The use of metaphor and counterfactual thinking in "Computer machinery and intelligence" by Alan M. Turing

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Abstract
One of the major tenets of Conceptual Metaphor Theory and Conceptual Blending Theory is that the mechanisms implicated in the simplest kinds of thought, such as cross-domain mapping and blending, are also involved in high-order thinking. This paper examines Alan Turing's (1950) "Computer machinery and intelligence" from the perspective of these two theories. In his pioneering article, Turing addresses the question of whether machines can think. Though mid-twentieth century computers were unable to imitate human cognitive performance satisfactorily, Turing concludes that machines may show intelligent behavior. I argue that the author reaches this conclusion by using counterfactual thinking, and, more specifically, by construing a counterfactual blended space in which computers display human-like characteristics. In addition to this, I suggest that Turing's (1950) thinking is driven by the metaphor COMPUTER INFORMATION BEHAVIOR IS HUMAN INTELLECTUAL BEHAVIOR. The constant mappings between the domain of COMPUTER BEHAVIOR and that of HUMAN COGNITION allows the author to reason about the former domain in terms of the latter. This provides support for the argument that supposedly bidirectional metaphors (e.g. COMPUTERS ARE HUMANS) are, in fact, asymmetrical, matching specific elements from a source domain to a target domain. Furthermore, it bolsters the claim that metaphor and conceptual integration constitute fundamental mechanisms of human thought, which come into play when conducting complex scientific inquiries as well.

Keywords
COMPUTER AS HUMANS metaphor, counterfactual thinking, Turing's imitation game, "thinking" computer

1 Introduction

Within the field of Cognitive Linguistics, two theories have been advanced to account for how the human mind constructs meaning: Conceptual Metaphor Theory, widely discussed in Lakoff & Johnson (1980), and Conceptual Blending Theory, developed by Fauconnier & Turner (2002). While the former understands "A is B" metaphors as a mapping between two domains, the latter considers that multiple mental spaces can participate in a mapping (Gibbs 2015: 170). Additionally, Fauconnier & Turner (2002) argue that metaphor is just a subcase of a more general theory of meaning construction. Building integration networks is fundamental to a myriad of mental processes: metaphors, counterfactuals, literal framing, analogy, hyperbole, as well as other semantic and pragmatic phenomena (Fauconnier & Turner 2002: 222).

Using the MIP-VU ("metaphor identification procedure"-VU), Steen et al. (2010) have found that discourse genres show various degrees of metaphoricity. Academic discourse contains the largest number of metaphorically used words (18%), followed by news stories (15%), fiction (11%), and finally conversation (7%) (Steen et al. 2010 cited in Gibbs 2015: 174). The greater use of metaphoric language in academic writing lies in the fact that in this type of discourse frequent reference is made to abstract concepts (Gibbs 2015: 174).

Within the field of molecular biology, for instance, the metaphor of language in the form of alphabetic script has underlain genetic research since 1953. The four nucleotide bases abbreviated by A, T, C, and G are called the "letters of the genetic alphabet"; RNA-polymerase is said to *read* DNA-sequences with their *reading frame(s)*, a process referred to as *transcription*; and the genome of a lot of species is being *deciphered*; to name but a few examples of linguistic vocabulary used in texts of microbiology (Raible 2001: 105-106). This metaphor has turned out to be highly productive because both written language and genetics share the same basic principles, "the principles allowing the reconstruction of multi-dimensional wholes from linear sequences of basic elements" (Raible 2001: 107).

Metaphors are pervasive in mathematics too. Most of the idealized abstract technical entities in mathematics, frequently regarded as the ultimate universal language, are actually created via everyday mechanisms embodied in human experience, among them conceptual metaphor and conceptual blending (Núñez 2008: 341). The idea of subtraction, for instance, mathematizes the common idea of distance; the idea of a derivative mathematizes the ordinary idea of instantaneous change. Basic and sophisticated mathematical ideas, e.g. the concept of limits, or the notion of continuity of functions, are metaphorical in nature.

The present works examines Turing's (1950) "Computing machinery and intelligence" using Conceptual Metaphor Theory, and Conceptual Blending Theory. Turing (1950) investigates the question of whether machines can think. Although this paper was published prior to any development in the field of artificial intelligence (Rasskin-Gutman 2009: 61), the author concludes that computers may show intelligent behavior. How can Turing (1950) arrive at this conclusion, if mid-twentieth century computers were unable to imitate human behavior? I suggest that this was possible because the author uses counterfactual thinking to address his research question. In addition, I hypothesize that Turing's (1950) reasoning is driven by a metaphor that can be labeled as COMPUTER INFORMATION BEHAVIOR IS HUMAN INTELLECTUAL BEHAVIOR.

This paper is structured as follows. I begin with a succinct introduction to Conceptual Metaphor Theory (Section 2.1), and Conceptual Blending Theory (Section 2.2), and go on to analyze Turing (1950) in view of these two theories (Section 3). Using Conceptual Blending Theory, I explain how the use of counterfactual thinking allows Turing (1950) to aver that computers can indeed show intelligent behavior (Section 3.1). In Section 3.2, I analyze the mappings between the domains of HUMAN COGNITION and COMPUTERS that structure the whole paper. Finally, in Section 4, the findings of the analysis are summarized.

2 The theoretical frameworks

2.1 Conceptual Metaphor Theory

Metaphor has been studied from various perspectives. Broadly speaking, two lines of research can be identified. According to classical rhetorical theory, and some pragmatic theories, such as Searle's or Grice's, metaphors are a deviation from everyday conventional language, a departure from a norm of literalness (Sperber & Wilson 2008: 84). Under this perspective, the term *metaphor* refers to "a novel or poetic linguistic expression where one or more words for a concept are used outside of their normal conventional meaning to express a 'similar' concept" (Lakoff 1993: 202). In this view, metaphor is regarded as a special rhetoric tool reflecting creative thinking and high aesthetic abilities (Gibbs 2015: 168). Cognitive linguists, and relevance theorists, on the other hand, consider metaphor as an everyday phenomenon. While the latter regard metaphor as emerging in the process of verbal communication,[1] the former see it as a pervasive phenomenon which does not only affect language but which is constitutive of human thought (Sperber & Wilson 2008: 84). For Cognitive Linguistics, metaphor is paradoxical: through its creative, novel, and culturally motivated characteristics it allows us to transcend the mundane, while being at the same time a very basic cognitive mechanism that is "rooted in pervasive patterns of bodily experience common to all people" (Gibbs 2008: 5).

Made widely known by Lakoff & Johnson (1980), Conceptual Metaphor Theory (CMT) holds as one of its central tenets that most of humans' ordinary conceptual system is essentially metaphorical. This means that metaphors structure "how we perceive, how we think, and what we do" (Lakoff & Johnson 1980: 21). In this view, metaphor is a matter of thought. It involves "a *unidirectional mapping* projecting conceptual material from one structured domain […] called the *source domain*, to another one, called the *target domain*" (Dancygier & Sweetser 2014: 14). Most notably, conceptual metaphor theorists reserve the use of *metaphor* for cross-domain mapping in the conceptual system, while the term *metaphoric expression* is used to refer to "a linguistic expression (a word, phrase, or sentence) that is the surface realization of such a cross-domain mapping" (Lakoff 1993: 203).

