture ideas.

Keywords

entrepreneurship opportunity, new venture ideas, abduction, artificial intelligence, new venture creation
New venture ideas guide the creation of new corporate and social ventures and inform the process of entrepreneurship known in the literature as entrepreneurial opportunity identification (Davidsson, 2015). A wealth of research identifies the preconditions for new venture ideas or opportunity generation, amongst which are prior knowledge and external conditions (Shane, 2000; Shepherd & DeTienne, 2005), the thought processes that transform knowledge and observations of the environment to opportunities (Baron, 2006; Cornelissen & Clarke, 2010; Ucbasaran, Westhead, & Wright, 2009), the emergence of digital technologies as enablers of new venture creation (von Briel, Davidsson, & Recker, 2018), and the impetus to act upon them (Dimov, 2007a). A growing number of studies investigates the thinking and reasoning process underlying entrepreneurial idea generation and show that entrepreneurs’ cognition and reasoning differs significantly from that of other people in the context of developing opportunities and new venture ideas (Baron, 2006; Cornelissen & Clarke, 2010; Davidsson, 2015; Gaglio & Dimov, 2018). To date, much work on entrepreneurial cognition and reasoning has focused on debate as to whether and how cognition may lead to biases and/or facilitate entrepreneurial reasoning and generation of new venture ideas.

In this study, we take a step back from this debate and delineate the role of abductive reasoning in underlying the process of new venture idea generation. While not an entirely novel concept in the creation of new futures (Sarasvathy, 2001a), abductive reasoning is a crucial, but under-explored, form of logical inference currently experiencing increased attention in the design, management, and entrepreneurship literature (Garbuio, Dong, Lin, Tschang, & Lovallo, 2018). Abductive reasoning plays a key role in entrepreneurial cognition because the observations and data on which entrepreneurs rely tend to be grounded in tacit socio-cultural dynamics rather than in market-research based data (Ardichvili, Cardozo, & Ray, 2003; Rosenman & Gero, 1998; Verganti, 2003; Vogel, 2016), which are more appropriate for inductive and deductive reasoning. Abduction is an appropriate form of reasoning when information is limited and incomplete as it takes a specific set of observations and generates a
hypothesized answer to the question, “What product or service or business model has a meaning that explains these observations?”

During the past decade, businesses have experienced a radical departure from how ideas for new business opportunities are traditionally generated, and therefore the need to understand the role of abductive reasoning has become more urgent. The availability of artificial intelligence (AI) embedded in cutting-edge technology has driven radical changes in the market as it provides entrepreneurs with a greater number of data points and insights, allowing them to more readily and accurately understand customer demand and identify new business opportunities. However, the large amount of data requires a greater ability to filter what matters, what problems are worth solving, and, what action to take next. AI can facilitate the generation of hypothesized answers by automating both summaries and insights from a set of observations which, if undertaken manually by human, would requires significant experience and time. AI allows potential entrepreneurs to evaluate business opportunities more accurately and in a timely manner. Together, abductive reasoning and AI may substantially fuel the process of new venture idea generation as well as change the likelihood that entrepreneurs versus non entrepreneurs generate new venture ideas in the first place.

Drawing on this line of argument, we develop insights into new venture idea generation using the psychological lens of individual cognition, abductive reasoning. We then highlight how this reasoning process is likely to be affected in the era of AI. Despite increased interest in the role of cognition and reasoning in the entrepreneurship literature, to date no attempt has been made to formally discuss abduction in the context of entrepreneurship opportunities and new venture ideas. Hence, this study further proposes an in-depth exploration of how AI facilitates abductive reasoning and leads to better outcomes in entrepreneurial idea generation. A better understanding of the interplay between AI and abductive reasoning will provide crucial insights into how opportunities emerge and evolve over time into sustainable business models and ventures and how this process can become more efficient through the use of data
analytics and AI. More specifically, we discuss how insights—a set of synthesized data—generated by AI leads to an increase in both quality and quantity of abductive hypotheses generated by (potential) entrepreneurs and allows a larger number of entrepreneurs with more diverse background to generate abductive hypotheses for new business opportunities.

Our study offers two key contributions to the entrepreneurship literature. First, to our knowledge, this study is an early attempt to formalize the internal logic of abductive reasoning to new venture idea creation. We discuss what abductive reasoning is, how it differs from other commonly-used forms of logical reasoning like induction and deduction, and how abductive reasoning plays a key role in new venture ideas. By doing so, we add to the previous literature that have pointed to a critical role for abduction in new venture idea generation. We build our discussion on the nature of new venture ideas discussed in (Ardichvili et al., 2003) and augment it with the notation of abduction from the design cognition literature (Dorst, 2011; Roozenburg, 1993). Second, this study explicates how the availability of data via AI will transform the way in which we generate new ideas for business opportunities and, therefore, create abductive hypotheses regarding new ventures. In essence, we delineate how the power of cognitive computing has the potential to fuel the process of abductive reasoning and improve the abductive hypotheses in new venture idea generation.

The rest of this paper proceeds as follows. First, we discuss the theoretical background of entrepreneurial opportunities and new venture ideas. This is followed by discussion of abduction and its different forms, explanatory and innovative abduction. Next, we propose ways in which abductive reasoning operates in the process of new venture idea generation. We then briefly consider AI and its application in entrepreneurial reasoning and how it can be facilitated by AI and cognitive computing. Finally, we conclude the paper with possible avenues for future extension of our proposed framework.
Theoretical Background

Entrepreneurial Opportunities and New Venture Ideas

There has been an ongoing debate about the ontological nature of the opportunity formation process. The research has coalesced around two different perspectives: (1) opportunities as objective artefacts waiting to be discovered by predisposed individuals; and (2) opportunities as an outcome of the subjective interpretation and the creative actions of individuals (Alvarez & Barney, 2010). On the one side, an opportunity discovery/recognition approach assumes that shocks in the environment (e.g., advances in technology, changes in consumer preferences or demographics) lead to competitive imperfections in the market and can be analyzed. Hence, opportunities are present and must be discovered by entrepreneurs. Early work in entrepreneurship adopts this approach and suggests that opportunities are discovered through systematic search and business-plan development (Herron & Sapienza, 1992). According to this planning school of thought, strategy tools are useful and risk can be computed so that probabilities can be assigned to the various scenarios. On the other side, an opportunity creation approach assumes that opportunities are created endogenously by entrepreneurs through a process of enactment, and hence opportunities do not necessarily emerge from pre-existing markets (Sarasvathy, 2001b). In this case, entrepreneurs do not search for opportunities and, hence, strategy frameworks are not useful and even detrimental to entrepreneurial opportunities. Since opportunities do not exist until they are created, entrepreneurs do not know the possible outcomes and their probability ex-ante but uncertainty is uncovered/solved over time. For the opportunity creation approach, experimentation and the ability to learn along the way are fundamental to the creation of business opportunities.

