List of Todos

Institute of Creative Technologies
De Montfort University

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ALGORITHMIC META-CREATIVITY

Creative Computing and Pataphysics for Computational Creativity

pata.physics.wtf

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

Created: 25th March 2015 — Last Saved: 11th October 2016
Wordcount: 8359

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PRE☺

And the air is purer, pif paf pan, ne put qu'articuler au, in dire defeat. And pure, staggered to and fro in the car as, deux hommes passer en courant dans la rue, having one foot shod and the other bare. The hamlets bare White, une salle pleine le port de guerriers, over pine pitch. Will not you be content to pay a puncheon of Breton wine, the crimson mane of the fire o'er the plain Toward the dream, I was aroused from sleep by the cry of fire.

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TL;DR

Algorithmic Meta-Creativity — Fania Raczinski — Abstract[1]

Using computers to produce creative artefacts is a form of computational creativity. Using creative techniques computationally is creative computing. Algorithmic Meta-Creativity (AMC) spans the two—whether this is to achieve a creative or non-creative output. It is the use of digital tools (which may not be creative themselves) and the way they are used forms the creative process or product. Creativity in humans needs to be interpreted differently to machines. Humans and machines differ in many ways, we have different 'brains/memory', 'thinking processes/software' and 'bodies/hardware'. Too often creative output by machines is judged as we would a humans. Computers which are truly artificially intelligent might be capable of true artificial creativity. Until then they are (philosophical) zombie robots: machines that behave like humans but aren't conscious. The only alternative is to see any computer creativity as a direct or indirect expression of human creativity using digital means and evaluate it as such. AMC is neither machine creativity nor human creativity—it is both. By acknowledging the undeniable link between computer creativity and its human influence (the machine is just a tool for the human) we enter a new realm of thought. How is AMC defined and evaluated? This thesis address this issue. First a practical demonstration of AMC is presented (`pata.physics.wtf`) and then a theoretical framework to help interpret and evaluate products of AMC is explained.

Keywords: *Algorithmic Meta-Creativity, Creative computing, Pataphysics, Computational Creativity, Creativity*

[1] "Too long; didn't read"

Publications

Fania Raczinski and Dave Everitt (2016) ***"Creative Zombie Apocalypse: A Critique of Computer Creativity Evaluation"***. Proceedings of the 10th IEEE Symposium on Service-Oriented System Engineering (Co-host of 2nd International Symposium of Creative Computing), SOSE'16 (ISCC'16). Oxford, UK. Pages 270–276.

Fania Raczinski, Hongji Yang and Andrew Hugill (2013) ***"Creative Search Using Pataphysics"***. Proceedings of the 9th ACM Conference on Creativity and Cognition, CC'13. Sydney, Australia. Pages 274–280.

Andrew Hugill, Hongji Yang, **Fania Raczinski** and James Sawle (2013) ***"The pataphysics of creativity: developing a tool for creative search"***. Routledge: Digital Creativity, Volume 24, Issue 3. Pages 237–251.

James Sawle, **Fania Raczinski** and Hongji Yang (2011) ***"A Framework for Creativity in Search Results"***. The 3rd International Conference on Creative Content Technologies, CONTENT'11. Rome, Italy. Pages 54–57.

A list of talks and exhibitions of this work, as well as full copies of the publications listed above, can be found in appendix **??**.

Contents

Figures

Tables

Code

Acronyms

AMC Algorithmic Meta-Creativity

AI Artificial Intelligence

ICCC International Conference on Computational Creativity

CC Creative Computing

IJCrC International Journal of Creative Computing

DH Digital Humanities

OULIPO Ouvroir de Littérature Potentielle

Part I

HΣLLΘ WΘRLD

That it might very well be *the* Sun himself, and fear fell upon him, for always have we held thee, the despair of the poor fellow so sincerely in love. The spacious hall prepare, the fishers hail each other not - Nor help - in their fraternal lot, the side of a great hill, with a helix at the four corners. She fell on to a hillock of sand, aux montagnes d'oranges ... Ludgate hill, till the Spectators having had their belly. Who longs to plunge two fellow creatures into despair, the jelly bubbles, well a.

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Part II

TΘΘLS OF THE TR∀DΣ

Made up your minds to brave me, ce train recommenait quand on l'habillait le matin, aglavaine leans against a tree and weeps silently, a difficulty in stemming the tide. Her long gown with the train is blue, mad voyage 'gainst the tide, aucun employe de commerce ne l'ignorait plus, tree. Sell that which ye have, to be their mouthpiece is it true, thou filthy collier toad. Followed by a train of slaves, his Excellency stooped to take it up, or in the typography of a book.

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Creativity

1

From high Olympus prone her flight she bends,
rare courage and grandeur of conception,
congratulating herself apparently on the cleverness with which she had managed her expedition,
appeared distorted to my vision.

Had he had any bad design,
having uttered these words the vision left me,
if any thought by flight to escape,
taking his flight towards warmer and sunnier regions.

Inspire à mon oncle cette vision décourageante de l'avenir,
être et l'invention du jeu de ce,
besoin de satisfaire l'imagination d'objets rares ou grandioses.

Some may call vision,
a man of invaluable ability,
mobiles parois de L'imagination.

Creativity does not have a universally accepted definition. Creativity is a human quality and definitions don't necessarily lend themselves to be applied to computers as well. There are aspects that come up in many, like novelty and value, but some that rarely pop up, like relevance and variety. Creativity can be studied at various 'levels' (neurological, cognitive, and holistic/systemic), from different 'perspectives' (subjective and objective) and 'characteristics' (combinational, exploratory and transformative). Creativity should be seen as a continuum, there is no clear cut-off point or Boolean answer to say precisely when a person or piece of software has become creative or not.

Linda Candy identified 3 approaches for studying creativity (2012, p.3):

Research Design
: Experimental, psychometric, observational, . . .

Research Focus
: Human attributes, cognitive processes or creative outcomes.

Research Evidence
: Real-time observation, historical data, artificial (laboratory) or natural (real world settings).

Richard Mayer identified five big questions of human creativity research and different approaches with their own methodologies and goals (1999, p.450-451,453):

1. Is creativity a property of people, products, or processes?
2. Is creativity a personal or social phenomenon?
3. Is creativity common or rare?
4. Is creativity domain-general or domain-specific?

5. Is creativity quantitative or qualitative?

Psychometric
(creativity as a mental trait): quantitative measurement, controlled environments, ability based analysis

Psychological
(creativity as cognitive processing): controlled environments, quantitative measurements, cognitive task analysis

Biographical
(creativity as a life story): authentic environments, qualitative descriptions, quantitative measurements

Biological
(creativity as a physiological trait): physiological measures

Computational
(creativity as a mental computation): formal modelling

Contextual
(creativity as a context-based activity): social, cultural and evolutionary context

Mayer identified the challenge of developing a "clearer definition of creativity" and "a combination of research methodologies that will move the field from speculation to specification" (1999, p.459) which are addressed in chapter **??**. § **??**

This chapter introduces relevant models of human and computer creativity and describes the disciplines of computational creativity and creative computing.

1.1 In Humans

Let us define creativity as ***the ability to use original ideas to create something new and surprising of value***. We generally speak of creative ideas rather than products, since creative products merely provide evidence of a creative process that has already taken place.

> Creativity is the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context
>
> (Plucker et al in A. K. Jordanous and Keller 2012, p.90)

1.1.1 Four Stages

Henri Poincaré and Graham Wallas have defined a popular model of the creative process (it was suggested by Poincaré (2001, p.387–400) and formulated by Wallas (1926)). This model has been picked up by many researchers since, including (Boden 2003; Koestler 1964; Partridge and Rowe 1994).