The definition of *metaphor* as stated above requires that the concepts *domain* and *mapping* be explained. According to Langacker (1987: 147), "domains are necessarily cognitive entities: mental experiences, representational spaces, concepts, or conceptual complexes". This knowledge structures – or chunks of conceptual matter – provide background information that allows us to understand and use lexical concepts in language (Evans & Green 2006: 230). A domain either contains structure that is projected into another domain or receives such a

1 Sperber & Wilson (2008) provide an explanation of relevance theory's approach to metaphor. The authors characterize this approach as "deflationary" (Sperber & Wilson 2008: 85). In contrast to Conceptual Metaphor Theory, where metaphor is studied as a distinctive phenomenon, relevance theory regards metaphor as the end of a continuum including literal, loose, and hyperbolic interpretations: "In our view, metaphorical interpretations are arrived at in exactly the same way as these other interpretations. There is no mechanism specific to metaphor, no interesting generalization that applies only to them" (Sperber & Wilson 2008: 85).

projection (Dancygier & Sweetser 2014: 17).[2] Concepts are usually organized in terms of various domains (Evans & Green 2006: 231)

The term *mapping* describes the relations or links existing between specific elements of the two domains' structures – the source domain and the target domain (Dancygier & Sweetser 2014: 14). Mappings are constrained by the Invariance Principle[3] (Lakoff 1993: 215).

Conceptual connections between the domains might be reflected in metaphoric expressions. The range of vocabulary choices available to refer to the target in terms of the source domain is contingent on the aspects being linked between the two domains. Furthermore, the mapping sanctions the use of source domain inference patterns for target domain concepts (Lakoff 1993: 208).

This may be exemplified by the widely discussed metaphor LOVE IS A JOURNEY[4] (Lakoff & Johnson 1980: 95-97, Lakoff 1993: 206-212). This metaphor is characterized by the following correspondences between the source domain (JOURNEY) and the target domain (LOVE):

Table 1. The LOVE-AS-JOURNEY mapping (Lakoff 1993: 207)

Target domain: LOVE	**Source domain: JOURNEY**
Lovers	Travelers
Love relationship	Vehicle
Lovers' common goals	Common destinations on the journey

This conceptualization of love in terms of a journey is reflected in a series of expressions based on these mappings, such as: "Look *how far we've come*"; "We're at a *crossroads*"; "We may have to *go our separate ways*"; and "The marriage is *on the rocks*", to cite just a few examples (Lakoff 1993: 206). The LOVE IS A JOURNEY metaphor allows us to think and reason about love in terms of a very different domain of experience, that is journeys. Inference

2 Some cognitive linguists prefer to define metaphors as mappings between frames – instead of between domains (Dancygier & Sweetser 2014: 17). The term *frame* was introduced by Fillmore (1982: 111) to refer to "any system of concepts related in such a way that to understand any one of them you have to understand the whole structure in which it fits". Fillmore's theory of frame semantics considers that the background context is absolutely essential to understanding a category (Fillmore 1982: 120). The difference in meaning between the words *land* versus *ground*, for example, lies not in the entity they refer to, but in "how they situate that thing in a larger frame" (Fillmore 1982: 121). The analysis of the commercial event frame, and the speech event frame provide further examples of this concept (Fillmore 1982: 116-117, Evans & Green 2006: 225-228). Just as domains, frames are knowledge structures, schematizations of experience represented at the conceptual level and stored in long-term memory (Evans & Green 2006: 222). For a comparison between Langacker's theory of domains and Fillmore's theory of frames, see Evans & Green (2006: 230-231).

3 The Invariance Principle holds that "metaphorical mappings preserve the cognitive topology (that is, the image-schema structure) of the source domain, in a way consistent with the inherent structure of the target domain" (Lakoff 1993: 215). Image schemas are "schematic or skeletal structure[s] representing a spatial configuration (such as verticality) and the various forces that affect a human body (e.g. pressure, gravity, etc.)" (Dancygier & Sweetser 2014: 22).

4 I follow the convention of using small capitals (e.g. TARGET-DOMAIN IS SOURCE-DOMAIN, or alternatively, TARGET-DOMAIN AS SOURCE-DOMAIN) as mnemonics to name mappings. The LOVE IS A JOURNEY metaphor refers to the set of correspondences holding between elements of the two domains. By contrast, the English sentence "love is a journey" is a metaphorical expression understood via the set of correspondences established at the conceptual level (Lakoff 1993: 209).

patterns used to reason about journeys are mapped from this domain of experience to love relationships. For instance, if two travelers in a vehicle, moving towards a common destination, encounter some impediment and get stuck, the travelers face a number of alternatives for action: (i) to get the vehicle moving again, either by fixing it or getting it past the impediment that stopped it; (ii) to remain in the nonfunctional vehicle and renounce reaching their destinations; or (iii) to abandon the vehicle, in which case the travelers do not satisfy the desire to reach their destinations (Lakoff 1993: 208). Similarly, two lovers in a love relationship, pursuing common life goals, may encounter some difficulty, which makes their relationship nonfunctional. They have three alternatives for action: (i) to get the relationship moving again, either by fixing it or getting it past the difficulty; (ii) to remain in the nonfunctional relationship, and give up on achieving their life goals; and (iii) to abandon the relationship, in which case the lovers do not satisfy the desire to achieve their common life goals (Lakoff 1993: 208).

As metaphors are part of our conceptual system, and not merely linguistic expressions, novel metaphoric expressions based on these same correspondences can be understood without significantly higher cognitive efforts. For example, speakers of English can easily comprehend the novel metaphoric expression "We're driving in the fast lane on the freeway of love", because it is underlain by the LOVE IS A JOURNEY metaphor (Lakoff 1993: 210).[5]

The mapping of elements from a source domain to a particular target domain is usually considered to be unidirectional or asymmetrical.[6] That is, while it is possible to understand the domain of love relationships in terms of a journey, the opposite does not hold, since people do not reason about journeys in terms of love relationships. Dancygier & Sweetser (2014: 30-31) maintain that even metaphors that might be argued to be reversible or bidirectional (e.g. PEOPLE ARE COMPUTERS and COMPUTERS ARE PEOPLE) actually represent unidirectional mappings from a source domain to a target domain. Though we can both say "my memory banks are scrambled", and "my computer is being stubborn and difficult today", these metaphors are not motivated by the same mappings; instead, they are structured by two different, specific frames, namely HUMAN COGNITIVE PROCESSING IS COMPUTER INFORMATION PROCESSING, and APPARENTLY ERRATIC ASPECTS OF COMPUTER BEHAVIOR ARE EMOTIONAL MOOD-BASED ASPECTS OF HUMAN BEHAVIOR, respectively (Dancygier & Sweetser 2014: 31).

The direction of the mapping from one domain to another is not arbitrary. It has been frequently assumed that metaphor allows us to grasp abstract concepts in terms of concrete ones (Dancygier & Sweetser 2014: 62). There are, however, some metaphors in which the target domain cannot be said to be more abstract than the source domain, e.g. the MORE IS UP metaphor. In this case, the direction of the mapping is not dependent on the degree of

5 Gibbs (2008: 5) argues that in many cases, creative, poetic metaphors are not completely original; instead, they represent extensions of preexisting schemes of metaphorical thought.

6 Zhong & Leonardelli (2008) contend that metaphors can also be bidirectional. The authors analyze the relationship between physical temperature and evaluation of personality. Based on their findings from two experiments, Zhong & Leonardelli conclude that "not only do people consciously describe social interactions using temperature concepts, but they also understand interpersonal situations differently depending on temperature concepts that are activated incidentally" (Zhong & Leonardelli 2008: 838).

concreteness of the two domains; it is, instead, based on the cognitive asymmetry between them: "Vertical Height is not more concrete than Quantity, but it is more assessable that Quantity and serves as a cue for assessing Quantity, rather than the other way around" (Dancygier & Sweetser 2014: 65). In metaphors like KNOWING IS SEEING ("I see what you mean"), a more subjective and less mutually accessible domain is understood using terms from a more intersubjectively accessible domain (Dancygier & Sweetser 2014: 27). The "cognitive directionality principle" reads as follows: "metaphorical source domains tend to represent conceptually more accessible, concrete, and salient concepts than do target domains" (Gibbs 2008: 9).