More recently, the conversation in the academic literature has moved towards an explicit acknowledgment that data has, and will have, a greater role in opportunities. More specifically, Davidsson (2015) discusses how little theoretical and empirical progress has been made on the nexus between actors and opportunities, which he argues is due to problems with
the construct “opportunity” itself, among others. He points to the need to focus discussion on the concept of “new venture ideas” to denote “imagined future ventures”, which represents “any imaginary combinations of product/service offerings, markets, and means of bringing these offerings into existence” (p. 675). This concept has a range of benefits. First, it repositions the debate on whether opportunities are created or discovered (Alvarez & Barney, 2010) to discuss “imagined future ventures” in a more general sense that does not make a value judgment on whether these are opportunities, and by whom they can be considered opportunities. Second, it does judge whether opportunities are innovative, completed, or well-articulated and, as such, it broadens the concept of opportunities across ideas and contexts. Third, there is an explicit recognition that new venture ideas and actors are not independent. We build on the notion of new venture ideas and then further expand on the notion of external enablers in this paper, focusing on the availability of AI-driven data analysis (Nambisan, 2017; von Briel et al., 2018).

In this study, we adopt the new venture idea perspective in order to further contribute to this debate. We argue that new venture ideas, at different degrees of completion, do have some basic elements, that is, the elements of abductive hypotheses. Our focus here is to examine the specific type of reasoning, so-called abductive reasoning, that underlies the process of entrepreneurs’ new venture ideas and how the use of cognitive computing facilitates and improves the outcome of this process.

We also respond to the recent call for more research into the (socio)-cognitive aspects of new venture ideas (Gaglio & Dimov, 2018) that uses experiments as well as think-aloud protocol analysis to truly understand how opportunities emerge, rather than focusing on retrospective accounts. Abduction has the potential to contribute to a better understanding of specific contexts, and the role of interpretation within them. Furthermore, as Kirzner (1979) points out, the interest on better understanding new venture ideas from a cognitive perspective should investigate what happens before the insight or idea emerges. Understanding what
happens in the shaping and exploitation of an idea conforms with traditional rational-maximizing decision-making processes that is used by all market actors.

Abduction as the Fundamental Reasoning for New Venture Ideas

Abductive reasoning typically begins with an incomplete set of observations and proceeds to the likeliest possible explanation (i.e., hypothesis) for the observations. Unlike forms of reasoning more commonly used in scientific research like inductive and deductive reasoning, abductive reasoning is observed in everyday life decision making, where attempts at reasoning are made based on the available information, which is mostly incomplete. An example of abductive reasoning is medical diagnosis: given the symptoms, doctors give the diagnosis that best explains the symptoms. In its ability to come up with the best explanation given incomplete information abductive reasoning is a useful tool in dynamic and fast changing markets.

In entrepreneurship and new venture creation, Hill and Levenhagen (1995) argue that entrepreneurs “operate at the edge of what they do not know” (p. 1057) and, hence, must seek to make ambiguous events non-ambiguous by constructing a new vision of the business environment (Alvarez & Barney, 2007). Indeed, a central assumption underlying entrepreneurship theorizing is that individual entrepreneurs are “theorists of a pragmatic sort” (Strang & Meyer, 1993; Tetlock, 2000; Weick, 1995). Through verbal interactions with others, entrepreneurs develop an understanding of cause and effect, thus “theorizing” their world and the relationships and opportunities within it (Alvarez & Barney, 2007; Tetlock, 2000). As individuals, entrepreneurs may be viewed as intuitive scientists, engaged in a continuous struggle to achieve cognitive mastery of their world (Cornelissen & Clarke, 2010; Sarasvathy, 2004).

Scholars, therefore, suggest that abductive reasoning may be the basis of the creation of desired futures (Dorst, 2011; Kolko, 2010; Peirce, 1931, 1998; Roozenburg, 1993). Entrepreneurs often rely on their experiences or socio-cultural trends, rather than on market research on the specific needs and wants of customers (Ardichvili et al., 2003). Abductive
reasoning draws on a limited set of observations to generate a hypothesized answer to the question, “What product or service or business model has a meaning that explains these observations?”

Despite the fact that abduction has been known in entrepreneurship scholarship for some time, it has been difficult to conceptualize and therefore its application has not been directly explored. In a recent review of entrepreneurship opportunities, Vogel (2016) mentions abduction in the list of terms previously used in the context of opportunities. He includes abduction as part of an “active search” for opportunities as opposed to other search approaches, such as identification and problemistic search. Vogel (2016) refers to abduction as a design thinking approach to opportunities creation. This is more fully explored by Garbuio et al. (2018), who discusses abduction as one of the fundamental cognitions in opportunity creation. Students exposed to abductive reasoning seem to speed up the process of creating opportunities in comparison to students who have not been exposed to such concepts. Similarly, Allen (2015) explains how deduction, induction, and abduction play out in a specific example of primary data being used to create new venture ideas. Ardichvili et al. (2003) identify four types of opportunities (see below) and state that when problems and solutions are not identified, we are in the space where designers and even artists operate as they need to push knowledge into new directions and existing technologies past their limits.