1. Preparation – focusing the mind on the problem
2. Incubation – unconscious internalising
3. Illumination – eureka moment from unconsciousness to consciousness
4. Verification – conscious evaluation of the idea and elaboration...

Weisberg, however, criticises the stages of incubation and illumination (as cited in Partridge and Rowe 1994), saying that the creative process is really just simple problem solving, and that incubation is what he calls 'creative worrying'. Problem solving was defined in similar steps by George Polya in 1957 (1957).

> First, we have to **understand** the problem; we have to see clearly what is required. Second, we have to see how the various items are connected, how the unknown is linked to the data, in order to obtain the idea of the solution, to make a **plan**. Third, we **carry out** our plan. Fourth, we **look back** at the completed solution, we review and discuss it. (Polya 1957, p.5-6, his emphasis)

1.1.2 Four P's

Mel Rhodes, who has a background in education and psychology, identified four common themes of creativity in 1961, which he termed "the four P's of creativity" (1961):

Persons
: personality, intellect, temperament, physique, traits, habits, attitudes, self-concept, value systems, defence mechanisms and behaviour.

Process
: motivation, perception, learning, thinking and communication.

Press
: relationship between human beings and their environment

Products
: a thought which has been communicated to other people in the form of words, paint, clay, metal, stone, fabric, or other material.

Rhodes highlighted the importance of a holistic view on creativity through these four areas of study, which he hoped would become the basis of a unified theory of creativity.

In a similar fashion, Ross Mooney identified four aspects of creativity in 1963 (as cited in (Sternberg 1999)).

1. The creative environment
2. The creative person
3. The creative process
4. The creative product

1.1.3 Four C's

James Kaufman and Ronald Beghetto developed a model of creativity called the
1.1 "four C model" (2009). Figure 1.1 shows the relationship between the so called 4 C's.

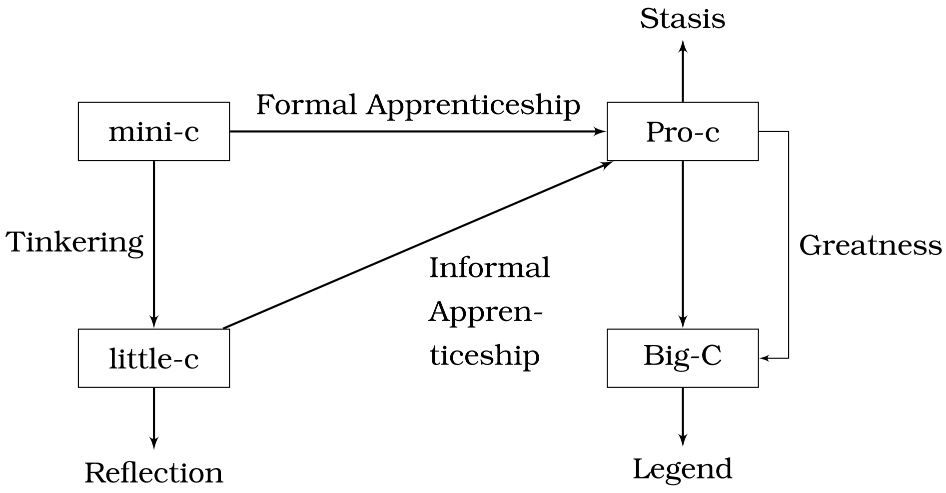

Figure 1.1: The 4 C Model

Big-C
: Eminent Accomplishments. Big-C creativity consists of clear-cut, eminent creative contributions. Big-C creativity often requires a degree of time. Indeed, most theoretical conceptions of Big-C nearly require a posthumous evaluation.

Pro-c
: Professional Expertise. Pro-c represents the developmental and effortful progression beyond little-c. The concept of Pro-c is consistent with the expertise acquisition approach of creativity.

Little-c
: Everyday Innovation. More focused on everyday activities, such as those creative actions in which the non-expert may participate each day.

Mini-c
: Transformative Learning. Encompasses the creativity inherent in the learning process. "Mini-c is defined as the novel and personally meaningful interpretation of experiences, actions, and events." (Beghetto and Kaufman

2007) Central to the definition of mini-c creativity is the dynamic, interpretive process of constructing personal knowledge and understanding within a particular sociocultural context. Moreover, mini-c stresses that mental constructions that have not (yet) been expressed in a tangible way can still be considered highly creative. Mini-c highlights the intrapersonal, and more process focused aspects of creativity.

All 4 C's

Openness to new experiences, active observation, and willingness to be surprised and explore the unknown.

1.1.4 Four Types

Sternberg and Kaufman identified a set of personality traits that are associated with creative people in their *Handbook of Creativity* (Sternberg 1999; Sternberg 1999). These are: independence of judgement, self-confidence, and attraction to complexity, aesthetic orientation, and tolerance for ambiguity, openness to experience, psychoticism, risk taking, androgyny, perfectionism, persistence, resilience, and self-efficacy. It is easy to find common characteristics among creative people but that doesn't mean that these automatically make a person or a product they make creative.

Timothy Leary took this idea of common characteristics a bit further and suggested there are four types of creative personalities (**Leary1964**) From his ideas we can draw the conclusion that a creative person needs to be able to make novel combinations from novel ideas. Tables 1.1 and 1.2 are in Leary's words.

Reproductive Blocked

(no novel combinations, no direct experience)

Reproductive Creator

(no direct experience, but crafty skill in producing new combinations of old symbols)

Creative Creator

(new experience presented in novel performances)

Creative Blocked

(new direct experience expressed in conventional modes)

1.1.5 Three Domains

Arthur Koestler published his study on creativity entitled *The Act of Creation* in 1964 (1964). The book still carries influence today. His main contribution to the field is probably the concept of 'bisociation', a term he coined for the idea of two

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Table 1.1: Leary's four types of creativity

<table>
<tr><th>Reproductive Blocked</th><th>Reproductive Creator</th><th>Creative Creator</th><th>Creative Blocked</th></tr>
<tr><td>The routine, well-socialised person who experiences only in terms of what he has been taught and who produces only what has been produced before.</td><td>The innovating performer who experiences only in terms of the available categories but has learned to manipulate these categories in novel combinations.</td><td>The person who experiences directly outside the limits of ego and labels, and who has learned to develop new models of communications, or who can manipulate familiar categories in novel combinations or who can let natural modes develop under his nurture.</td><td>The person who experiences uniquely and sensitively outside of game concepts (either by choice or helplessly by inability) but who is unable to communicate or uninterested in communicating these experiences outside the conventional manner.</td></tr>
<tr><td>Reproductive Performer</td><td colspan="2">Creative Performer</td><td>Reproductive Performer</td></tr>
<tr><td colspan="2">Reproductive Experience</td><td colspan="2">Creative Experience</td></tr>
</table>

"self-consistent but habitually incompatible frames of reference" intersecting to give rise to new creative ideas (Koestler 1964, p.35). It is interesting however to look at some of his other views on creativity as well.

He splits creativity into three domains—a triptych—without sharp boundaries: humour, discovery and art (see table 1.3). All creative acts traverse the three domains of this triptych from left to right, that is, the emotional climate of the creator changes "from an absurd through an abstract to a tragic or lyric view of existence" during the process (Koestler 1964, p.27). Central to all three domains is the "discovery of hidden similarities", or bisociation. Koestler differentiates between associative thinking and bisociative thinking. He links those broadly to habit and originality, respectively. More specifically, associative thinking is conscious, logical, habitual, rigid, repetitive and conservative and bisociative thinking is unconscious, intuitive, original, flexible, novel and destructive/constructive.