However, one of the points of criticism raised against Cognitive Linguistics theories of metaphor is that it overgenerates metaphoricity. In that vein, Gibbs (2015:73) has moaned that "many conventional expressions viewed as metaphoric by cognitive linguists are not metaphoric at all".[7] Expressions like "I'm off to a good start in graduate school", for example, are said to be entirely literal as to process them does not involve any cognitive operation of cross-domain mapping. Hence, they are sometimes regarded as "dead" metaphors.[8] Gentner & Bowdle (2008: 115-119) propose the "career of metaphor" hypothesis to account for the conventionalization of metaphors. They identify four stages of conventionalization of metaphors: (i) novel metaphors, (ii) conventional metaphors, (iii) $dead_1$ metaphors, and (iv) $dead_2$ metaphors (Gentner & Bowdle 2008: 117-118). The hypothesis states that:

> a metaphor undergoes a process of gradual abstraction and conventionalization as it evolves from its first novel use to becoming a conventional "stock" metaphor. This process results in a shift in mode of alignment. Novel metaphors are processed as comparisons, in which the target concept is structurally aligned with the literal base concept. But each such alignment makes the abstraction more salient, so if a given base is used repeatedly in a parallel way, it accrues a metaphoric abstraction as a secondary sense of the base term. When a base term reaches a level of conventionality such that its associated abstract schema becomes sufficiently accessible, the term can function as a category name. (Gentner & Bowdle 2008: 116)[9]

Although hence not free of criticism, Conceptual Metaphor Theory has succeeded in (i) showing – based both on linguistic and non-linguistic evidence (Gibbs 2015: 177-179) – that conceptual metaphors are part of thought and not just language; (ii) that they constitute a basic cognitive mechanism through which we conceptualize the world and perform abstract reasoning (Lakoff 1993: 244, Gibbs 2008: 3); and (iii) that they are rooted in human embodied experience, and are constrained by human cognition (Dancygier & Sweetser 2014: 22).

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7 Other common objections against Conceptual Metaphor Theory are discussed in Gibbs (2015: 173-177).

8 Giving evidence from gestures in language, Müller (2008) maintains that it would be more appropriate to refer to "dead" metaphors as "sleeping" metaphors, since they can be awaken and become fully productive (222-223). Müller (2008) advocates a dynamic approach to metaphor that assigns metaphors a place in a continuum ranging from sleeping to waking metaphors (222-223, 233-238).

9 Coulson & Oakley (2005: 1524-1530) propose a similar account of the differences between novel, and entrenched or conventionalized metaphors, from the perspective of conceptual blending theory.

2.2 Conceptual Blending Theory

The theory of conceptual blending, also known as conceptual integration theory, the theory of online meaning construction, the many space model, and the network theory (Coulson & Oakley 2000: 175), derives from two traditions within the field of Cognitive Linguistics: Conceptual Metaphor Theory, and Mental Spaces Theory, to which it is most closely related (Evans & Green 2006: 400). Developed by Fauconnier & Turner (2002), the theory centers on the "dynamic aspects of meaning construction and its dependence upon mental spaces and mental space construction as part of its architecture" (Evans & Green 2006: 400). It hypothesizes that "meaning construction typically involves integration of structure that gives rise to more than the sum of its parts" (Evans & Green 2006: 400). Fauconnier & Turner (2002: 18) aver that conceptual blending is one of the basic mental operations performed by the human mind. The process of blending is essential to even the simplest kinds of thought, and is involved in all sorts of cognitive and linguistic phenomena, ranging from "creative examples that demand the construction of hybrid cognitive models" to "more conventional instances of information integration", e.g. integrating *blue* and *cup* to yield *blue cup*[10] (Coulson & Oakley 2005: 1515). Conceptual blending considers metaphor as a subcase of this general theory of meaning emergence.[11]

Within the theory of mental spaces, developed by Fauconnier (1994) to answer questions about indirect reference or referential opacity, "mental spaces" are understood as "small conceptual packets constructed as we think and talk, for purposes of local understanding and action" (Fauconnier & Turner 2002: 40). They constitute "partial representations of entities and relations of any given scenario as perceived, imagined, remembered or understood by a speaker" (Coulson & Oakley 2000: 177). These elements are structured by frames and cognitive models in a coherent way. Establishing mappings from one mental space to another is a crucial component of the theory. Once an element from one space has been linked to an element from another space, speakers may refer to one or the other element by naming, describing, or referring to its counterpart in another space.

Mental spaces operate in working memory but are partially construed by activating structures available from long-term memory. The theory considers that:

> meaning construction is successful because speakers utilize background knowledge, general cognitive abilities, and information from the immediate discourse context to help them decide when to partition incoming information and how to establish mappings among elements in different spaces. (Coulson & Oakley 2000: 178)

10 Some scholars disagree with calling this type of integration *blends* (e.g. Gibbs 2000); however, Fauconnier & Turner (2002) argue that it is useful to appreciate the continuum ranging from extremely novel examples of conceptual integration to more conventional ones (Coulson & Oakley 2005: 1515).

11 In contrast to Conceptual Metaphor Theory, which analyzes metaphor as a two-domain mapping, blending theory treats metaphor as an integration network consisting of at least two input spaces, a generic space, and a blended space (Dancygier & Sweetser 2014: 75). Fauconnier & Turner (2008: 53) maintain that conceptual metaphors are "never the result of a single mapping"; instead, they "turn out to be mental constructions involving many spaces and many mappings in elaborate integration networks constructed by means of overarching general principles" (Fauconnier & Turner 2008: 53). Fauconnier & Turner's (2008: 54-61) analysis of the often-studied metaphor TIME AS SPACE illustrates this.

Mental spaces can be modified as thought and discourse unfold. Because of this, they constitute dynamic representations of thought processes.

Like the theory of mental spaces, conceptual blending theory also postulates a system of backstage cognition that includes partitioning, mapping, selective structure projection, and dynamic mental simulation. Crucially, this theory posits a conceptual integration network, "an array of mental spaces in which the processes of conceptual blending unfold" (Coulson & Oakley 2000: 178). The most basic representation of a conceptual integration network, called a minimal network, includes four spaces: two input spaces, a generic space, and the blend (Fauconnier & Turner 2002: 47). Elements in the different spaces in the network are partially mapped onto their counterparts in other spaces of the network. These counterpart connections produced by matching can be of many kinds: change, identity, time, space, cause-effect, part-whole, uniqueness, among others. Fauconnier & Turner (2002: 92) refer to them as "vital relations", because of their ubiquity in conceptual blending processes.[12]

The generic space captures the structure that the input spaces share. This structure is in turn mapped onto each of the inputs. The blend contains generic structure captured in the generic space, structure projected from the input spaces, plus structure that is not contained in any of the other spaces. This projection of elements and relations from the input spaces to the blend is selective.[13] The structure projected into the blend gives rise to a coherent whole containing elements and relations that do not come directly from any of the inputs – the emergent structure. This structure is generated in three ways: through composition of projections from the input spaces, through completion of information based on access to frames and scenarios, and through elaboration (Fauconnier & Turner 2002: 47-48).