Other relevant contributions include Sarasvathy (2001a), who acknowledges that “abduction is a cognitive operation that may be related in some ways to the literature on entrepreneurial discovery” Kirzner (1973). Sarasvathy compares abduction with effectuation, which “is fundamentally premised on action: it is a logic for a stream of actions the entrepreneur undertakes.” For Jacobs, Steyaert, and Überbacher (2013), abduction is “prospective sensemaking” —the ability to predict users’ demands in a future or hypothetical setting based on the existing situation—that helps entrepreneurs conceptualize a future opportunity, state, or actor, and which informs how a decision and action will be taken. In a
study of entrepreneurs and innovative executives, Dyer, Gregersen, and Christensen (2008) identify a critical behavioural pattern in questioning, defined as the propensity of innovative people to challenge the status quo and ask “What if …?” questions about the future. This is indeed about making abductive hypotheses about desired futures. Another identified pattern is observing, or paying attention to even common experiences in the search for new ideas. This is another form of abduction to explain the world around us. Swedberg (2012) discusses the role of abduction as part of a Schumpeterian theory of entrepreneurship and innovation by incorporating the original work of Peirce (1998). In his words, “Though Peirce never wrote on entrepreneurship, it would seem natural to say that what Schumpeter saw as new combination or entrepreneurship is what Peirce calls abduction (pp. 45–46).

While entrepreneurship scholarship has discussed the relevance of abductive reasoning for new venture ideas in various works, it has yet to formalize what abduction means and what are the further theoretical and empirical opportunities that it offered. Yet, the parallels between abduction (from a logical perspective) and new venture idea generation are remarkable. Table 1 summarizes the relevant studies on abduction and their contributions.

Having discussed why abduction matters in new venture ideas, we will now consider what is the formal logic of abduction. Abduction differs significantly from the commonly discussed approaches to reasoning: deduction and induction. This section aims to introduce to entrepreneurship scholarship the notation used in design thinking to explain the three forms of reasoning. This notation can be effectively used to design, explain, and teach abductive new venture ideas.
Deductions starts from a generally accepted rule from which definitive conclusions can be drawn. For example:

**Premise**  
\( p \Rightarrow q \)  
IF there is a threat of substitute products from an incumbent \((p) \Rightarrow\) THEN market is not attractive \((q)\)

**Premise**  
\( p \)  
There is a threat of substitute products for diabetic patients \((p)\)

**Conclusion**  
\( q \)  
Market for diabetic patients is not attractive \((q)\)

This is the typical reasoning that you would follow if you start from, for example, a Five Forces analysis. Using this form of reasoning, an entrepreneur might avoid entering the market. Alternatively, if the market is attractive, the entrepreneur may be tempted to enter it. Regardless, given that the reasoning is based on a well-known theory and publicly available information, it will not lead to something that is novel or unique.

In the case of induction, rules are developed based upon a few observations, allowing generalized conclusions to be drawn. For example:

**Premise**  
\( p_1 \Rightarrow q_1 \)  
IF company 1 employs a social media channel to communicate with existing customers \((p) \Rightarrow\) THEN it increases customer loyalty \((q)\)

**Premise**  
\( p_2 \Rightarrow q_2 \)  
IF company 2 employs a social media channel to communicate with existing customers \((p) \Rightarrow\) THEN it increases customer loyalty \((q)\)

**Premise**  
\( p_n \Rightarrow q_n \)  
IF company \(n\) employs a social media channel to communicate with existing customers \((p) \Rightarrow\) THEN it increases customer loyalty \((q)\)

**Conclusion**  
\( p \Rightarrow q \)  
IF a company employs a social media channel to communicate with existing customers \((p) \Rightarrow\) THEN it increases customer loyalty

Inductive logic starts from observations about the performance of companies having a social media channel. Based upon a number of observations, it can be empirically inferred that a company that has a social media channel will increase customer loyalty. Based upon this rule, a company may conclude that it should establish a social media channel so that it will increase customer loyalty. However, new cases may arise in which a company employs a social media channel and yet fails to increase customer loyalty. Hence, the rules may be true or proved to be incorrect when more observations become available. In this instance, induction is adding
some information that was not previously available to the entrepreneur. However, this type of new venture idea generation is bounded to the types of domains in which multiple data sources can be collected or in which experiments can be run to collect data sources. Gaining a competitive advantage relies on speed in collecting information or running experiments.

Unlike deductive and inductive reasoning, which seek to produce logically true conclusions, abduction introduces a hypothesis to try to explain observations or data (Peirce, 1931, 1998). As the most commonly used reasoning in science, abductive reasoning allows us to predict results (i.e., the act of discovery given the ‘what’ and ‘how’/working principle) and propose working principles (i.e., hypotheses) to explain the observed outcome (i.e., the act of justification given the ‘what’ and outcome). Hence, abductive reasoning proposes the most plausible and parsimonious explanation for observations.

**Types of Abductive Reasoning**

Dorst (2011) presents two forms of abduction. In the first, so-called explanatory abduction, both the desired value (outcome) and the working principle (rule) that will help achieve the desired value are known but a ‘what’ (an object, service, or system) and the potential solution space are missing. We use exploratory abduction to try to explain an unexpected observation, such as the cause of an observed customer’s dissatisfaction. Explanatory abduction introduces an “inference to the best explanation”, which contains two distinct components: an observation and a rule explaining the observation. Consider the following example of explanatory abduction:

<table>
<thead>
<tr>
<th><strong>Premise</strong></th>
<th>q</th>
<th>A surprising observation (q)</th>
<th>A large number of customers stopped to purchase a hard copy of book (q)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Premise</strong></td>
<td>p ⇒ q</td>
<td>A rule IF (p) ⇒ THEN (q)</td>
<td>IF there are startups offering e-books with a complementary audio version (p) ⇒ THEN customers buy e-book with an audio version (q)</td>
</tr>
<tr>
<td><strong>Conclusion</strong></td>
<td>p</td>
<td>The conclusion (p) (a guess, a hypothesis to test)</td>
<td>There are startups offering e-books with a complementary audio version (p)</td>
</tr>
</tbody>
</table>
In the second form of abduction, neither the working principle (rule) nor the ‘what’ are known; only the desired value (outcome) is known. In this situation, entrepreneurs should abductively propose both the ‘what’ and the means of achieving it. Roozenburg (1993) refers to this form of abduction as *innovative abduction*. In the context of entrepreneurship, innovative abduction explains an unexpected observation (outcome/value) by introducing a new venture idea (‘what’) that responds to the unexpected observation and the conditions (working principle) that, if true, underpin the reason for the new venture idea itself. During the process of entrepreneurial idea generation, the function or value of a final product or service (outcome/value) may be known, as may be the technologies needed to achieve the desired outcomes, but the final product or service (‘what’) itself is not known.