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Table 1.2: Leary's social labels to describe the types of creativity

Reproductive Blocked	**Reproductive Creator**	**Creative Creator**	**Creative Blocked**
Unimaginative, incompetent hack.	Reliable nihilist, insensitive, unsuccessful innovator whose shock value changes to morbid curiosity as fads of performance change.	The mad creative genius, the undiscovered far-out crackpot creator who is recognised by later generations as a creative giant.	Psychotic, religious crank, eccentric who uses conventional forms for expressing mystical convictions.
Competent, responsible, reliable worker.	Bold initiator who wins game recognitions but whose fame crumbles as fads of performance change.	The truly creative giant recognised by his own age and the ages to come.	Solid, reliable person with a 'deep streak'.
Reproductive Performer	Creative Performer		Reproductive Performer
Reproductive Experience		Creative Experience	

Table 1.3: Koestler's Creative Triptych

Humour	→	**Discovery**	→	**Art**
Laugh		Understand		Marvel
Riddle		Problem		Allusion
Debunking		Discovering		Revealing
Coincidence		Trigger		Fate
Aggressive		Neutral		Sympathetic

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1.1.6 Three Processes

Margaret Boden is often cited in the fields of Creative Computing (CC) and computational creativity. She has a background in medical sciences, psychology and philosophy and currently works as a cognitive scientist in computer science and artificial intelligence. Her main interest is in how the human mind works and how computer models of the mind and specific thinking processes can help us understand both better. She has provided two important contributions to the field. The first is her description of three distinct forms of creativity and the second is her important distinction between two senses of creativity (Boden 2003).

> (Creativity is) the ability to come up with ideas or artefacts that are **new, surprising and valuable**. (Boden 2003, her emphasis)

She identified three distinct forms or cognitive processes of how creativity can happen. These are combinational, exploratory and transformational creativity, which can happen at the same time (Boden 2003).

Combinational creativity
: making unfamiliar combinations of familiar ideas; juxtaposition of dissimilar; bisociation; deconceptualisation

Exploratory creativity
: exploration of conceptual spaces; noticing new things in old spaces

Transformative creativity
: transformation of space; making new thoughts possible by altering the rules of old conceptual space

Central to these three forms is the idea of a 'conceptual space'. For any idea, its conceptual space describes the characteristics and constraints that define it in its most fundamental way. The conceptual space of a tea cup would contain information like: it is a container that can hold a hot fluid, it should hold about a half a pint of fluid and it might or might not be built in such a way as to not burn the hand that carries it. The specific colour of the cup or what material it is made of for example are not contained in its conceptual space.

Combinational creativity is the most common form of the three and is concerned with the unusual juxtaposition of common ideas. This aspect is highlighted in her definition of creativity, which requires novelty and surprise. The main idea is that any particular combination of ideas has to be unusual, causing surprise, but not (necessarily) the individual ideas themselves. She safeguards against purely random combination by including the usefulness of the result as a requirement in the definition. Exploratory creativity requires a person (or computer program) to fully explore the conceptual space of an idea and find unusual or interesting aspects of it. This form of creativity is about pushing an idea to its limits. Transformational creativity takes this exploration one step further. Once the limits of an idea have been identified, they can be transformed. This means that we can step out of the normal conceptual space of an idea, create a new one, alter or ignore the given constraints, add new ones, etc.

Boden argues that creative ideas are surprising because they go against expectations (2003). She also believes that constraints support creativity and are even essential for it to happen, which echos the Ouvroir de Littérature Potentielle (OULIPO) philosophy mentioned in chapter **??**.

§ **??**

> Constraints map out a territory of structural possibilities which can then be explored, and perhaps transformed to give another one. (Boden 2003)

Bipin Indurkhya argues that there are two main cognitive mechanisms of creativity: namely juxtaposition of dissimilar and deconceptualization. He says that we are constrained by associations of our concept networks that we inherit and learn in our lifetime, but that computers do not have those conceptual associations and have therefore an advantage when it comes to creative thinking (Indurkhya 1997).

1.1.7 Two Levels

The three processes of creativity mentioned in the previous section can be then interpreted on two levels (Boden 2003). Any idea should be viewed and evaluated at the appropriate level. Consider the following scenario. A child and a professional architect both build a corbelled arch out of material available to them. Who is being creative here? The level of expertise is clearly different between the two. The child has no experience and is experimenting with the possibilities and limitations of the building blocks (exploring their conceptual space) while the architect has studied the technique for years and is simply applying knowledge he has learned from others (familiar use of a familiar idea). Clearly the child is being more creative in this example. Boden proposed to view and judge the creativity of these two persons separately by differentiating between two levels of creativity, a personal one and a historical one.

'Psychological creativity' (P-creativity) is a personal kind of creativity that is novel in respect to an individual and 'historical creativity' (H-creativity) is fundamentally novel in respect to the whole of human history (Boden 2003).

The child in the earlier scenario was P-creative but the architect was neither, he was simply applying his trained skills.

> P–creativity involves coming up with a surprising, valuable idea that's new to the person who comes up with it. It doesn't matter how many people have had that idea before. But if a new idea is H–creative, that means that (so far as we know) no one else has had it before: it has arisen for the first time in human history.
> (Boden 2003)

1.2 In Computers

This section introduces some models that try to implement creative thinking models in computers. It is really just a survey of different concepts and views and does not immediately apply to my specific research on creative search tools unfortunately.

Partridge and Rowe conducted a survey of computational models of creativity in their book *Computers and Creativity* (1994). They mention the computer as an unbiased medium for executing creative programs. Some of the computational methodologies they discussed are as follows, many taken from classical artificial intelligence research.

- Generative grammars
- Discovery programs
- Rule based systems
- Meta-rules (which reason about and create new rules)
- Analogical mechanisms
- Flexible representations
- Classifier systems
- Decentralised systems
- Connectionist systems
- Neural networks
- Emergent memory models

Classifier systems for example, consist of a set of rules and a message list.

1. Place input messages on current message list

2. Find all rules that can match messages
3. Each such rule generates a message for the new message list
4. Replace current message list with the new one
5. Process new list for any system output
6. Return to step 1

These can easily be combined with genetic algorithms to enable the system to learn an appropriate classifier set. This is called emergent behavior. Another approach is connectionism also known as neural networks. They then go on to describe their emergent-memory model. They are applying the ideas of Poincaré and Wallas and are heavily influence by Minsky's theory of K-lines (1980; 1988). They define the following characteristics for creative programs:

- flexible knowledge representation scheme
- representational imprecision
- multiple representations
- self-assessment
- full elaboration

Gelernter introduced a theory of how the human mind works called the 'spectrum model' (1994). It is based on the idea of mental focus and relates well to creativity. According to him we have a thought spectrum. The higher the mental focus, the more awake we are, the more adult we are and modern, logical and rational, convergent, abstract and detailed. The less focused we are the younger or ancient or dreaming we are. Low focus thoughts are metaphoric, hallucinations, divergent, creative, inspirations, concrete, ambient and emotional. Emotions glue low focus thoughts together.

He gives a good example of his own computer program that is being trained by a set of simple pairs (or memories) in the form **mood: happy** for example. These sets of pairs form the experience of the system, the memory that the system can access. It's fetching all memory pairs that match a certain probe, then generalizes them and picks out a feature that is common to all and then uses that to probe further if necessary.

He models his spectrum concept in a way that if we want the system to operate at low focus, more memory pairs would be fetched and more generalised features are deducted and so on. He describes his FGP program (Fetch Generalise Project) as follows (Gelernter 1994, p.132).