Composition involves "attributing a relation from one space to an element from the other input spaces" (Coulson & Oakley 2000: 180). Completion refers to the process of pattern completion that takes place when structure in the blend matches information in long-term memory, i.e. when background information and structure are brought into the blend (Coulson & Oakley 2000: 180, Fauconnier & Turner 2002: 48). Finally, elaboration involves simulating and running the blend according to the principles established, in part, by the operation of completion. The blend can be run "as much and as long and in as many alternative directions as we choose" (Fauconnier & Turner 2002: 49). The creative possibilities of blending arise out of the (in principle) "open-ended nature of completion and elaboration" (Fauconnier & Turner 2002: 49). Running the blend involves understanding the inferences it yields as a

12 A vital relation can be defined as "a link that matches two counterpart elements or properties" (Evans & Green 2006: 419-420). Vital relations connect counterparts in the input spaces and establish outer-space relations, links between the input mental spaces. These conceptual relations can also give rise to compressions in the blend, creating inner-space relations, or relations inside the blend. Fauconnier & Turner (2002: 93-102) provide a classification of vital relations, as well as of the ways these relations can be compressed.

13 Grady (2000) criticizes conceptual blending theory's account of selective projection for postulating that individuals construct input spaces with elaborate knowledge, and then actively select a projection of that knowledge, inhibiting the rest. In contrast to this account, he proposes that only the relevant information is initially activated. There is therefore no need for suppression or inhibition of knowledge at a later stage.

result of the way the various elements and their relations have been set up in the integration network (Dancygier & Sweetser 2014: 82).

Conceptual integration networks can be classified into four major types[14] (Fauconnier & Turner 2002: 119-135, Evans & Green 2006: 426-431):

(i) **Simplex networks** involve two input spaces, one that contains a frame with roles, and another containing values. They are instances of basic framing.

(ii) **Mirror networks** are characterized by the fact that all of the spaces in the network, including the blend, share a common frame.

(iii) In **single-scope networks**, each of the input spaces is structured by a distinct frame; however, only one of the input frames organizes the blend.

(iv) **Double-scope networks** are similar to single-scope networks in that both inputs contain distinct frames; nevertheless, as opposed to the latter, in double-scope networks the blended space is organized by structure taken from both frames. Blends in this type of integration networks can sometimes include structure from the inputs that is incompatible, giving rise to clashes between the two organizing structures. This is why double-scope networks can be highly imaginative, and lead to novel inferences.

Building integration networks provides us with "a forum for the construction and development of scenarios that can be used for reasoning about aspects of the world" (Evans & Green 2006: 431). Furthermore, it "gives us global insight, human-scale understanding, and new meaning" (Fauconnier & Turner 2002: 92). It is therefore an indispensable tool for human cognitive reasoning[15].

Let us illustrate conceptual blending theory through an often-cited example within the literature of the field: "In France, Bill Clinton wouldn't have been harmed by his relationship with Monica Lewinsky" (Evans & Green 2006: 406-407, Coulson & Oakley 2005: 1514-1519).[16] Besides being a case of double-scope blending, this expression is also an example of counterfactual thinking. Frequently restricted to causal analysis (see, for example, King et al. 1994), Fauconnier & Turner (2002: 219) argue that "great ranges of counterfactual thought are directed at important aspects of understanding, reason, judgment, and decision that are not concerned principally with causality". Expressions like "If I had milk, I would make

14 Based on the taxonomy of integration networks proposed by Fauconnnier & Turner (2002), Bache (2005) proposes a new typology of blends that takes into account the notion of conceptual disintegration (1626-1632). This term is used to describe "a basic general mental skill enabling us to divide wholes into relevant component parts, and to differentiate individual properties or features of objects, situations and structures" (Bache 2005: 1627). This typology includes three main types of blends, as well as a typology of disintegration.

15 Due to its descriptive power, it has been pointed out that blending theory runs the risk of being excessively powerful, "accounting for everything, and, hence, explaining nothing" (Coulson & Oakley 2000: 186). To ward off this criticism, Fauconnier & Turner (2002: 312-336) have proposed a series of "optimality principles", or constraints under which blends function most effectively. Some of these principles include: the integration principle, the topology principle, the web principle, the unpacking principle, the good reason principle, and the metonymic tightening. For a discussion of this and other objections raised against conceptual integration theory, see Coulson & Oakley (2000: 192-193).

16 See also Fauconnier & Turner's (2002: 225-226) analysis of "In France, Watergate would not have hurt Nixon".

muffins", "Kant disagrees with me on this point", or "Coming home, I drove into the wrong house and collided with a tree I don't have" all require that counterfactual reasoning be put into action. The term *counterfactual* pertains to, or expresses, "what has not in fact happened, but might, could, or would, in different conditions" (Oxford English Dictionary Online, 11 August, 2015). Within the theory of conceptual blending, a space is *countefactual* when "that one space has forced incompatibility with respect to another", which is commonly taken to be "actual" (Fauconnier & Turner 2002: 230).

In the case of "In France, Bill Clinton wouldn't have been harmed by his relationship with Monica Lewinsky", the integration network of this expression includes two input spaces. One input space contains the elements Clinton, Lewinsky, and their relationship. This space is organized by the frame AMERICAN POLITICS, which includes a role for American President, as well as certain attributes related to this role, among them moral virtue, one of its symbols is marital fidelity. In this space, marital infidelity is politically harmful. The second input space is structured by the frame FRENCH POLITICS. This frame includes, among other elements, a role for French President. In this second input space, marital infidelity does not cause political harm, since in France it is widely accepted that the President may have a mistress.The generic space relates the two input spaces. It includes the roles Country, Head of State, Sexual Partner, and Citizens. Finally, the blended space contains the elements Bill Clinton and Monica Lewinsky, together with the roles French President and Mistress of French President. These roles are associated with Clinton and Lewinsky, respectively. Significantly, the frame structuring the blend is FRENCH POLITICS rather than AMERICAN POLITICS. Hence, in the blend Clinton's image is not politically damaged by his affair with Monica Lewinsky. Because the input spaces maintain their connection to the blend, structure in the blend projects back towards the inputs, generating a disanalogy between American and French moral values and attitudes as to the behavior of politicians in their private lives. Whereas in the United States Clinton was severely criticized for his affair with Lewinsky, in France this type of behavior would not have damaged him politically. The disanalogy between the United States and France is achieved by building a counterfactual blended space[17] (Evans & Green 2006: 407). This analysis is represented in Figure 1.

17 Coulson & Oakley (2005) analyze the expression "In France, the Lewinsky affair wouldn't have hurt Clinton" slightly different. Based on Brandt & Brandt's (2002) proposal of six mental spaces integration networks, Coulson & Oakley (2005) include a grounding box in their diagram of conceptual integration network (1517). The grounding box contains "the analyst's list of important contextual assumptions – assumptions that need not be explicitly represented by speakers, though they influence the way that meaning construction proceeds" (Coulson & Oakley 2005: 1517). The grounding box might be used to specify roles, values, experiences, and contextual information that can function as a basis for understanding speakers' subsequent representations. In the case of the CLINTON AS PRESIDENT OF FRANCE blend, different inferences are derived depending on the elements contained in the grounding box (specifically, in the context of utterance) (Coulson & Oakley 2005: 1518).