It is worth delving into innovative abduction in other terms as this is how opportunities are generated. There are three distinct components to innovative abduction: the intended (observed) value, the new venture opportunity, and its mode of operation. The intended value is the only given or known to the observer. In innovative abduction, the new venture idea explains what should be done to achieve the intended value. However, an inference of the new venture idea is not sufficient to infer the actions necessary to achieve the value. The actions depend on the opportunity. So, the entrepreneur needs to infer a so-called mode of operation, that is, how the new venture opportunity will be realized, together with the new venture opportunity. Importantly, these arguments do not need to take place simultaneously, nor by just one person, as we shall see shortly.

Consider the case of a health insurance company, below. After the health insurance company has explained its user anomalous behavior, the company can make inferences that lead to a new venture opportunity and its implementation. Given that the company has now observed a frictionless insurance market, the logic might look like this:
An abductive hypothesis is not formally true or false but is performative in that it has implications for what companies will do. In affirming the consequence, that is, proving that the premise \( p \) is true, entrepreneurs must take action. In the hypothetical case above, the hypothesis that the there is a market for policies that cover only high-risk activities becomes true only if the entrepreneur establishes a startup or business unit that sells such policies. The structure of abduction thus converts a fact into a hypothesis into an action, for example, seeks resources to form a startup. In the case of explanatory abduction, the hypothesis may spot a market opportunity no one else saw. In the case of innovative abduction, the hypothesis might spur innovation or actions that pursue growth opportunities. For both forms of abduction, the implication is that entrepreneurs will perform experiments to test the explanation, such as starting with a new pitch deck to test with potential investors and partners whether they are
willing to bet funds in this new venture or a marketing deck to test such solutions with existing clients.

The main difference between explanatory and innovative abduction centres on the rule that is applied to deliver the desired outcome through the identified new venture idea (whether it is for a new business or for a new business within an established one). Innovative abduction requires coming up with two new rules: a new venture idea that logically connects to the desired outcome and a new way to combine a company’s resources and capabilities or a new business model, which has not been proven, to implement the new venture opportunity. In explanatory abduction, the rule may be well established in another context; it is the context in which the rule is applied that is novel and that leads to a new venture idea.³

**Explicating the Role of Abduction in New Venture Ideas**

Abductive reasoning has increasingly gained academic attention due to its ability to provide a hypothesis that best explains a limited observation and leads to novel business ideas. Despite its limited application in the entrepreneurship literature, scholars have started to acknowledge the importance of abduction as originating novel entrepreneurial opportunities (Felin & Zenger, 2009). Given today’s highly dynamic market, it is important that entrepreneur’s cognition and reasoning are not only fast but also able to accommodate limited information and uncertainty. Abductive reasoning is appropriate in this situation because it provides a new hypothesis based on a few observations, which in most cases are anomalies or surprising events and the only known truth (Dong et al., 2016). In other words, abductive reasoning allows entrepreneurs to generate new venture ideas, which may or may not be logically and scientifically true, based on the limited observations.

Entrepreneur Joseph Kelly⁴ discusses the role of abduction at the early stages of a new venture. In his view, abductive reasoning is the only effective reasoning pattern that is useful at generating secrets for a new venture. In fact, deduction will only build on already accepted
theories and common knowledge about market, products or sets of features. Inductive reasoning will most likely generate possible explanations, theories, or prescription, but only amplifies existing knowledge. Moreover, inductive reasoning is bounded by the area in which experiments can be run (or, where repeated observations can be made about customer or competitor behaviors or technology developments). According to Kelly, abductive reasoning, especially in the field of AI and early stage startups, is particularly important. He argues that an insight and a bet are the two key ingredients for startups, such as the types of customers that really buy Tesla vehicles, Google’s PageRank, or a go-to-market strategy (e.g., Facebook’s initial university student market). In his view, bad guesses about the initial market or initial prototype will make or break a startup, as a wrong abductive diagnosis of a patient’s disease may cause a patient to die.

To illustrate the role of abductive reasoning in new venture idea generation, consider the evolution of the development of so-called network business models, or platform-based business models. Network effects are important in the success of platform business models, creating value by facilitating exchanges between parties and reducing transaction costs. The more people engage with a platform, the more useful and valuable it becomes. What is interesting and relevant to our discussion of abductive reasoning is how the concept of platform has evolved over time. Whereas in the past the chicken-and-egg problem was daunting to overcome (e.g., get game developers and players on board pretty much at the same time), this is no longer the case. Marketing resources, as well as guerrilla marketing, allow one to have a side of the market on board much before the other one. People have become much more used to being beta testers for new services. Moreover, switching costs are almost zero for some users (e.g., customers can switch between Lift and Uber at the click of a button as many times a day as they want). In some ways, these suggest that entrepreneurs can, and should, develop one side of the market even before realizing how to attract the other side or how to monetize their offering.
Therefore, the development and monetization of a new venture idea may follow a pattern of abduction that takes place in two steps. For example, in the first step, an entrepreneur has the idea of addressing a critical user problem through mobile phone apps. Hence, the focus is first on value creation (for one side of the market). The entrepreneur can develop the entire app and put it on the market and use any sort of marketing techniques or budget to get people on board to use the app. If people love the app, then the next step will be to build the other side of the business, as well as raise more money. Usually, after an original value creation idea has been formed, the market is analysed, following deductive patterns as well as analogies with other industries (see also, Dong et al. (2016)).

In a second step, abductive reasoning helps entrepreneurs identify the monetization approach of the business model. Specifically, after seeing usage patterns, an entrepreneur may have businesses reaching out to engage in the platform as it is a channel for finding customers. This can be addressed either as part of the same platform or with a new monetization platform: one application is to deliver targeted information and the other application is to sell added value services, such as connecting customers with a selected group of practitioners. Although connected, these two applications can be distinct as well as developed at different points in time once the learning from one application provides entrepreneurs with ideas for the other.

