Defining Creativity

*Webster’s Collegiate Dictionary* (1991) defines *creative* as “resulting from originality of thought: imaginative” (p. 319). Interestingly, this same dictionary defines *imagination* as “creative talent or ability” (p. 671). The circular nature of these definitions should not be surprising, given that this same dictionary defines *intelligence* as a “capacity for learning, reasoning, and understanding” (p. 700) and *reasoning* as “the power of intelligent and dispassionate thought” (p. 1123). Dictionaries are by definition self-referential, thus providing us with the sense of a word’s meaning given that we have a familiar context of other words in which to place that sense of meaning.

E. H. Gombrich asks, “... are we not led into what philosophers call an infinite regress the explanation of one thing in terms of an earlier which again needs the same type of explanation?” (E. H. Gombrich, as quoted in Minsky 1986, p. 150).

Curiously, *Webster’s New World Dictionary* (1984, p. 34) defines *art* as simply “human creativity,” while *Webster’s Collegiate Dictionary* (1991, p. 77) defines *art* as “the quality, production, expression, or realm of what is beautiful or of more than ordinary significance.” I am sure that, given enough time, I could find several more contradictory, or at least significantly varied, definitions of *art*. Obviously, according to the first definition, the output of computer programs does not qualify as *art*, unless you consider its output as the human programmer’s output. Certainly, many individuals view creativity as something that only humans can do. (When I encounter someone with this viewpoint, I usually argue that if humans cannot create machine programs that themselves create, then humans are not in fact very creative after all.) The more generous second definition of *art* above could include the output of computer programs, depending on whether one considered this output beautiful or of more than ordinary significance.

Most books that deal with creativity in serious ways provide descriptions of the contributions of the human biological system. Axons, dendrites, synapses, neurons, sensory transducers, and so on, along with explanations of the related hydrocarbons, phosphates, and various proteins, appear often in these sources. The various lobes (frontal, temporal, parietal, occipital), as well as the right (principally visual-spatial) and left (principally verbal) hemispheres, function as separate and integrated parts of the brain, providing a foundation for creative thinking. However, I will avoid these kinds of biological descriptions of creativity here for a variety of reasons. First, there are other, more detailed sources for such information (Adelman 1987; Jacobson 1978, Shepherd 1988), and a simple summary here would do them and their subject an injustice. Second, while we have begun to unravel the chemistry and processes of thinking and cognition, we still have very little understanding of the neurobiology involved in human biological creativity.

At the opposite extreme, more casual definitions of *creativity* take forms not unlike those expressed by Frederick Dorian (1947) in his book *The Musical Workshop*:

> Everything is inspiration to the born musician. The voice of his mother, the smile of his friend, the muffled tread of human passions—life on earth from the cradle to the grave. The curses of hell and the glory of God. There is no vision and no experience which has not been turned into an inspirational impulse by creative musicians. Inner and outer events, the whole gamut of psychic and physical experiences to which the human being is exposed or which his imagination can conjure up—they all have been the springboard of inspirational impulses in the music of thousands of years. “There is a song,” in Eichendorff’s beautiful words, “which slumbers in all things that dream endlessly, and the world will begin to sing if thou findest the key word.” (Dorian 1947, p. 19)

This broad description of inspiration leading to creativity would be difficult to code. While I do not doubt the sincerity that the author brings to his observations, and while a certain emotional part of me resonates with at least some of his words, I cannot find much practical use for these sentiments.

Herbert Simon suggests that we

> ... should not be intimidated by words like “intuition” that are often used to describe human thinking. We have seen that “intuition” usually simply means problem solving by recognition, easily modeled by production systems. (Simon 1995, p. 689)

Douglas Hofstadter describes creativity more explicitly as consisting of four basic ingredients:
Having a keen sense for what is interesting: that is, having a relatively strong set of a priori "prejudices". ... This aspect of creativity could be summarized in the phrase central but highly discriminating taste.

Following it recursively: that is, following one's nose not only in choosing an initially interesting-seeming pathway, but also continuing to rely on one's nose over and over again. ... This aspect of creativity could be summarized in the term self-confidence.

Applying it at the meta-level: that is, being aware of, and carefully watching, one's pathway in "idea space" (as opposed to the space defined by the domain itself). This means being sensitive to unintended patterns in what one is producing. ... This aspect of creativity could be summarized in the term self-awareness.