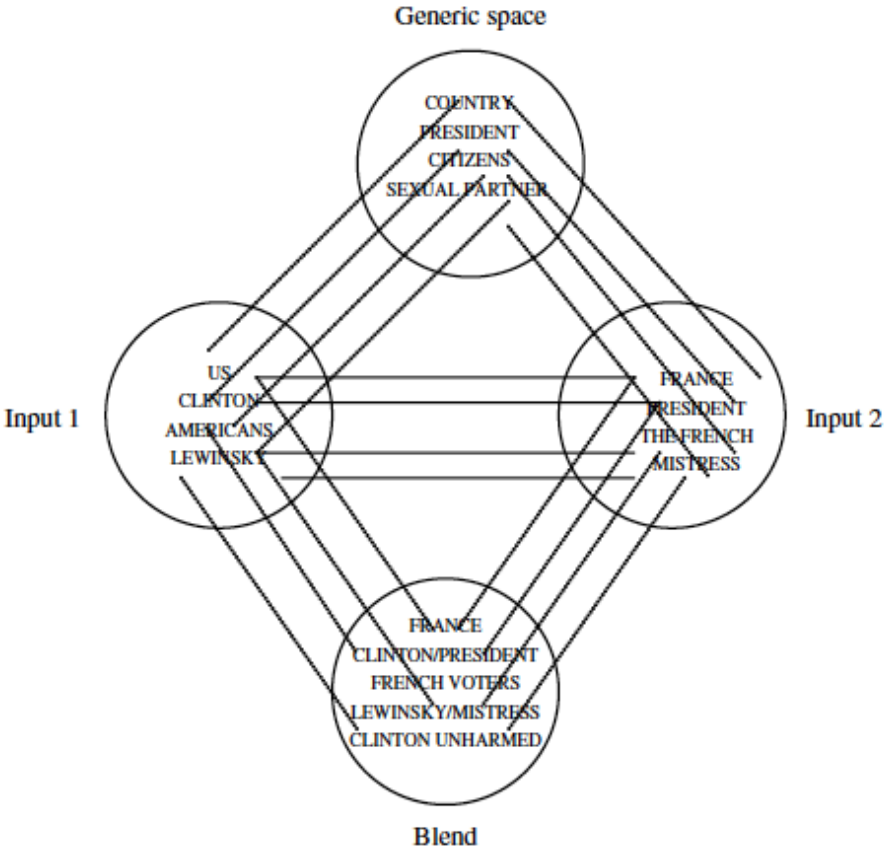

Figure 1. CLINTON AS PRESIDENT OF FRANCE blend (Evans & Green 2006: 408)[18]

Counterfactual thought is involved in our understanding of large amounts of utterances, ranging from everyday expressions to highly complicated scientific argumentations. According to Goodman (1983: 3), science depends in critical ways on counterfactual reasoning, and, hence, on the availability of counterfactual constructions in language. As will be shown below, counterfactual thinking plays a crucial role when conducting complex scientific inquiries.

3 Analysis of "Computing machinery and intelligence" by Alan M. Turing

3.1 The use of counterfactual thinking in Turing (1950)

In his seminal paper (1950, "Computing machinery and intelligence"), theoretical computer scientist Alan M. Turing investigates the question "Can machines think?" (Turing 1950: 433). To avoid problems defining the words *machine* and *think*, the author proposes to reformulate this question into a more specific one, "which is closely related to [the former] and is

18 It is important to hold in mind that this diagram "is really just a snapshot of an imaginative and complicated process that can involve deactivating previous connections, reframing previous spaces, and other actions" (Fauconnier & Turner 2002: 46). The lines in the diagram are supposed to correspond to neural coactivations and bindings (Fauconnier & Turner 2002: 46). The specific content of spaces may be different depending on the reader or listener; the diagram aims at describing at least the minimal components of such a blend, that is, the elements that enable this blend to be understood by speakers of, in this case, English (Dancygier & Sweetser 2014: 78).

expressed in relatively unambiguous words" (Turing 1950: 433). It is described in terms of a game Turing calls the "imitation game" (Turing 1950: 433).

The game displays the following characteristics. First, it requires three participants: a man (A), a woman (B), and an interrogator (C). The interrogator stays in a room separate from the other two players. Each of the participants plays a specific role in the game, and pursues different goals. The aim of the game for the interrogator is "to determine which of the other two is the man and which is the woman" (Turing 1950: 433). To be in a position to do this, he is allowed to put questions to both A and B. The interrogator only knows the other players by labels X and Y. At the end of the game he should either say "X is A and Y is B", or "X is B and Y is A". A's purpose in the game is to try to deceive the interrogator, and cause him to make the wrong identification. By contrast, B's purpose in the game is to help the interrogator. The best strategy for her is to give truthful answers. Suppose, for example, that C puts the following question to X: "Will X please tell me the length of his or her hair?" (Turing 1950: 433). If X turns out to be A, i.e. the man, he might answer something like this, to try to mislead C: "My hair is shingled, and the longest strands are about nine inches long" (Turing 1950: 434). If X is the woman, then X can add to her answers remarks such as "I am the woman, don't listen to him!"; however, since A, the man, can make similar comments, these remarks will be of little or no avail (Turing 1950: 434).

So that the tones of voice of participants A and B do not help the interrogator, the answers provided by A and B should be written, or, even better, typewritten. Crucially, the interrogator cannot request any practical demonstrations. Hence, participants A and B "can brag, if they consider it advisable, as much as they please about their charms, strength or heroism" (Turing 1950: 435).

The new form of the problem, which replaces the question "Can machines think?", reads as follows: "'What will happen when a machine takes the part of A in this game?' Will the interrogator decide wrongly as often when the game is played like this [between a computer and a human being] as he does when the game is played between a man and a woman?" (Turing 1950: 434). To approach this new question, Turing applies counterfactual thinking. It is only by means of building a counterfactual blended space that the author can conclude that computers may show intelligent behavior. When reasoning about his question, Turing does not limit himself to the evidence provided by mid-twentieth century computers:

> There are already a number of digital computers in working order, and it may be asked, "Why not try the experiment [the imitation game] straight away? It would be easy to satisfy the conditions of the game. A number of interrogators could be used, and statistics compiled to show how often the right identification was given". The short answer is that we are not asking whether all digital computers would do well in the game nor whether the computers at present available would do well, but whether there are imaginable computers which would do well. (Turing 1950: 436)

Fauconnier & Turner's (2002) conceptual blending theory allows us to grasp how Turing addresses his research problem. The imitation game as described above would build Input 1

of the integration network. The second input space would be structured as follows. In contrast to the imitation game structuring Input 1, the imitation game framing Input 2 is played by these three participants: a computer (A), a human being (B), and a (human) interrogator (C). The object of the game for C is to determine which participant is the computer, and, by default, which one is the human being. The computer has to try to imitate the behavior of a human being. B's role is to try to help C. The interrogator can only put questions or demand tasks requiring intellectual abilities, e.g. writing poetry ("Please write me a sonnet on the subject of the Forth Bridge"), carrying out arithmetic operations ("Add 34957 to 70764"), or playing chess ("I have K at my K1, and no other pieces. You have only K at K6 and R at R1. It is your move. What do you play?") (Turing 1950: 434-435). Both Input 1 and Input 2 are "actual", or real, spaces. The computer playing the role of A in Input 2 is a mid-twentieth century digital computer. Because of its limited storage capacity, this computer is unable to play the imitation game satisfactorily (see Section 3.2).

By construing a counterfactual blend, Turing can aver that computers may successfully play the game. The imitation game structuring the blend is played by three participants: a computer (A), a human being (B), and an interrogator (C). The role of these participants is exactly the same as in Input 2. While A must try to imitate the behavior of a human being, B has to help the interrogator. At the end of the game, the interrogator must determine which of the other two players is the computer and which is the human. Crucially, the computer playing in the blend is not an "actual" computer, but an "imaginable" one (Turing 1950: 442). This computer is able to imitate human behavior satisfactorily, so that "an average interrogator will not have more than 70 per cent. (*sic*) chance of making the right identification after five minutes of questioning" (Turing 1950: 442). The outcome of the game is projected from Input 1. The following diagram represents this integration network.[19]

19 In the diagram, we follow Fauconnier & Turner's (2002: 45) conventions on how to draw integration networks. The circles represent mental spaces, the solid lines the cross-space mapping between the input spaces, and the dotted lines indicate connections between the inputs, and the generic or the blended space.