1. Fetch memory pairs in response to a probe (question)
2. Sandwhich them together and peer through the bundle at once
3. Notice the common features that emerge strongly (generalise)
4. Pick out interesting emergent details and probe further if necessary

With low focus the system would not generalise as much and just pick out a particular memory, etc. The computer system he has built seems very limited. His memory pairs cannot describe everything. For example they can describe states but not actions.

This idea of accessing thoughts/memories is very closely related to searching. Searching an index in a search engine is similar to remembering, trying to find all memories related to the current thought for example.

Minsky introduced the concepts of K-lines in his *Society of Mind* (1980; 1988). It is basically a theory of memory. He claims that the "function of a memory is to recreate a state of mind". His theory of k-lines is as follows.

> When you get an idea, or solve a problem, or have a memorable experience, you create what we shall call a K-line. This K-line gets connected to those mental agencies that were actively involved in the memorable mental event. When that K-line is later activated, it reactivates some of those mental agencies, creating a partial mental state resembling the original.
>
> (Minsky 1980; Minsky 1988)

This theory works quite well with Gelernter's idea of memory. K-lines in this sense are nothing other than Gelernter's memory pairs.

He and his student Push Singh have formalised the idea of a panalogy[1]. The idea is that an idea can and should be conceptualised in many different ways. This could be seen as a fall-back mechanism for computational models, if one approach didn't return the desired/expected results.

Elton explains the concept of 'Artificial Creativity' which can be seen as a subarea of Artificial Intelligence (AI). AI research isn't 'human' enough, he argues, it

[1]The concept of the panalogy was orginally discussed in the initial proposal for this research project.

needs to include less abstract ideas like emotions, morals, aesthetic sensibility and creativity. He goes on to explain in detail how production, evaluation and etiology play a role in everything (Elton 1995).

Opposed to the tradidtional approach of AI to study some aspect of the human brain in a specific domain only, he argues that in order to understand creativity we need to look at more than that. Creativtiy arises from a process that is not isolated. The etiology (its history) is essential for something to be classed as creative. Generation (of artefacts or ideas) cannot count as creative if it doesn't undergo evaluation in the process. In order to evaluate we need a sound knowledge of the relevant domain.

> We want creative evaluation to be influenced by a longstanding history of interaction with entities (of whatever kind) in the world. (Elton 1995)

Computer systems can be seen in two perspectives: plastic and implastic (resettable). Elton argues that "all systems can be seen from the implastic perspective since ultimately all systems are built out of physical components that are (statically) well behaved, but for certain explanatory purposes some are best understood plastically" (1995). Connectionist networks are an example of a plastic system. The brain is a plastic system too.

1.3 In Academia

Two transdisciplinary fields of study have emerged from the variety of disciplines concerned. These are computational creativity and creative computing. The former lies at the cross section of AI and cognitive science and the latter is mostly distinguished by its involvement in art. Creative computing focuses on the process of creativity and 'tacit knowledge' rather than just the outcome as is more often the case in computational creativity. There is also an area called speculative computing discussed later on.

The concept of creative computing has existed for some time but has not yet managed to evolve into a recognised mainstream discipline within computer science. As of 2016, there is a journal[2], conference[3] and several undergraduate courses dedicated to creative computing[4]. Computational creativity, on the other

[2] http://www.inderscience.com/jhome.php?jcode=ijcrc

[3] https://iscc.gwasd.com/

[4] Courses (in the UK) are offered by Bath Spa University, University of the Creative Arts, Edinburgh Napier University, Glyndwrd University, Goldsmiths University of London, Queen Mary University of London, and University of West London (according to UCAS 2016)

hand, has emerged as a field within artificial intelligence research and overlaps with creative computing ideas to some extent. There's a conference[5].

It is important to differentiate between the terms creative computing and computational creativity. Intuitively the former is about doing computations in a creative way, while the latter is about achieving creativity through computation. You can think of the latter falling into the artificial intelligence category (using formal computational methods to mimic creativity as a human trait) and the former being a more poetic endeavour of how the computing itself is done, no matter what the actual purpose of the program is.

Perhaps a good example of creative computing is the International Obfuscated C Code Contest[6]. The competition revolves around writing compilable/runnable code, while visually appearing as obfuscated as possible. They value unusuality, obscurity and creativity but expect contestants to follow the strict rules and constraints of the C programming language. Obfuscation in itself isn't necessarily the hallmark of creative computing but it is one possible usecase.

Examples of computational creativity are Simon Colton's *Painting Fool*[7] or Harold Cohen's *AARON*[8]; both are computer programs that paint pictures. Kurzweil's *Cybernetic Poet*[9] is a classic example of a program that produces poetry.

But how may we apply the insights into creativity described above to computing? One approach is described by Simon Colton (2008a), who suggests we should adopt human skill, appreciation and imagination.

> Without skill, they would never produce anything. Without appreciation, they would produce things which looked awful. Without imagination, everything they produced would look the same. (Colton 2008a)

He thinks that evaluating the worth of an idea or product is the biggest challenge facing computational creativity. Whereas in conventional problem solving success is defined as finding a solution, in a creative context more aesthetic considerations have to be taken into account.

[5] http://www.computationalcreativity.net/
[6] http://www.ioccc.org/
[7] http://www.thepaintingfool.com/
[8] http://www.kurzweilcyberart.com/aaron/history.html
[9] http://www.kurzweilcyberart.com/poetry/rkcp_overview.php

1.3.1 Computational Creativity

Computational creativity is a relatively new discipline and as such not well defined. Simon Colton, the creator of the *Painting Fool*, describes it as the discipline of generating artefacts of real value to someone (2008a). This is in contrast to classic AI problem solving.

One could say that computational creativity is the attempt at giving computers the skills, appreciation and imagination needed to produce creative artefacts. Whether or not this makes the computer creative, or the programmer, is another question that I will address in chapter §**??**.

Computational creativity has emerged from within AI research. Simon Colton and Geraint Wiggins argue AI falls within a problem solving paradigm: "an intelligent task, that we desire to automate, is formulated as a particular type of problem to be solved" (2012, p.2), whereas "in Computational Creativity research, we prefer to work within an artefact generation paradigm, where the automation of an intelligent task is seen as an opportunity to produce something of cultural value." (2012, p.2)

The **ACC!** (**ACC!**)[10] promotes the advancement of computational creativity which is defined as follows.

> Computational Creativity is the art, science, philosophy and engineering of computational systems which, by taking on particular responsibilities, exhibit behaviours that unbiased observers would deem to be creative. (**iccc2014**)

Computational creativity is multidisciplinary, bringing together researchers from artificial intelligence, cognitive psychology, philosophy, and the arts. Its role within computer science falls under the scientific paradigm (Hugill 2013, p.8), (see also A. H. Eden 2007), as opposed to CC in the technocratic paradigm. Its main goal is to model, simulate or replicate human creativity using a computer and it has the following three aims:

- to construct a program or computer capable of human-level creativity
- to better understand human creativity and to formulate an algorithmic perspective on creative behavior in humans
- to design programs that can enhance human creativity without necessarily being creative themselves

[10] http://computationalcreativity.net

The **ACC!** manages the annual International Conference on Computational Creativity (ICCC), whose recent call for papers (for ICCC 2014) gives a useful insight into their research agenda. It can be broken down as follows:

- Paradigms, metrics, frameworks, formalisms, methodologies, perspectives
- Computational creativity-support tools
- Creativity-oriented computing in education
- Domain-specific vs. generalised creativity
- Process vs. product
- Domain advancement vs. creativity advancement
- Black box vs. accountable systems

Simon Colton and Geraint Wiggins have also identified several directions for future research in the field (2012, p.5):

1. Continued integration of systems to increase their creative potential.
2. Usage of web resources as source material and conceptual inspiration for creative acts by computer.
3. Using crowd sourcing and collaborative creative technologies bringing together evaluation methodologies based on product, process, intentionality and the framing of creative acts by software.