Modifying it accordingly: that is, not being inflexible in the face of various successes and failures, but modifying one's sense of what is interesting and good according to experience. This aspect of creativity could be summarized in the term adaptability. (Hofstadter 1995, p. 313–314)

As I will demonstrate in chapter 6, "adaptability" is programmable. The notions of "self-confidence," "taste," and "self-awareness," however, continue to baffle our most distinguished philosophers (see Damasio 1999; Dennett 1995; Searle 1997), no less computer scientists wishing to model or emulate these characteristics. Hofstadter's use of the terms "prejudices," "interesting," "sense," "good," and so on, unfortunately means many different things to different people. His choice of these terms, therefore, presents enormous challenges to those of us who would attempt to code them into computer programs.

Antonio Damasio posits that:

Creativity itself—the ability to generate new ideas and artifacts—requires more than consciousness can ever provide. It requires abundant fact and skill memory, abundant working memory, fine reasoning ability, language. But consciousness is ever present in the process of creativity; not only because its light is indispensable, but also because the nature of its revelations guide (sic) the process of creation, in one way or another, more or less intensely. ... there is a circle of influence—existence, consciousness, creativity—and the circle closes. (Damasio 1999, p. 235)

I have chosen to ignore such highly romanticized definitions of creativity even though I know that many individuals share their sentiments. One wonders if Damasio, and those who agree with his views, could recognize these ingredients for creativity (e.g., consciousness) in a test of human versus computer output (see chapter 2).

Margaret Boden eloquently points out that...

...[t]he way in which people commonly deny the possibility of "real" creativity in computers is to appeal to the consciousness argument. "Creativity requires consciousness," they say, "and no computer could ever be conscious." We have seen, time and time again, that much—even most—of the mental processing going on when people generate novel ideas is not conscious, but unconscious. The reports given by artists, scientists, and mathematicians show this clearly enough. To that extent, then, this argument is misdirected. (Boden 2004, p. 294)

Marvin Minsky takes a somewhat different tack to defining creativity by addressing the often conflicting nature of creative and logical thought:

What is creativity? How do people get new ideas? Most thinkers would agree that some of the secret lies in finding "new ways to look at things." ... Why must our minds keep drawing lines to structure our reality? The answer is that unless we made those mind-constructed boundaries, we'd never see any "thing" at all! (Minsky 1986, p. 134)

Modeling this bifurcated nature of the mind with computers seems possible by measuring, cataloging, and referencing boundaries while simultaneously attempting to extend those boundaries. However, Damasio would argue that without consciousness, we would not have to define boundaries, and thus never really need to create anything at all. Hofstadter might add the notion that without "discriminating taste," computer programs could never really know which boundaries to extend.

Boden, Bringsjord and Ferucci, and Damasio all take up the consciousness argument—that creativity requires consciousness—with interesting but contradictory and inconclusive results. Two particular questions arise when "consciousness" becomes a requisite for creativity:

1. Is it important that creators know they are creating?
2. Is it important that creators appreciate their own creations?

As interesting as these questions may be, however, I have opted not to respond to them. My reasons are simple: How do we know that humans know they create, and in fact appreciate their creations? It would certainly seem important that creators know the difference between a creative output and an uncreative output, but is it necessary for them to self-relate to this output or to find this output appealing? Can we, as interpreters of their creations, discern the creators' feelings toward their own creations without being explicitly informed of these feelings? These questions all relate to creativity but, it seems to me, skirt the primary issue of precisely what constitutes creativity. Henceforth, I have avoided considering them in the definition I will use in this book.

According to Scott Turner, creativity should produce significantly different results than noncreativity does.

We all recognize that creative solutions must be original. They must be new and different from old solutions. But the differences must also be significant. If an artist were to paint the Mona Lisa in a red dress instead of a blue one, the resulting painting would not be considered
creative, despite its differences from the original. Significant novelty distinguishes creative solutions from ones that are only adaptations of old solutions. (Turner 1994, p. 22)

As well, originality must be useful.

We expect problem solvers to be capable. They must develop solutions that solve their problems. Replacing a flat tire with an air raft is novel but not creative, because it doesn’t effectively solve the original problem. (Turner 1994, p. 22)

Musical creativity, on the other hand, does not offer clear “flat tire” and “air raft” equivalents. The question of legitimate creativity regarding works of art seems tied less to novelty and more to aesthetics.