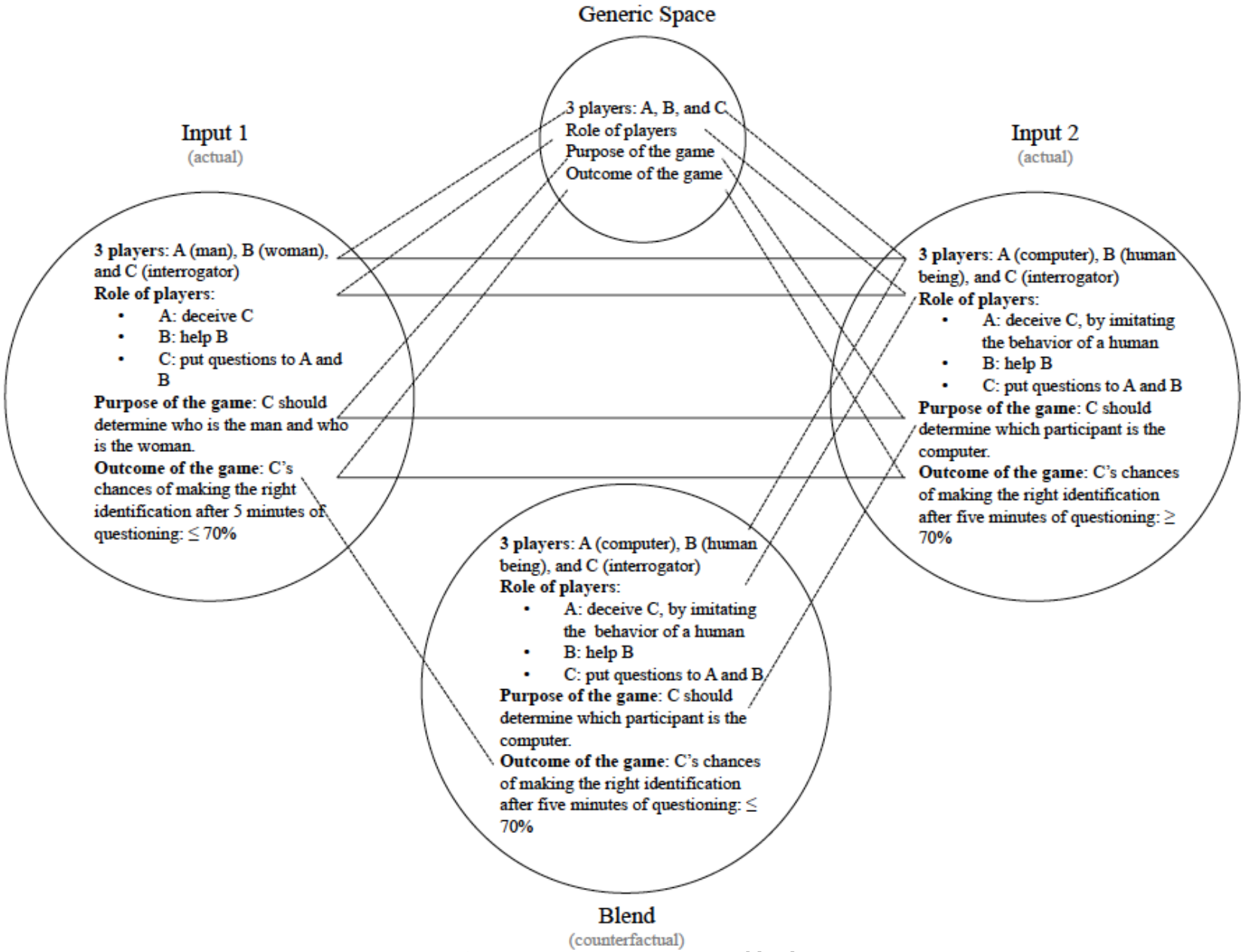

Figure 2. THE IMITATION GAME blend

The blend develops emergent structure of its own. By combining elements from Input 1 and 2, the blended space gives rise to new inferences. The probability that the interrogator C correctly determines which of the other two players is the computer and which is the human being is as high as the probability of correctly identifying which participant is the man and which is the woman in Input 1. Computers in the blend are able to play the imitation game satisfactorily, that is, they are able to show intelligent behavior. It follows from this that computers can think.

It should be borne in mind that blending is not the only cognitive operation involved in this process of counterfactual thinking. The man, the woman, and the computer playing the game in each of the mental spaces are compressions of whole classes of entities, carried out via the vital relation of Uniqueness. Moreover, the computer playing the imitation game in the blend is itself a blend. This computer combines elements from two input spaces: HUMAN COGNITION, and MID-TWENTIETH CENTURY DIGITAL COMPUTERS (see Section 3.2).

3.2 COMPUTER AS HUMANS metaphor in Turing (1950)

Turing affirmatively responds to his research question by using counterfactual thinking. The computer playing the imitation game can satisfactorily imitate human behavior. Throughout his paper, the author matches characteristics of human cognition to characteristics computers have or may have. The investigation is thus guided by the COMPUTERS AS HUMANS metaphor. Based on Turing's argumentation, it is possible to identify a more precise mapping of frames between humans and computers. Two remarks made by the author are essential for identifying these specific frames. First, from the beginning Turing makes it clear that the questions put by the interrogator to A and B must be restricted to intellectual tasks. By doing this, he draws a sharp distinction between the physical and the intellectual capacities of a human being: "We do not wish to penalize the machine for its inability to shine in beauty competitions, nor to penalize a man for losing in a race against an aeroplane (*sic*). The conditions of our game make these disabilities irrelevant" (Turing 1950: 435). Second, the author clearly states that, for the purposes of his investigation, it is not important whether computers and human beings carry out similar processes to arrive at a particular response. What is important is their response or behavior:

> May not machines carry out something which ought to be described as thinking but which is very different from what a man does? This objection is a very strong one, but at least we can say that if, nevertheless, a machine can be constructed to play the imitate game satisfactorily, we need not be troubled by this objection. (Turing 1950: 435)

Based on these two remarks, I propose to label the metaphor underlying Turing (1950) as COMPUTER INFORMATION BEHAVIOR IS HUMAN INTELLECTUAL BEHAVIOR.

Turing first compares digital computers to human computers. The word *computer* was originally coined to refer to "human computers", "a person who makes calculations or computations […] a person employed to make calculations in an observatory, in surveying, etc." (Oxford English Dictionary Online, 28 August, 2015). The author assumes that human

computers follow fixed rules, from which they have no authority to deviate in any sense (Turing 1950: 436). He hypothesizes that these rules are provided in a book, which is modified whenever the human computer has to carry out new tasks.[20] Human computers have an unlimited supply of paper or a "desk machine" to do their calculations (Turing 1950: 436). In some cases, they may carry out their calculations mentally, in their memory. Digital computers, on the other hand, consist of three main parts: (i) store, (ii) executive unit, and (iii) control (Turing 1950: 437). A digital computer's storage of information corresponds to a human computer's paper – both the paper on which he does his calculations, and the paper on which his book of rules is printed. It also corresponds to a human computer's memory. The executive unit of a digital computer is the part where the different individual operations involved in a calculation are conducted. The control is in charge of supervising that the instructions contained in the book of rules, or instruction table, be obeyed correctly and in the right order (Turing 1950: 437). This mapping between human computers and digital computers is shown in the following table.