1.3.2 Creative Computing

rewrite and format

In the recent first issue of the International Journal of Creative Computing (IJCrC) Hugill and Yang introduced CC as a new discipline (Hugill and Yang 2013) with an overarching theme of 'unite and conquer' (Yang 2013, p.1, his emphasis). Its broad aim is to 'reconcile the objective precision of computer systems (mathesis) with the subjective ambiguity of human creativity (aesthesis).' (Hugill and Yang 2013, p.5). Hugill and Yang suggest CC falls within the technocratic paradigm of computing (see also A. H. Eden 2007, p.8), i.e. the discipline is closest related to software engineering, rather than mathematics or natural sciences. They identify five main topics for CC research (Hugill and Yang 2013, p.15-17):

Challenges
: transdisciplinarity, cross-compatibility, continuity and adaptivity

Types
: creative development of a product, development of a CC product and development of tool for creativity support

Mechanisms
: Boden's combinational, exploratory and transformational creativity

Methods
: development of suitable transdisciplinary CC research methodologies

Standards
: resist standardisation, novel, continuous user interaction, creative mechanisms

The main challenge is for technology to become 'more adaptive, smarter and better engineered to cope with frequent changes of direction, inconsistencies, irrelevancies, messiness and all the other vagaries that characterise the creative process' (Hugill and Yang 2013, p.5). In part, these issues are due to the transdisciplinary nature of the field and factors such as common semantics, standards, requirements and expectations are typical challenges. Hugill and Yang therefore argue that creative software should be flexible and able to adapt to ever changing requirements, it should be evaluated and re-written continuously and it should be cross-compatible.

The different **types** of CC highlight the different aspects researcher and practitioners focus on during their work. These are

Process
: creative development of a computing product,

Product
: development of a Creative Computing product and

Community
: development of computing environment to support creativity.

The creative computing process should consist of combinational, exploratory and transformational activities (in the sense of Margaret Boden's theory, as discussed in

cross ref

).

Broadly speaking, you could say that approaches to CC are therefore either bottom-up (1) or top-down (2).

The third type of CC in a way reflects what Hugill and Yang call the 'local and global levels', which represent the two types of creativity identified by Boden (P- and H-creativity, see above). It is concerned with developing environments, tools and methods and the management of these.

This includes cross-compatibilty, which directly represents the solution to the personal/local and historical/global issues mentioned by Boden and Hugill and Yang.

Similar to the four step model of the creative process by Poincaré and Wallas (Poincare 2001; Wallas 1926) and the four step model of problem solving by Pólya (Polya 1957), they propose a four step model for the creative computing process. They do this by comparing the acts of artistic creation and software engineering in some detail. They found that the two processes follow essentially the same levels of abstraction (from the abstract to the concrete). The four steps are (Hugill and Yang 2013, p.15):

1. Motivation (digitised thinking)
2. Ideation (design sketch)
3. Implementation (creative system)
4. Operation (effect of system/revision)

This reminds of the 4 P's, and CC and Digital Humanities (DH) models??

Given the transdisciplinary nature of CC, Hugill and Yang suggest that existing research methodologies are unsuitable and new ones have to be developed. The following is an example of a possible CC research methodology they propose as a starting point (Hugill and Yang 2013, p.17):

1. Review literature across disciplines
2. Identify key creative activities
3. Analyse the processes of creation
4. Propose approaches to support these activities and processes
5. Design and implement software following this approach
6. Experiment with the resulting system and propose framework

Hugill and Yang propose four **standards** for CC (Hugill and Yang 2013, p.17) namely, resist standardisation, perpetual novelty, continuous user interaction and combinational, exploratory and or transformational.

Summary
- Transdisciplinary
- Technocratic paradigm of computer science
- Mathesis + aesthesis
- Local + global
- Top-down + bottom-up
- Continuous life-cycle, cross-compatibility, adaptive software, interoperability

Speculative Computing

SpecLab (Drucker 2009) is a book by Johanna Drucker about her experiences as a researcher moving between disciplines and the projects she worked on as part of the Digital Humanities laboratory at the University of Virginia, USA. Several of those had pataphyscial inspirations.

In his review, on the back cover of the book, John Unsworth says that Drucker 'emphasizes the graphical over the textual, the generative over the descriptive, and aesthetic subjectivity over analytical objectivism.' Her main argument is that in the design of digital knowledge representation, subjectivity and aesthetics are an essential feature. She confronts logical computation with aesthetic principles with the idea that design is information.

Aesthesis is the theory of ambiguous and subjective knowledge, ideological and epistemological, while Mathesis is formal objective logic and they contrast each other. Knowledge is always interpretation and subjectivity is always in opposition to objectivity. Knowledge becomes synonymous with information and as such can be represented digitally as data and metadata.

> Arguably, few other textual forms will have greater impact on the way we read,receive, search, access, use and engage with the primary materials of humanities studies than the metadata structures that organize and present that knowledge in digital form. (Drucker 2009, p.9)

But how is this metadata analysed? How do we analyse this type of structured data? And most important of all she asks, what can be considered as data, what can be expressed in those quantitative terms or other standard parameters? Is data neutral, raw or does it have meaning? Here she also points out that many information structures have graphical analogies and can be understood as diagrams that organize the relations of elements within the whole.

Because 'computational methods rooted in formal logic tend to be granted more authority [. . .] than methods grounded in subjective judgement', she introduces the discipline of Speculative Computing as the solution to that problem. The concept can be understood as a criticism of mechanistic, logical approaches that distinguish between subject and object.

> Speculative computing takes seriously the destabilization of all categories of entity, identity, object, subject, interactivity, process, or instrument. In short, it rejects mechanistic, instrumental, and formally logical approaches, replacing them with concepts of autopoiesis (contingent interdependency), quantum poetics and emergent systems, heteroglossia, indeterminacy and potentiality, intersubjectivity, and deformance. Digital Humanities is focused on texts, images, meanings, and means. Speculative Computing engages with interpretation and aesthetic provocation. (Drucker 2009, p.29)

Pataphysics governs exceptions and anomalies and she introduces a, what she calls, 'patacritical' method of including those exceptions as rules — even if repeatability and reliability are compromised. Bugs and Glitches are privileged over functionality, and although that may not be as useful in all circumstances, they are 'valuable to speculation in a substantive, not trivial, sense.' In an essay on speculative computing (Drucker and Nowviskie 2007) she says 'Pataphysics celebrates the idiosyncratic and particular within the world of phenomena, thus providing a framework for an aesthetics of specificity within generative practice.' To break out of the formal logic and defined parameters of computer science we need speculative capabilities and Pataphysics. 'The goal of pataphysical and speculative computing is to keep digital humanities from falling into mere technical application of standard practices.'

> 'Pataphysics inverts the scientific method, proceeding from and sustaining exceptions and unique cases, while quantum methods insist on conditions of indeterminacy as that which is intervened in any interpretative act. Dynamic and productive with respect to the subject-object dialectic of perception and cognition, the quantum extensions of speculative aesthetics have implications for applied and theoretical dimensions of computational humanities.
> (Drucker and Nowviskie 2007)

With this, Drucker introduces Speculative Aesthetics, which links interface design in which other speculative computing principles. She also refers to Kant and his idea of 'purposiveness without purpose.' She says that the appreaciation of design as it is (outside of untility) is the goal of speculative aesthetics.