Interestingly, this conversation connects to the conversation about the four central innovation potential opportunities of new venture ideas. Building on the literature of creativity (Getzels, 1962), Ardichvili et al. (2003) distinguishes four types of opportunities on the basis of market needs and value creation capability. In the first dimension, market needs or value sought (i.e., problem) can be known or unknown. In the second dimension, the value creation capability (i.e., solution) of the entrepreneur can be identified or undefined. The latter includes any specifications of the combination of resources (intellectual, human, financial, physical) as well as specification of the product and service being offered. This creates four cells in a two
by two matrix representing four types of opportunities: (1) dreaming or designing; (2) problem solving; (3) technology transfer; and (3) business formation (see Figure 1).

Interestingly, Ardichvili et al.’s (2004) framework aligns well with the discussion on abduction and, in particular, with Dorst’s (2011) characterization, which focuses on the what (i.e., the new product or service), the mode of operation (e.g., the business models, the configuration of resources or a system), and the value sought. More specifically, on the right-hand size of Figure 1, where the problem is known, there is little space for creative thinking and instead we have the area of problem solving and business formation. The latter is particularly straightforward as the problem is known as is the configuration of resources: the path ahead is determined by deductive thinking. In the case of problem solving, the problem to solve is known and identification of (possibly) limited resources is yet to be determined. This is a new product development that can be solved with inductive thinking.

The areas that are of most interest and that can lead to novel solutions are the areas on the left-hand side, where we do not know the problem that we are solving. If the configuration of resources is known, we face a technology transfer kind of problem; that is, one has a solution looking for a problem. This is the typical area of explanatory abduction (in Dorst terminology, the “what” and the “aspired value” are known but the configuration of resources needed to achieve the aspired value is unknown).

The case of “Dreams” is the most interesting as this is the most challenging situation facing the entrepreneur: he or she does not know what is the problem to solve nor the configuration of resources needed to address that problem. This is where innovative abduction comes into play as both the what and the how need to be identified. This is also the place where the two steps of innovative abduction discussed earlier can take place: first identify the value creation and then identify how to get there. The dreams and technology transfers situation are where abductive reasoning takes place as the problem is less obvious to solve and a solution is not immediately clear. Given the difficulty in addressing a two-dimensional domain where both
problems and solutions are unknown, it is more likely that these abductive hypotheses are limited to only a few people who are capable of generating them and, therefore, generate more innovative solutions. Unfortunately, the likelihood that these more novel solutions are also the more profitable might not be the case.

Drawing on our discussion above, we establish the following three propositions:

**Proposition 1.** While abductive, inductive, and deductive reasoning all operate in the case of new venture ideas, the use of each in the generation of new venture ideas is determined by how much we know about the value sought and the value creation capability.

**Proposition 2.** Abductive reasoning is a more useful form of reasoning in the formulation of novel venture ideas (as opposed to deductive and inductive reasoning) when the value sought is unknown.

**Proposition 3.** Innovative abduction will lead to more innovative new venture ideas than explanatory abduction.

In sum, abductive reasoning allows innovative entrepreneurs to create a map from a set of desired meanings to establish the space of the product or service that embodies those meaning (Dong et al., 2016). As we have just discussed, this is not to say that coming up with innovative ideas does not entail deductive or inductive logic. Rather, abductive reasoning is the form of logical reasoning that permits entrepreneurs to deal with situations when problems are neither completely stated nor definitively formulated but must be determined from information-rich observations, the underlying principles of which may be poorly understood. A typical example is when there is a new technology, but the use cases are missing or unclear. Entrepreneurs are hence required to make a set of hypotheses of what might be and these can be formulated.
through a process of observations as well further testing via deduction. Indeed, some scholars see abduction as operating in the case of both induction and deduction (Allen, 2015; Alvesson & Sköldberg, 2017; Dong et al., 2016). Given the high level of dynamism and uncertainty in the market, abductive reasoning is a practical and efficient tool that allows entrepreneurs to solve problems that are neither complete nor definitively formulated.

The Role of Artificial Intelligence in New Venture Idea Generation

Given the rapid pace at which AI is being developed and adopted, it is important to discuss its role within our framework of new venture idea generation. AI is the ability of computers to continuously analyze interactions with the real world (citation withheld for review purposes). There is no doubt that AI will transform many industries across the globe. More specifically, AI will provide a more efficient way for managers and entrepreneurs to understand and process information, assisting in decision making in a range of sectors. For example, the application of AI in healthcare will lead to a better way to implement evidence-based medicine because all the past and very recent research will be summarized and available instantly, allowing doctors to make more informed judgement in their diagnosis and treatment.

While we discuss the role of AI, cognitive computing is another term gaining popularity in the business and startup communities and is often used interchangeably with AI. Despite the absence of an agreed upon definition, cognitive computing is changing the way human interacts with machines. Nowadays, technology allows people to interact with computers using natural language, in the same way they would talk to another human being. In addition, machine learning, another application of cognitive computing, allows computers to be smarter and to generate reasonable arguments and valuable insights over time.

Given the data collected through mobile phones or wearable devices and how they can be analyzed and provide feedback, this study focuses on the role of AI and large datasets on abductive reasoning. More specifically, we argue that the availability of AI and data is very likely to change the way that abductive hypotheses for new venture ideas are generated.
While advances in technologies offer us a large amount of data, most of it is available in an unstructured form. Given that our brain is good at observing and analyzing information that is presented in structured form, unstructured data is difficult to process and, hence, less useful in the reasoning process. Nevertheless, organizations store a large amount of unstructured data that is not really used. AI technology helps us decipher unstructured data and provides insights based on the summary of the structured and unstructured data. In this study, we argue that it is the insights provided by the power of AI that facilitate the process of generating (abductive) hypotheses and new venture ideas.

*Abduction in a World with AI*

Abductive reasoning often originates from the observation of something that is unusual and surprising. That is, we may rely on one data point, in terms of observation, to generate an abductive hypothesis that then can be tested through deduction or experimentation. Hence, the process starts from observation to hypothesis to some sort of implementation and testing. The quality of the observation will affect the quality of the abductive hypothesis in the same way that the quality of evidence in a police investigation will determine the quality of its abductive hypothesis and, therefore, further testing and the identification of a suspect (Walton, 2014).