Table 2. Mapping between human computers and digital computers

Target: DIGITAL COMPUTER	*Source:* HUMAN COMPUTER
Storage of information	Memory Paper on which he does his calculations
Table of instructions	Book of rules
Executive unit	Specific part(s) of the human brain
Control	Specific part(s) of the human brain

Mid-twentieth century digital computers were built according to the principles described above (Turing 1950: 438). Turing's "thinking" computers are also structured along these same principles (Turing 1950: 438).

Because of their limited storage capacity, computers in the 1950s were unable to give a good performance in the imitation game. One of Turing's central tenets is that by modifying a digital computer "to have an adequate storage, suitably increasing its speed action, and providing it with an appropriate programme" (Turing 1950: 442), it would be able to imitate the behavior of a human being satisfactorily. It is estimated that the human brain storage capacity ranges from 10^{10} to 10^{15} binary digits, only a very small amount of which is used for higher types of thinking (Turing 1950: 455). Most of this capacity is directed at retaining visual impressions. Turing (1950: 455) estimates that digital computers would require no more than 10^{9} for successfully playing the imitation game. With such a storage capacity, digital computers would overcome many of the limitations that they showed in the 1950s: the disability to be kind, have initiative, tell right from wrong, learn from experience, be the subject of their own thought, have as much diversity of behavior as a man, and take us by surprise, among others (Turing 1950: 447, 450).

20 Turing (1950: 438) himself recognizes that this book of rules is "a convenient fiction. Actual human computers really remember what they have got to do".

METAPHOR AND COUNTERFACTUAL THINKING IN TURING (1950)

In the first half of the 20th century, a series of objections have been raised against considering computers as "thinking" entities. Turing analyzes some of these objections, and refutes them. By doing this, he continues to establish mappings between human intellectual behavior and computer performance. One of these objections reads more or less as follows: "If it [the computer] is rigged up to give answers to questions as in the imitation game, there will be some questions to which it will either give a wrong answer, or fail to give an answer at all however much time is allowed for a reply" (Turing 1950: 444). Turing recognizes that this might well be true, however, he contends that it must be borne in mind that, on the one hand, human beings also often give wrong answers to questions, and that, on the other hand, a question that a computer might answer wrong may be answered correctly by another computer: "There would be no question of triumphing simultaneously over *all* machines. In short, then, there might be men cleverer than any given machine, but then again there might be other machines cleverer again, and so on" (Turing 1950: 445).

A second objection raised against the possibility of "thinking" machines is the argument of consciousness:

> Not until a machine can write a sonnet or compose a concerto because of thoughts and emotions felt, and not by the chance fall of symbols, could we agree that machine equals brain – that is, not only write it but know that it had written it. No mechanism could feel (and not merely artificially signal, an easy contrivance) pleasure at its successes, grief when its valves fuse, be warmed by flattery, be made miserable by its mistakes, be charmed by sex, be angry or depressed when it cannot get what it wants. (Jefferson 1949 cited in Turing 1950: 445-446)

To address this criticism, Turing restates this argument in its most extreme form: the solipsist point of view. According to this perspective, the only way of being sure that a machine thinks would be "to be the machine and to feel oneself thinking" (Turing 1950: 446). Likewise, the only way by which we could know that a man thinks would be to be that particular man (Turing 1950: 446). If a computer were capable of giving satisfactory and sustained answers to questions about the process of writing a poem, it would be difficult to maintain the claim that it is "merely artificially signaling" these answers (Turing 1950: 447).

> Interrogator: In the fist line of your sonnet which reads "Shall I compare thee to a summer's day", would not "a spring day" do as well or better?
> Witness [computer]: It wouldn't scan.
> Interrogator: How about "a winter's day". That would scan all right.
> Witness: Yes, but nobody wants to be compared to a winter's day. (Turing 1950: 446),

When given by a human being, these answers would be regarded as intelligent responses. If given by a computer, wouldn't the same adjective be appropriate to characterize them?

Another objection lodged against "thinking" machines is that, as opposed to human beings, they are unable to "be the subject of [their] own thought" (Turing 1950: 449). Although a computer's thought and subject matter might be different from those of a human being, it does have "*some* thought with *some* subject matter" (Turing 1950: 449), and this subject matter

does seem to mean something, at least to the people dealing with it: "If, for instance, the machine was trying to find a solution of the equation $x^2–40x–11=0$ one would be tempted to describe this equation as part of the machine's subject matter at that moment" (Turing 1950: 449). Both humans and computers utilize this type of matter to conduct further operations. Because of this, both of them can be said to be able to be the subject of their own thought.

Whereas computers are unavoidably regulated by laws, it is commonly believed that human beings are not governed by any laws of behavior. This assumption, however, cannot be countenanced so easily: "The only way we know for finding such laws is scientific observation, and we certainly know of no circumstances under which we could say, 'We have searched enough. There are no such laws'" (Turing 1950: 452). Additionally, if this were the case, being regulated by laws would not necessarily prevent a computer from satisfactorily playing the imitation game, as it would be practically impossible for an interrogator to discover by observation sufficient about the computer so as to predict its future behavior (Turing 1950: 453).

Finally, Turing addresses the issue of "learning machines". In a normal human brain, "an idea presented to such a mind may give rise to a whole 'theory' consisting of secondary, tertiary and more remote ideas" (Turing 1950: 454). These ideas are, at least to some extent, the product of education or learning. Three components contribute to bringing the adult mind to its state: (i) the initial state of the mind at birth, (ii) the education to which it is subjected, and (iii) other experience, not to be described as education, to which it has been subjected (Turing 1950: 455). Turing (1950: 455) assumes that a child's brain is presumably "something like a notebook as one buys it from the stationers. Rather little mechanism, and lots of blank sheets". He hypothesizes that if there is so little mechanism in the brain of a child, something like it can be easily programmed (Turing 1950: 456). Based on these assumptions, the author establishes the following mappings between a child's brain and a child machine:

Structure of the child machine	=	Hereditary material
Changes of the child machine	=	Mutations
Judgment of the experimenter	=	Natural selection

(Turing 1950: 456)

The child machine may have a complete system of logical inference "built in", made up of propositions of various kinds (Turing 1950: 457). Importantly, while some of these propositions would be "given by authority" (i.e. programmed by the experimenter), others would be produced by the machine itself, using scientific induction. The teacher of a learning machine "will often be very largely ignorant of quite what is going on inside" (Turing 1950: 458), and he or she will be unable to predict the machine's behavior on every occasion. If intelligent behavior is "a departure from the completely disciplined behavior involved in computation, but a rather slight one, which does not give rise to random behavior, or to pointless repetitive loops" (Turing 1950: 459), it can be concluded that learning machines can think.

Having shown the characteristics Turing's "thinking" digital computers would have, we can now complete the mapping between humans and this type of computers.

Table 3. Mapping between human computers and digital computers

Target: "THINKING" DIGITAL COMPUTER	*Source*: HUMAN COGNITION
Storage of information (capacity of 10^9 binary digits) Table of instructions	Memory (capacity of 10^{10}-10^{15} binary digits) Paper on which a human does his calculations Book of rules
Executive unit	Specific part(s) of the brain
Control	Specific part(s) of the brain
Makes mistakes (gives wrong answers to questions)	Makes mistakes (gives wrong answers to questions)
Programmed to appear conscious of creative acts and emotions	Conscious of creative acts and emotions
Subject of its own thought	Subject of its own thought
Regulated by laws of behavior	Regulated by laws of behavior (until proven otherwise)
Able to learn	Able to learn
Departure from predicted behavior	Departure from predicted behavior

Turing's "thinking" computers are built based on the same principles as mid-twentieth century computers. This is why they too have a storage unit, an executive unit, and a control. By modifying some of their characteristics, especially their storage capacity, Turing hypothesizes that these computers will be able to play the imitation game satisfactorily. "Thinking" computers draw structure from the domain of MID-TWENTIETH CENTURY DIGITAL COMPUTERS, as well as from the domain of HUMAN COGNITION. These computers are thus the product of blending two domains.