Daniel Dennett offers yet another view of creativity:

... my three-year-old grandson, who loves construction machinery, recently blurted out a fine mutation on a nursery rhyme: “Pop! goes the diesel!” He didn’t even notice what he had done, but I, to whom the phrase would never have occurred, have seen to it that this mutant meme gets replicated. As in the case of jokes discussed earlier [a result of a slow evolution], this modest moment of creativity is a mixture of serendipity and appreciation, distributed over several minds, no one of which gets to claim the authorship of special creation. (Dennett 1995, p. 355)

Dennett’s prosaic but pertinent observations demonstrate how cross-wiring can produce interesting, unique, and important creative connections. This notion of cross-wiring will offer a valuable resource when I define association networks in chapter 9.

I find David Gelernter’s quotations of Gilhooley and Shelley in the following abstraction of creativity equally attractive.

Rather than beating your head against the wall of a difficult problem that doesn’t yield to ordinary, methodical approaches, you discover a different way to see the problem ... put another way, “The creative thinker comes up with useful combinations of ideas that are already in the thinker’s repertoire but which have not been previously brought together” (Gilhooley 1988, p. 186; Or as Shelley wrote in 1821, “Reason respects the differences, and imagination the similitudes of things.” (Shelley 1821/1966, p. 416; as quoted in Gelernter 1994, pp. 79–80)

Edward deBono (see particularly deBono 1970) distinguishes between what he calls “vertical” and more creative “lateral” thinking. For deBono, vertical thinking is selective and analytical, while lateral thinking is generative and instigative. Lateral thinking invites intrusion of possibly irrelevant information. Vertical thinking proceeds by logical steps, while lateral thinking is nonlinear (deBono 1971, 1984).

W. J. J. Gordon describes creativity using analogies and metaphors that play major roles in synectics, an important approach to defining creativity (see Gordon 1972). Synectics incorporates personal, direct, symbolic, and fantasy analogies to creatively solve otherwise intractable problems. Personal analogy involves personal identification, particularly with inanimate objects. Direct analogy compares parallel situations to develop solutions. Symbolic analogy objectifies the elements of a problem. Fantasy analogy follows Freud’s view that creativity is wish fulfillment. Each of these analogical processes attempts to make the familiar strange and, in so doing, to provide alternative possibilities that may not otherwise be considered.

Margaret Boden, in her book on creativity (1990), paraphrases Ada (Lady) Lovelace—close friend of Charles Babbage, designer of the first model of the modern-day computer—in her comments on computation and creativity.

The first Lovelace-question is whether computational ideas can help us understand how human creativity is possible. The second is whether computers (now or in the future) could ever do things which at least appear to be creative. The third is whether a computer could ever appear to recognize creativity—in poems written by human poets, for instance. And the fourth is whether computers themselves could ever really be creative (as opposed to merely producing apparently creative performance whose originality is wholly due to the human programmer).

(Boden 990, p. 7)

Boden responds positively to the first three of these questions, but negatively to the fourth, arguing that the question has moral and even political (more likely philosophical) implications. I will argue the opposite point of view in ensuing chapters, but certainly agree with Boden’s assessment of her first three questions.

Selmer Bringsjord and David Ferrucci (2000) take up these same questions, responding negatively to the first and fourth, arguing in the first case that “... moving squiggle-squiggles around is somewhat unlikely to reveal how Hamlet came to be” (p. 11). The term “squiggles-squiggles” here refers to John Searle’s well-known Chinese-room argument, in which Searle attempts to prove that computer programs are entirely syntactical, as opposed to humans, who think using semantics as well as syntax (see Searle 1997).

I include these many differing views here to point the reader to their sources and the sources these sources themselves point toward. I also include them to argue that these views, and the many others that arise from the discussions they spawn, critically contribute to any serious study of creativity; for it is on the resulting definition that all arguments for computer creativity, pro and con, rest. After researching this subject for many years, I have chosen the following definition of creativity for this book:

The initialization of connections between two or more multifaceted things, ideas, or phenomena not otherwise considered actively connected.