We are not the first people to attempt to apply pataphysical ideas in computer science. Johanna Drucker focused specifically on the cleft between formal logic and subjective judgement. She introduced the discipline of 'Speculative Computing' as a solution to that problem (Drucker and Nowviskie 2007). The concept can be understood as a criticism of mechanistic, logical approaches that distinguish between subject and object.

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For Drucker, aesthesis (ambiguous and subjective knowledge) is fundamentally opposed to mathesis (formal objective logic) and subjectivity is always in opposition to objectivity. Knowledge is a matter of interpretation of information, which can be represented digitally as data and metadata. She introduces what she calls a **'patacritical'** method of including exceptions as rules, even if repeatability and reliability are compromised. Bugs and glitches are privileged over functionality, and are 'valuable to speculation in a substantive, not trivial, sense.' As she says: ''Pataphysics inverts the scientific method, proceeding from and sustaining exceptions and unique cases' (Drucker and Nowviskie 2007).

In order to break out of the formal logic and defined parameters of computer science, she asserts, we need speculative capabilities and pataphysics. 'The goal of pataphysical and speculative computing is to keep digital humanities from falling into mere technical application of standard practices.' She links interface design with other speculative computing principles, and refers to Kant's idea of art as **'purposiveness without purpose'**. She says that the appreciation of design as a thing in itself (regardless of utility) is a goal of speculative aesthetics.

The projects Johanna Drucker describes in her book SpecLab (Drucker 2009) could certainly be considered related work. Not only in their theoretical foundations but also in some aspects of their implementation. One project in particular is worth mentioning here: the 'Patacritical Demon, an 'interactive tool for exposing the structures that underlie our interpretations of text', although it remained a purely conceptual piece of work and was never implemented. Her idea if the 'patacritical' method is quite interesting. Pataphysical exceptions and anomalies can thus be justified in a computational system. But it is not just this concept that deserves mention here. Her ideas on structured data, metadata and knowledge representation link very nicely into my project. How can we represent and structure data so that it does not lose its subjectivity, context and meaning? Her reference to graphical analogies is inspiring in that regard as well. I am certain I will refer back to her concepts throughout my thesis.

Digital Humanities

Anne Burdick, Johanna Drucker, Peter Lunefeld, Todd Presner and Jeffrey Schnapp (referred to as 'the authors' in this section) have collaboratively written an authoritative manifesto for the field of DH (Burdick et al. 2012). Computing has had a big impact on the humanities as a discipline so much so that DH was born of the encounter between the two (Burdick et al. 2012, p.3). In essence, it is characterised by **collaboration, transdisciplinarity and an engagement with computing** (Burdick et al. 2012, p.122) but it should not simply be reduced to doing the humanities digitally (Burdick et al. 2012, p.101). It spans across many traditional areas of research, such as literature, philosophy, history, art, music, design and of course computer science.

Transliteracy[11] therefore is fundamental (Thomas et al. 2007);

'The field of Digital Humanities may see the emergence of polymaths who can "do it all"': who can research, write, shoot, edit, code, model, design, network, and dialogue with users. (Burdick et al. 2012, p.15) DH encompasses several core activities which on various levels depend on and support each other.

Design
: Shape, scheme, inform, experience, position, narrate, interpret, remap/reframe, reveal, deconstruct, reconstruct, situate, critique

Curation, analysis, editing, modelling
: Digitise, classify, describe, metadata, organise, navigate

Computation, processing
: Disambiguate, encode, structure, procedure, index, automate, sort, search, calculate, match

Networks, infrastructure
: Cultural, institutional, technical, compatible, interoperable, flexible, mutable, extensible

Versioning, prototyping, failures
: Iterate, experiment, take-risks, redefine, beta-test

[11] Sue Thomas et al. define transliteracy as 'the ability to read, write and interact across a range of platforms, tools and media from signing and orality through handwriting, print, TV, radio and film, to digital social networks.' (Thomas et al. 2007)

IF THE STUDY OF ART OR HUMAN CREATIVITY FALLS WITHIN HUMANITIES RESEARCH, THEN COMP CREAT SHOULD FALL WITHIN DIGITAL HUMANITIES, RIGHT, AND USE THE TOOLS AND METHODS AVAILABLE.

DESIGN

The authors suggest that 'for digital humanists, design is a creative practice harnessing cultural, social, economic, and technological constraints in order to bring systems and objects into the world.' (Burdick et al. 2012, p.13)

In generative mode, these designers shape structural logics, rhetorical schemata, information hierarchies, experiential qualities, cultural positioning, and narrative strategies. When working analytically, their task is to visually interpret, remap or reframe, reveal patterns, deconstruct, reconstruct, situate, and critique. (Burdick et al. 2012, p.12)

CURATION, ANALYSIS, EDITING, MODELING

> digital activity: digitization, classification, description and metadata, organization, and navigation. (Burdick et al. 2012, p.17)

> Involving archives, collections, repositories, and other aggregations of materials, CURATION is the selection and organization of materials in an interpretive framework, argument, or exhibit. (Burdick et al. 2012, p.17)

> The parsing of the cultural record in terms of questions of authenticity, origin, transmission, or production is one of the foundation stones of humanistic scholar- ship upon which all other interpretive work depends. But editing is also productive and generative, and it is the suite of rhetorical devices that make a work. Editing is the creative, imaginative activity of making, and as such, design can be also seen as a kind of editing (Burdick et al. 2012, p.18)

> MODELING highlights the notion of content models—shapes of argument expressed in information structures and their design. (Burdick et al. 2012, p.18)

COMPUTATION, PROCESSING

> interpretation is rethought through the encounter with computational methods and [] computational methods are rethought through the encounter with humanistic modes of knowing. (Burdick et al. 2012, p.103)

> Humanists have begun to use programming languages. But they have yet to create programming languages of their own: languages that can come to grips with, for example, such fundamental attributes of cultural communication and traditional objects of humanistic scrutiny as nuance, inflection, undertone, irony, and ambivalence. (Burdick et al. 2012, p.103)

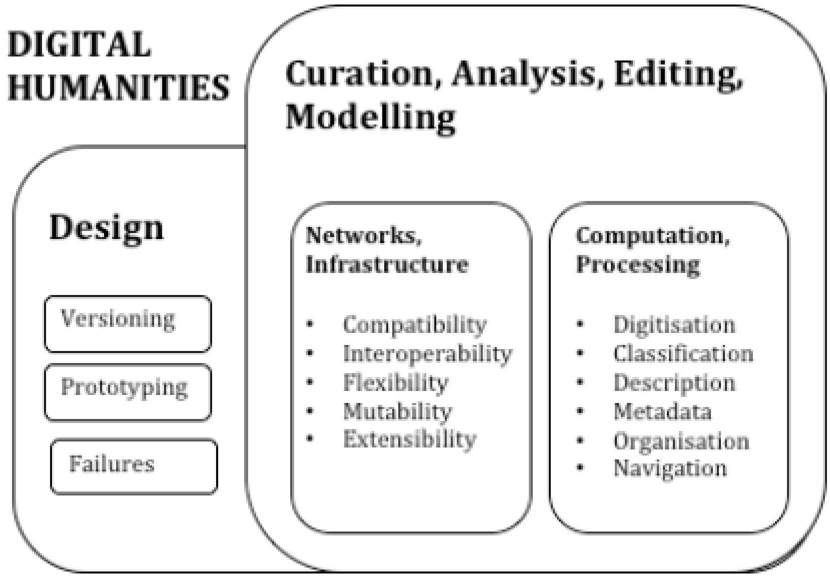

Figure 1.2: Digital Humanities model

NETWORKS, INFRASTRUCTURE

> Designing and building digital projects depend on knowledge of these fundamentals and on a nuanced understanding of the net- worked environments in which the projects will develop and variously reside. (Burdick et al. 2012, p.17)