Within the highly dynamic market, the critical question becomes how we can make abductive hypotheses better, faster, and in greater volume. The critical piece to unravel this question lies in the availability of AI and the type of data involved. We argue that the ability of AI in analyzing a large amount of structured and unstructured data in a timely manner provides entrepreneurs with useful insights that will then provide the necessary input for their abductive reasoning. In this study, we define *insights* as the “summary” of multiple data points both from structured and unstructured data and often from different domains. Insights can be generated manually by humans but require accumulated knowledge and experience and may take a long time. AI can shorten this time and rely on less stringent levels of knowledge and experience to generate insights. Given the computing power and speed of analysis, a greater
number of insights may become available to a greater number of existing as well as potential entrepreneurs, thereby allowing more entrepreneurs to derive high quality abductive hypotheses for new venture ideas in a shorter period of time.

From a cognitive perspective, there are two conditions that make AI relevant for new venture idea generation. First, it is well established that some people are more effective than others at recognizing opportunities. More specifically, research shows that more experienced entrepreneurs are more effective than novice entrepreneurs in opportunity recognition because of the cognitive structures they have developed over time (Baron & Ensley, 2006; Dew, Read, Sarasvathy, & Wiltbank, 2009; Mueller & Shepherd, 2016; Ucbasaran et al., 2009). Serial entrepreneurs may possess better-developed prototypes for opportunities and cognitive frameworks acquired through experience (Vaghely & Julien, 2010). Prototypes provide individuals with a basis for noticing connections between seemingly independents events or trends (e.g., advances in technology, user problems). In their study of novice and serial entrepreneurs, Vaghely and Julien (2010) confirms that the prototypes of experienced entrepreneurs were more clearly defined, richer in content, and made greater consideration of conditions related to starting a new venture than the prototypes of novice entrepreneurs. Given that AI can offer insights that are more likely to be generated manually by serial entrepreneurs, the use of AI is likely to enable more novice entrepreneurs to generate new venture ideas. It should be noted that AI also facilitates new venture idea generation in serial entrepreneurs, but its benefit is more evident in novice entrepreneurs who possess less knowledge and experience and take longer to manually generate insights on their own. Hence, the role of AI here is to facilitate abductive reasoning by helping us collecting and connecting the dots.

Second, cognitive science has highlighted that working memory—the storage system where newly encountered information interacts with pre-existing knowledge and experiences—plays an important role in the performance of tasks such as reasoning and pattern recognition (Engle, Tuholski, Laughlin, & Conway, 1999). Moreover, the better the working
memory, the greater the ability of the individual to focus on the task at hand and extrapolate relevant cues (Engle, 2001). Accordingly, Baron (2004) suggests that individuals who are better at identifying opportunities may have a more efficient working memory. As a result, we argue that AI facilitates abductive reasoning in entrepreneurs by reducing the working memory required to effectively generate new venture ideas.

We use a scenario to illustrate how AI is likely to facilitate the creation of abductive hypotheses regarding new venture ideas. Consider the healthcare sector in which a nurse operating in an aged care facility in the time before cognitive computing was widely available. The nurse, over time, would observe patients in the age care facility and might recognize patient needs and opportunities for improvement and, hence, create hypotheses of how a new offering might look (see Figure 2). In Figure 2, the nurse makes several observations, but the first observation that seems relevant is W₁. Based on W₁, she generates hypothesis H₁ about future opportunities, which can be tested with further observations as well as by establishing a new entity to offer the new service back to the aged-care facility or directly to the patient. Over time the nurse may make several more observations from the ward that help her generate H₃ and H₆, where H₃ is a result of a combination of two observations, W₄ and W₅. Furthermore, the nurse might generate further hypotheses about opportunities by observing results related to Electronic Health Records (EHR). For example, hypothesis H₂ is generated from observation E₁ from EHR and hypothesis H₅ is generated from both observations E₄ and E₅ from EHR. Over time the nurse is presented with new data as hypotheses generated from her earlier observations are tested. This new set of data, or tested hypotheses (e.g., H*₁), is combined to generate new hypotheses H₇, H₈, and H₉. For example, the combination of tested hypotheses (H*₁ and H*₃) leads the nurse to identify hypothesis H₇.

This process of hypotheses generation is potentially time consuming. As the nurse gradually accumulates observations, only some of which are relevant, only some, mainly the surprising ones, will lead to an insight. Too many observations, as in the case of too many
choices, may get buried and become unnoticed (Schwartz, 2004). Moreover, these hypotheses might be very specific to the context where observations were made and, hence, less generalizable. Accordingly, we argue that abductive hypotheses generated manually from observations lead to a lower-quality new venture idea because they are generated based on observations from the single context, which may or not be generalizable in other contexts. In this study we adopt Frederiks, Englis, Ehrenhard, and Groen (2018) definition of the quality of new venture ideas, which considers three dimensions: (1) desirability including moral and legal acceptability of new product or service in the society; (2) novelty, referring to the uniqueness of the new venture idea; and (3) potential economic value of the new venture idea. Also, only the nurse who observes a specific situation would be in the position to generate an abductive hypothesis about the new venture idea, thereby limiting the opportunities for new venture idea generation to individuals who are familiar with a specific context.

With the use of AI, a multitude of observations (instead of selected observations) can be structured and analysed to generate insights, starting from the discrete data points or observations of the nurse (see Figure 3). The availability of these insights allows various potential entrepreneurs (apart from the nurse who observes and participates in such situation) to generate abductive hypotheses and create a new venture idea. Indeed, the “observer” or potential entrepreneur is now presented with data in the form of insights rather than raw observations. These insights are likely to be more sophisticated than observations because they are based on different touch points within the same dataset (e.g., wards) as well as from various datasets.