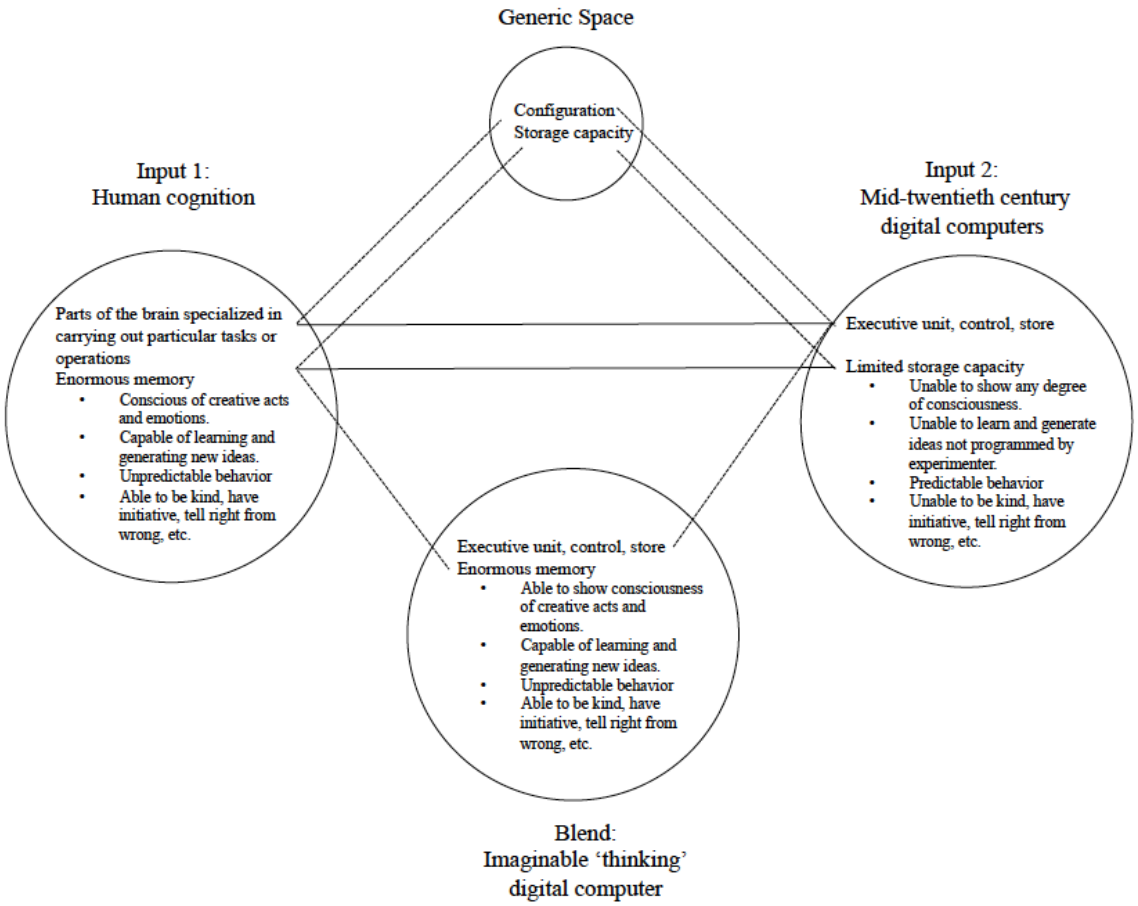

Figure 3. "THINKING" COMPUTER blend

By means of increasing their storage capacity, computers can be made to imitate human intellectual behavior: to show consciousness of having written a sonnet, be kind, have initiative, tell right from wrong, depart from predicted behavior, and learn and give rise to ideas that have not been implanted in it, among other things.

4 Conclusion

In Turing (1950), the author addresses the question of whether machines can think, and more precisely, of whether digital computers can satisfactorily play the imitation game. Though computers in the first half of the twentieth century were unable to imitate human behavior successfully, mainly because of their limited storage capacity, Turing reaches the conclusion that computers can indeed think. To be able to do this, Turing uses counterfactual thinking. Drawing structure from two input spaces, the author creates a counterfactual blend, in which computers are able to give human-like answers to a series of questions requiring intellectual thought.

The computer playing in the blend is itself a product of blending two domains. This "thinking" computer takes elements from two inputs, namely HUMAN COGNITION and MID-TWENTIETH CENTURY DIGITAL COMPUTERS. Turing's "imaginable" computers are built based on the same principles as computers in the first half of the twentieth century. Both of these machines have a storage unit, an executive unit, and a control. In contrast to mid-twentieth

century computers, however, "thinking" computers exhibit an enormous storage capacity. This allows them to overcome some of the limitations previous computers displayed. Although thinking computers and human beings process information differently, both of these entities are able to produce similar responses to intellectual tasks, i.e. to show intelligent behavior. The metaphor underlying Turing (1950) can therefore be labeled as COMPUTER INFORMATION BEHAVIOR IS HUMAN INTELLECTUAL BEHAVIOR. Throughout his paper, Turing uses this metaphor to reason about the domain of COMPUTER BEHAVIOR.

This supports Dancygier & Sweetser's (2014: 30-31) argument that supposedly bidirectional metaphors, e.g. PEOPLE ARE COMPUTERS and COMPUTERS ARE PEOPLE, actually represent asymmetrical mappings from a source domain to a target domain. The metaphor structuring Turing (1950) adds to the metaphors related to humans and computers identified by Dancygier & Sweetser (2014: 31): HUMAN COGNITIVE PROCESSING IS COMPUTER INFORMATION PROCESSING ("my memory banks are scrambled"), and APPARENTLY ERRATIC ASPECTS OF COMPUTER BEHAVIOR ARE EMOTIONAL MOOD-BASED ASPECTS OF HUMAN BEHAVIOR ("my computer is being stubborn today"). In each of these three metaphors, specific frames related to humans and computers are being mapped.

In Turing (1950), the author expresses the belief "that at the end of the century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted" (Turing 1950: 442). Two examples allow us to show how predictive this belief has turned out to be. First, when referring to a computer's storage capacity, Turing never uses the word *memory*. By contrast, nowadays, a computer's storage capacity is commonly referred to as its memory. Second, at least within the field of artificial intelligence, it is usual to talk of computers as thinking devices. In fact, within this field, the word *intelligent* may be used to describe useful devices that are not necessarily similar to human or animal minds, as regards their mechanics (Barnden 2008: 312).

Going beyond Turing's (1950) concern, the Human Brain Project, aimed at accelerating our understanding of the human brain, making advances in diagnosing and treating brain disorders, and developing new brain-like technologies, significantly relies on computers to achieve its goals (Human Brain Project 2013). On the assumption that computers and the human mind might be similar, the Human Brain Project is building supercomputers to simulate "multi-level models of brain circuits and functions" (Human Brain Project 2013). As opposed to the common view that "scientists proceed inexorably from well-established fact to well-established fact, never being influenced by any unproved conjecture" (Turing 1950: 442), Turing shows how conjectures, and counterfactual thinking can contribute to making crucial advances in various fields of research inquiry. Providing further support for Lakoff & Johnson's (1980), and Fauconnier & Turner's (2002) claims, Turing (1950) makes it clear how the same mechanisms implicated in the simplest kinds of thought, namely conceptual cross-domain mapping and blending, are also involved in higher-order thinking, e.g. in conducting complex scientific inquiries.

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