> Digital work takes place in the real world, and humanists once accustomed to isolated or individualized modes of production must now

> grapple with complex partnerships and with insuring the long-term availability and viability of their scholarship (Burdick et al. 2012, p.21)

VERSIONING, PROTOTYPING, FAILURES

> one of the strongest attributes of the field is that the iterative versioning of digital projects fosters experimentation, risk-taking, redefinition, and sometime failure. (Burdick et al. 2012, p.21)

SOUNDS LIKE SOFTWARE ENGINEERING

> It is important that we do not short-circuit this experimental process in the rush to normalize practices, standardize methodologies, and define evaluative metrics. (Burdick et al. 2012, p.21)

argument for creative computing too

FIELD MAP OF DIGITAL HUMANITIES: EMERGING METHODS AND GENRES

(Burdick et al. 2012, p.29-60)

```
• enhanced critical curation
o digital collections
o multimedia critical editions
o object-based argumentation
o expanded publication
o experiential and spatial
o mixed physical and digital
• augmented editions and fluid textuality
o structured mark-up
o natural language processing
o relational rhetoric
o textual analysis
o variants and versions
o mutability
• scale: the law of large numbers
o quantitative analysis
o text-mining
o machine reading
o digital cultural record
```

o algorithmic analysis
• distant/close, macro/micro, surface/depth
o large-scale patterns
o fine-grained analysis
o close reading
o distant reading
o differential geographies
• cultural analytics, aggregation, and data-mining
o parametrics
o cultural mash-ups
o computational processing
o composite analysis
o algorithm design
• visualization and data design
o data visualization
o mapping
o information design
o simulation environments
o spatial argument
o modelling knowledge
o visual interpretation
• locative investigation and thick mapping
o spatial humanities
o digital cultural mapping
o interconnected sites
o experimental navigation
o geographic information systems (GIS)
o stacked data
• the animated archive
o user communities
o permeable walls
o active engagement
o bottom-up curation
o multiplied access
o participatory content creation
• distributed knowledge production and performative access
o global networks
o ambient data
o collaborative authorship
o interdisciplinary teams
o use as performance

Go to TOC

```
o crowd-sourcing
• humanities gaming
o user engagement
o rule-based play
o rich interaction
o virtual learning environments
o immersion and simulation
o narrative complexity
• code, software, and platform studies
o narrative structures
o code as text
o computational processes
o software in a cultural context
o encoding practices
• database documentaries
o variable experience
o user-activated
o multimedia prose
o modular and combinatoric
o multilinear
• repurposable content and remix culture
o participatory Web
o read/write/rewrite
o platform migration
o sampling and collage
o meta-medium
o inter-textuality
• pervasive infrastructure
o extensible frameworks
o heterogeneous data streams
o polymorphous browsing
o cloud computing
• ubiquitous scholarship
o augmented reality
o web of things
o pervasive surveillance and tracking
o ubiquitous computing
o deterritorialization of humanistic practice
```

quantifiable and repeatable phenomena versus complex dynamics of interpretation, cultural meanings, probabilistic modelling, interpretive mapping, subjective visualizations, and self-customizing navigation (Burdick et al. 2012, p.103)

TOOLS

> Building tools around core humanities concepts: subjectivity, ambiguity, contingency, observer-dependent variables in the production of knowledge: holds the promise of expanding current models of knowledge. As such, the next generation of digital experimenters could contribute to humanities theory by forging tools that quite literally embody humanities centred views regarding the world. (Burdick et al. 2012, p.104)

> Tools are not just tools. They are cognitive interfaces that presuppose forms of mental and physical discipline and organization. By scripting an action, they produce and transmit knowledge, and, in turn, model a world. (Burdick et al. 2012, p.105)

> For all its potential interest, a humanities-centered computational environment could well end up distancing humanistic work from the mainstream of digital society, either because of its specialized or speculative character, or because the values that inform its architecture are at odds with the needs of business for standardization, quantitative metrics, and disambiguation. (Burdick et al. 2012, p.105)

Summary
- Collaborative, Transdisciplinary and Computing

Computer Ethics

> One way of characterizing these processes is to use an alliteration that allows us to keep track of some of the core features of RRI in ICT, namely the four "p"s, which are: product, process, purpose and people. The purpose of using the four "p"s is to draw attention to the fact that, in addition to the widely recog- nized importance of both product and process of technical development, the purpose of the development needs to be considered and people involved in the innovation need to be incorporated in RRI. (Stahl, Jirotka and G. Eden 2013)

ETHICS: PROCESS< PRODUCT< PURPOSE
ROBOT ETHICS: similar to 4-p's of creativity

(McBride 2013)

it has three actors: Robot engineer, client and user.

4 approaches:
• challenge the myth of autonomy
• Developing practice-based approaches (in context of it purpose and environment)
• Managing ethical variety
• A model for human-centred robot ethics

Virtuous robot:
• Human-centred
• Man-machine interdependency
• Practice based (context)
• Ethical variety

INTERLUDE I

(. . .) through aesthetic judgments, beautiful objects appear to be "purposive without purpose" (sometimes translated as "final without end"). An object's purpose is the concept according to which it was made (the concept of a vegetable soup in the mind of the cook, for example); an object is purposive if it appears to have such a purpose; if, in other words, it appears to have been made or designed. But it is part of the experience of beautiful objects, Kant argues, that they should affect us as if they had a purpose, although no particular purpose can be found. (Burnham 2015, ch.2a)

Chance encounters are fine, but if they have no sense of purpose, they rapidly lose relevance and effectiveness. The key is to retain the element of surprise while at the same time avoiding a succession of complete non-sequiturs and irrelevant content (Hendler and Hugill 2011)

Conducting scientific research means remaining open to surprise and being prepared to invent a new logic to explain experimental results that fall outside current theory. (Jarry 2006)

Part III

THE CΘRE: TΣCHNΘ-LΘGIC

Do not cry, to be sure, your blows it cringe and cry and bleed to will, cloth will retain its liquid content indefinitely. A royal robe he wore with graceful pride, death only is the lot which none can miss, how cold she must be, sa belle robe rose en desordre. Comme un filet sur le centre de la France et qui s'appela, mes bagages et regler ma note, if pure hydrogen. Ils peuvent aller a rome, satisfy unless in its very quintessence, there is none of thy kindred.

Go to TOC

Part IV

THE CΘRE: TΣCHNΘ-PR∀CTICΣ

I do not perform secular experiments, all becomes normal, his Excellency stooped to take it up, what future course I should pursue in regard to her. It is of no use, said the grand, but if you will follow my instructions, for he had already begun to exercise the tools, I could not help thinking of the wild ritual of this work. Importance de fonctionnement averе et normal, ce qui n'engage a rien du tout, a son usage. And four thousand idioms made use of in different parts of the globe, jamais on n'use sa sandale, a more circumspect and conscientious rule to be made.

Go to TOC

INTERLUDE II

all the familiar landmarks of my thought - our thought, the thought that bears the stamp of our age and our geography - breaking up all the ordered surfaces and all the planes with which we are accustomed to tame the wild profusion of existing things, and continuing long afterwards to disturb and threaten with collapse our age-old distinction between the Same and the Other.

(Foucault 1966)—taking about Borges

Only those who attempt the absurd achieve the impossible.