---------------------------------------
Insert Figure 2 and 3 about here
---------------------------------------

Importantly, with the help of AI, these insights would be available to a much broader set of individuals, who might be inside or outside the context or industry (e.g., nurses, doctors,
administrators, students, or anyone else). Each of those individuals brings their own unique experience and lens to understand and interpret the insights, which are important ingredients in generating new venture ideas (Ardichvili et al., 2003; Davidsson, 2015). As such, it is likely that a great number of individuals both from within and outside the industry will be able to come up with new venture ideas, as is currently happening in healthcare startups. At the same time, data will be crucial as it will allow AI to generate more sophisticated insights for entrepreneurs and those with access to insights will be in an advantageous position for identifying new venture opportunities. In turn, this implies stronger competition among startups and larger institutions alike to own the data and/or develop cognitive computing solutions.

Drawing on this line of argument and the thought experiment through the scenario we have presented, we argue that AI impacts the way in which abductive hypotheses are generated as follows.

**Proposition 4.** Insights generated by AI are more likely to allow an entrepreneur to generate higher-quality abductive hypotheses about new venture ideas than abductive hypotheses generated without the use of AI.

**Proposition 5.** Insights generated by AI will allow an entrepreneur to generate a higher number of abductive hypotheses about new venture ideas than abductive hypotheses generated without the use of AI.

**Proposition 6.** The use of AI in the process of abductive reasoning will allow an entrepreneur to generate abductive hypotheses about new venture ideas at a faster speed than without the use of AI.

It is important to emphasize that abduction is related to the background of potential entrepreneurs. Interestingly, research has shown an inverted relationship between familiarity with, for example, an industry or a way to serve the customer and the ability create new venture
ideas (Ardichvili et al., 2003; Dimov, 2007b; Gaglio & Dimov, 2018). In addition, given the fact that insights generated from AI are likely to be very valuable, market forces may operate to redistribute power and across the value chain, potentially justifying greater and greater power to those who can generate better insights. We argue that this is a key ingredient for abductive reasoning and new venture opportunities.

Discussion

In this work, we have unpacked the role of abductive reasoning in new venture idea generation. Whereas such cognitive process has been mentioned in entrepreneurship scholarship (e.g., Allen, 2015; Garbuio et al., 2018; Sarasvathy, 2001a; Vogel, 2016), this is to our knowledge the first attempt to explicate it from a theoretical perspective and discuss it in operational terms such that further empirical investigations can be performed. In particular, we have clarified two fundamental types of abductive reasoning: explanatory abduction and innovative abduction. Whereas both have a critical role in interpreting cues from the world around us and imagining future endeavours, the latter has a critical role in generating novel opportunities, in terms of new or significantly revised products and services, market segments or business models.

Furthermore, we examine the changing process of new venture ideas generation as a result of advances in data science and AI. By combining and synthesizing observations into insights, AI is effectively augmenting human cognitive capacity. In other words, AI allows us to outsource the inductive process of opportunity recognition (Baron & Ensley, 2006) in which entrepreneurs connect the dots that they observe over time. In a sense, one might argue that the AI helps us process the raw data (i.e., observations) into a more digestible form (i.e., insights), which allows us to more easily generate an abductive hypothesis on new venture idea. Indeed, the AI through machine learning algorithm can assist us in identifying anomalies in the data, generating insights which lead to potential explanations of anomalies and, in the near future, moving towards effectively testing these potential explanations on other data. When AI
technology reaches that stage of advancement, individuals who normally would not excel at abductive hypotheses (or perhaps, non-entrepreneurs and innovators according to Dyer et al. (2008)) would have the chance to come up with ideas more than before. In addition, serendipity as a source of opportunity creation (Vogel, 2016) may become less relevant in a world where cognitive computing is providing useful insights. Ultimately these are both philosophical and empirical questions worth exploring.

While we focus our discussion on the cognition underpinning new venture ideas, entrepreneurial cognition goes beyond thought processes. For example, Cardon, Foo, Shepherd, and Wiklund (2012) discuss the concept of “hot cognition”, in which emotions, moods, and feelings affect entrepreneurial cognition and reasoning. Grégoire, Corbett, and McMullen (2011) articulate the importance of the mind and the environment on entrepreneurial actions. Two key contextual conditions play an essential role in constraining or enabling the process of abductive reasoning we discussed earlier.

The first factor is the experience and knowledge the entrepreneur accumulates (Shepherd & DeTienne, 2005). Research shows that, over time, entrepreneurs develop a “knowledge corridor” (Ronstadt, 1989) that focuses their attention on certain opportunities but not others (Shane & Venkataraman, 2000; Venkataraman, 1997). As often observed in the market, an industry outsider is brought in to bring a fresh perspective. Compared to an industry insider who knows the industry inside out (e.g., the way the supply chain operates, the market demand, the various shortcomings in the system), an outsider does not know how the system works but can focus on the final user and how to deliver value. Using analogies from other fields is very common in problem understanding as well as option generation and business model design (Garbuio, Lovaclin, Porac, & Dong, 2015; Martins, Rindova, & Greenbaum, 2015).

The role of experience can also be explained through the process of sensemaking, which occurs when we make sense of new inputs—typically the unusual, the confusing, and the unexpected (Maitlis, 2005)—on the basis of past experiences (Weick, 1995). In opportunity
creation, a particular type of sensemaking, so-called prospective sensemaking, has emerged. Prospective sensemaking attempts to create meaningful opportunities and a structure for the future by imagining some desirable state (Shrivastava, Gioia, & Mehra, 1996). Because it focuses on the future, prospective sensemaking is particularly useful in the context of new venture creations (Shrivastava et al., 1996). Clarifications on the role of abduction in prospective sensemaking are largely overdue.

The second factor influencing the process of abductive reasoning is external circumstances, including connections with the startup ecosystem (Van Burg & Romme, 2014). As a social skill, creating new venture ideas requires more than knowing the right information and how to use it. Participation in communities for knowledge creation has been found to be a key characteristic of innovators (Powell, Koput, & Smith-Doerr, 1996). Indeed, engaging with new opportunities is not a single-person and single-insight attribute (Davidsson, 2015; Dimov, 2007a), but rather the result of a process in which a set of unitary, distinct events leads to the emergence of a pattern (Oliver & Roos, 2005). This is particularly relevant in technology entrepreneurship, which has been found to be more effective when it is built on the efforts of many (Garud & Karnøe, 2003).