I use the word “multifaceted” to differentiate musical creativity from other types of creativity, as suggested by my description of Solresol at the beginning of this chapter.
Multifacetedness here represents, among other things, various aspects of harmony and counterpoint—when notes occur at the same time. I believe that music’s ability to function simultaneously on both the horizontal and the vertical planes helps to make it unique among the arts. (Note that Sudre and his followers had little idea what to do with harmony and counterpoint in Sibelius, and hence kept their language monophonic.) One could argue that, say, visual art has the dimensions of color and shape as correlates to counterpoint. However, for me at least, color and shape match timbre and form in music. These and other distinctions between creativity in music and the other arts will become clearer in subsequent chapters.

Note that my definition of creativity does not include the word “human” or any other such limiting words or phrases. To have included such words or phrases would, I believe, be simplistic and self-defeating. Worse yet, such inclusion would limit and do disservice to the human branch of creativity. My definition of creativity is also articulate—each word and phrase is clearly definable within its context—with each part quantifiable in ways that make programming them feasible.

My definition of creativity seems to find resonance with Gelernter:

...the core achievement of restructuring and creativity is the linking of ideas that are seemingly unrelated. The originality we impute to an insight centers just on the seeming dissimilarity between the problem and the analogy. Of course, similarity between the two must exist on some level, otherwise no analogy would exist. But that similarity must be deep, hidden, obscure, indirect—not a mundane matter of two ideas attracting each other because they share obvious similarities. (Gelernter 1994, p. 84)

Originality, in the view of many, represents a critical facet of creativity. Interestingly, computers can generate seemingly original output quite easily. In fact, so-called randomness, a standard function of every computer programming language and which I discuss at length in chapter 3, produces apparently original output far more often and efficiently than it produces predictable output. For those believing that computers cannot be creative, then, originality should not be the focus of their definition of creativity.

For many, however, the decisive measure of creativity results from a determination of whether or not the results of a process are “derivative”—few words having more vile connotations for artists. While all art and music are derivative to a degree, at least in the sense of alluding to other art and music (see chapter 5), some art and music apparently borrow too heavily to be considered truly creative. I argue that while plagiarism certainly cannot fall within the boundaries of creativity, many of the most renowned artists and composers of history have borrowed extensively from their predecessors (again see chapter 5 for examples).

Boden (1990) also argues against the notion of creativity as originating from nowhere:

In the abstract, however, creativity can seem utterly impossible, even less to be expected than unicorns. This paradox depends on the notion that genuine originality must be a form of creation ex nihilo. If it is, then—barring the miraculous—originality simply cannot occur. (Boden 1990, p. 29)

One measure of the veracity of my definition of creativity rests on the necessary conditions that must prevail before creativity can occur. In other words, if true creativity cannot exist in a vacuum, then the potential for “connectedness” of all of creativity’s connections-to-be must already exist at the time of inception. Boden adds an extremely important point about this creativity-in-context:

If, by some miracle, a composer had written atonal music in the sixteenth century, it would not have been recognized as creative. To be appreciated as creative, a work of art or a scientific theory has to be understood in a specific relative to what preceded it... Only someone who understood tonality could realize just what Schoenberg was doing in rejecting it, and why. (Boden 1990, p. 61)

Many of those who attempt to define creativity ignore the types of contextualizations to which Boden refers here. We are much more apt to consider a child’s drawing creative because of that child’s acknowledged inexperience and lack of training, whereas the same drawing produced by an adult would be considered silly or tentative. However, rather than contextualizing every potentially creative act with its creator’s credentials, I have opted to include the more universal “...initialize of connections...” and “...hitherto not otherwise considered actively connected...” things, ideas, or phenomena, leaving the interpretation of the context to those evaluating each particular instance.

Note that my definition of creativity is relatively active (initialization, not discovery) and uses connections (not aesthetics). This definition also avoids notions of consciousness (since no one has yet fully explained consciousness, at least to my satisfaction), interesting and uninteresting work (since such decisions seem personal and have little intrinsic value for a broadly conceived definition), and originality (which, as Boden points out, probably does not exist, at least on any fundamental level). My definition of creativity further avoids such limitations as whether or not the discoveries are easy or hard, beautiful or ugly, and valued or not valued. Critics will argue that my definition welcomes, for example, “creating a mess” as an instance of creativity. In fact, many important artists have created in just this way, to encourage the “initialization of connections between two or more multifaceted things, ideas, or phenomena hitherto not otherwise considered actively connected.”