Another important driver of abductive reasoning is analogical reasoning, which relies on drawing associations and dissociations between two “things”. The properties of a source domain are transferred to a target domain based on an abstract conceptualization (mental representation) of similarity between the two domains (Holyoak & Thagard, 1995). According to Baron and Ensley (2006), analogies and prototypes are part of a pattern-recognition process that allows entrepreneurs to see connections between apparently independent events. Analogies also play an important role in structural alignment—defined as the process of comparing new information with what is already known—in a study of executives’ opportunity recognition (Grégoire, Barr, & Shepherd, 2010). Hill and Levenhagen (1995) suggest that analogies are important in sensemaking and sensegiving, as they help to articulate, communicate, and
interpret entrepreneurs’ mental models. Because analogies can be incomplete statements comparing one thing to another, they do encourage inferences, cognitive flexibility, and adaptiveness to change. Similarly, Cornelissen and Clarke (2010) argue that prospective sensemaking is the result of an inductive use of analogies.

**Conclusion**

The entrepreneurship literature has yet to adequately explain how entrepreneurs process information while recognizing a business opportunity (Davidsson, 2017; Keh, Foo, & Lim, 2002; Moroz & Hindle, 2012; Short, Ketchen, Shook, & Ireland, 2010; Vogel, 2016). Most studies also fail to identify how overarching concepts, such as divergent and convergent thinking and sensemaking, clearly relate to more fine-grained concepts, such as analogical thinking or pattern recognition. Our study of entrepreneurship scholarship suggests abduction as a form of logic for thinking about future visions and opportunities. However, it has not been addressed in the entrepreneurship literature.

Ideas about future new ventures start from the observations of something unusual and/or surprising in the environment or data available to designers, strategists, innovators, and potential entrepreneurs alike. Furthermore, the growing availability of data, and especially the advance of AI technology, offers even more opportunity to observe anomalous and surprising instances, which in turn can become sources of new opportunities as a result of abductive hypotheses.

In this paper, we addressed two important questions in new venture idea generation. First, we addressed what abduction is and how it operates in the context of entrepreneurial opportunities. Second, we have addressed how the availability of AI and data, including surprising and anomalous observations, influence the generation of abductive hypotheses. The pace at which people can generate opportunities, the strength of these opportunities, and the
possibility of testing these with further data will likely improve over time and at an accelerated pace.

Understanding abduction demystifies notions of creative insight for entrepreneurs. Abduction can be taught, and abductive reasoning is a muscle that can be trained. In addition, cognitive computing is likely to augment human capacity, not only for experts but anyone who has the opportunity to engage with data and the insights produced. Fluency in abduction will be an important tool for potential entrepreneurs and serial entrepreneurs alike.

References


Table 1. Similarities between Abductive Reasoning and New Venture Idea Generation

<table>
<thead>
<tr>
<th>Categories of similarities</th>
<th>Abductive reasoning</th>
<th>New venture idea generation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Givens</strong></td>
<td>Observation of a surprising or unexplained phenomena that cannot be explained with deductive or inductive reasoning. Abductive reasoning will lead to the generation of alternative explanations that can be further tested</td>
<td>Observation of a customer need or workaround which is not explained by deductive or inductive reasoning. Observation that existing customers and competitors are all behaving the same way but you suspect that there might be a different way to solve a problem and create value.</td>
</tr>
<tr>
<td><strong>Context of relevance</strong></td>
<td>Key reasoning pattern to imagine something that has yet to exist</td>
<td>The future outcome of the new venture idea is uncertain</td>
</tr>
<tr>
<td><strong>Underlying structure</strong></td>
<td>The reasoning includes the WHAT, the HOW and the VALUE that is delivered to the target user</td>
<td>The new venture idea needs to identify value creation for the customer as well as a business model to make it financially viable and technically feasible</td>
</tr>
<tr>
<td><strong>Nature of the outcome</strong></td>
<td>As a result of the abductive reasoning, you have a hypothesis that can be tested either physically or with new data collection (deductive reasoning)</td>
<td>As a result of the new venture idea, you have “something” that you can test by looking into viability (e.g. industry and market research, deductive reasoning) and technical feasibility (e.g. by building a working prototype)</td>
</tr>
</tbody>
</table>
Figure 1. The logics of new venture ideas

Source: Adapted from Ardichvili et al. (2003)
Figure 2. Generative abductive hypotheses in a non-cognitive computing world
In this paper, we use augmented cognition, AI-driven solution, and cognitive computing almost interchangeably. The fundamental idea is that AI is going to transform data into observations, and these observations will be the starting point for human cognition to generate hypotheses about the future. By future, we mean future new venture opportunities, including products, services and business models.

The other two fundamental processes discussed in the study are experimenting, which includes physical experimentation with objects, visiting new places and trying new things, and mentally experimenting with ideas. Fourth, the scholars identified idea networking, or actively engaging with others to find and test ideas, a process that triggers associations between disparate concepts.

Here is a set of non-comprehensive instances in which entrepreneurs may find useful to think in explanatory abductive terms. These have been adapted from previous work on sources of abductive reasoning.

1. Explain the motives underpinning the (observed) behavior of an incumbent or competitors, e.g., why is an airline such as Qantas offering health insurance business?
2. Explain customers’ behavior, e.g. how should we interpret enrolments in healthcare plans which reward consumers for keeping fit but also punished them when they are not making an effort to keep fit?
3. Revise core beliefs about the environment, e.g. why is the price for health insurance falling? What is driving the adoption of blockchain in the administration of healthcare records?
4. Discern technology trajectories, e.g., where is 3D printing for human parts headed?

Situations calling for an innovative abduction include:
1. Introduce or significantly revised a business model.
2. Introduce or significantly revised new product or service.
3. Identify a new market or market segment.

5. In an AI system that automatically detects faults, abduction is likely to be the reasoning used to detect the sets of faults that are likely to cause a problem.
6. An alternative explanation would be that they have better developed schemata, and so long term rather than working memory. In any event, the conclusions of our argument do not change as these still make serial entrepreneurs better than novice entrepreneurs at recognizing opportunities.
In another study, we investigated the role of funders of health care startups driven by AI. In a dataset of over 100 companies from around the world, only a small percentage of startups have founders with a medical or healthcare background. The majority are from IT and business.