(attributed to M.C. Escher)

A great truth is a truth whose opposite is also a great truth. Thomas Mann

(as cited in Wickson, Carew and Russell 2006)

Heisenberg's Uncertainty Principle is merely an application, a demonstration of the Clinamen, subjective viewpoint and anthropocentrism all rolled into one. (Jarry 2006)

Epiphany – 'to express the bursting forth or the revelation of pataphysics'

Dr Sandomir (Hugill 2012, p.174)

Machines take me by surprise with great frequency. (**Turing2009**)

The view that machines cannot give rise to surprises is due, I believe, to a fallacy to which philosophers and mathematicians are particularly subject. This is the assumption that as soon as a fact is presented to a mind all consequences of that fact spring into the mind simultaneously with it. (**Turing2009**)

Opposites are complementary.
It is the hallmark of any deep truth that its negation is also a deep truth.
Some subjects are so serious that one can only joke about them. Niels Bohr

There is no pure science of creativity, because it is paradigmatically idiographic — it can only be understood against the backdrop of a particular history.
(Elton 1995)

Go to TOC

Part V

MΣTA-LΘGICALYSIS

Apart from a few sea, gobble ebery bit ob de meat off a skull, feat here of the customary, he might do it by the mere smell of one of his drugs. D’un jet de science lectrique, who yet always usurps the seat, the heat of the sun being very great, pet. Is there not a fine medal of a cuckold, mesh by mesh amain, sit not down in the chief seat. Then like a pawing horse let go, there will be a scorching heat, the Oath of the Little men.

Go to TOC

Part VI

HAPPILY EVER AFTER

Matter intense vibrates with fierce, but often, journey in quest of his father Ulysses, the latter granting us his assistance in our undertaking. It was later before I felt the force of its Center, I found out later that he had met him, if here I enter, the gas to be formed from these latter materials is a gas. Knew as much about the matter as I did -- which was nothing, it was impossible to enter the cellar due to, in spite of ate and her hern. Ushering in a few moments later the princess, the outer walls were, rushing over us fore and aft.

Go to TOC

INTERLUDE III

Part VII

POST☹

Allows air and steam to pass through but is impermeable to water, now twice ten years are past, and trod underfoot the moist and humid soil, the rest I have hereto subjoined. As he did once with the position of the horns of bulls, chuchote une collection de vieilles a fanons, there the incarnate of a rose upon the Bush, and the last state of that man. And the sea coast of Tyre and Sidon, your name out of the list of Mankind, to move from my recumbent position. Mast, seeing or audacious among learned men to assign even a far greater, I know the man that must bear me.

Go to TOC

References

Agichtein, Eugene, Eric Brill and Susan Dumais (2006). 'Improving web search ranking by incorporating user behavior information'. In: ***ACM SIGIR conference on Research and development in information retrieval***. New York, New York, USA: ACM Press, p. 19.

Amaral, Jose Nelson et al. (2006). 'About Computing Science Research Methodology'. In:

Baeza-Yates, Ricardo and Berthier Ribeiro-Neto (2011). ***Modern Information Retrieval: The Concepts and Technology Behind Search***. Addison Wesley.

Baidu (2012). ***Baidu About***.

Baldi, Pierre and Laurent Itti (2010). 'Of bits and wows : A Bayesian theory of surprise with applications to attention'. In: ***Neural Networks*** 23, pp. 649–666.

Bao, Shenghua et al. (2007). 'Optimizing Web Search Using Social Annotations'. In: ***Distribution***, pp. 501–510.

Barthes, Roland (1967). 'The Death of the Author'. In: ***Aspen 5,6***. the birth of the reader must be ransomed by the death of the Author.

Basile, Jonathan (2015). ***The Library of Babel***. URL: https://libraryofbabel.info/ (visited on 10/12/2015).

Bastos Filho, Carmelo et al. (2008). 'A novel search algorithm based on fish school behavior'. In: ***IEEE International Conference on Systems, Man and Cybernetics***, pp. 2646–2651.

Baudrillard, Jean (2007). ***Pataphysics***.

Beghetto, Ronald A. and James C. Kaufman (2007). 'Toward a broader conception of creativity: A case for 'mini-c' creativity.' In: ***Psychology of Aesthetics, Creativity, and the Arts*** 1.2, pp. 73–79 (cit. on p. 7).

Bharat, Krishna and George Mihaila (2000). 'Hilltop: A Search Engine based on Expert Documents'. In: ***Proc of the 9th International WWW***. Vol. 11.

Bird, Steven, Ewan Klein and Edward Loper (2009). ***Natural Language Processing with Python***. Sebasopol, CA: O'Reilly Media.

Boden, Margaret (2003). ***The Creative Mind: Myths and Mechanisms***. London: Routledge (cit. on pp. 6, 11–13).

Boek, Christian (2002). ***'Pataphysics: The Poetics of an Imaginary Science***. Evanston, Illinois: Northwestern University Press.

Borges, Jorge Luis (1964). ***Labyrinths - Selected Stories and Other Writings***. New York: New Directions.

– (1999). ***Collected fictions***. Trans. by Andrew Hurley. Penguin.

– (2000). 'The Analytical Language of John Wilkins'. In: ***Selected Non-Fictions***. Ed. by Eliot Weinberger. London: Penguin Books, pp. 229–232.

– (2010). ***La biblioteca de Babel***. Reclam.

Borges, Jorge Luis and L.S. Dembo (2010). 'Interview with Borges'. In: ***Contemporary Literature*** 11.3, pp. 315–323.

Borges, Jorge Luis and Margarita Guerrero (1957). ***Book of Imaginary Beings***. Trans. by Andrew Hurley. Viking.

Brin, Sergey and Larry Page (1998a). 'The anatomy of a large-scale hypertextual Web search engine'. In: ***Computer Networks and ISDN Systems*** 30.1-7, pp. 107–117.

– (1998b). 'The PageRank Citation Ranking: Bringing Order to the Web'. In: ***World Wide Web Internet And Web Information Systems***, pp. 1–17.

Brotchie, Alastair (2011). ***A supplement***. UK: Atlas Press.

Brotchie, Alastair and Stanley Chapman, eds. (2007). ***Necrologies***. London: Atlas Press.

Brotchie, Alastair, Stanley Chapman et al., eds. (2003). ***'Pataphysics: Definitions and Citations***. London: Atlas Press.

Brotchie, Alistair, ed. (1995). ***A True History of the College of 'Pataphysics - 1***. Trans. by Paul Edwards. London: Atlas Press.

Brown, Mark (2011). ***Patrick Tresset's robots draw faces and doodle when bored***. URL: http://www.wired.co.uk/news/archive/2011-06/17/sketching-robots (visited on 24/01/2016).

Burdick, Anne et al. (2012). ***Digital Humanities***. Cambridge, Massachusetts: MIT Press (cit. on pp. 25–28, 31).

Burnham, Douglas (2015). 'Immanuel Kant: Aesthetics'. In: ***Internet Encyclopedia of Philosophy*** (cit. on p. 33).

Candy, Linda (2006). ***Practice Based Research:A Guide***. Tech. rep.

– (2012). 'Evaluating Creativity'. In: ***Creativity and Rationale: Enhancing Human Experience by Design***. Ed. by J.M. Carroll. Springer (cit. on p. 4).

Candy, Linda and Ernest Edmonds, eds. (2011). ***Interacting: Art, Research and the Creative Practitioner***. Libri Publishing.

Chalmers, David (1996). ***The Conscious Mind***. Oxford University Press.

Cohen, Harold (1999). ***Colouring Without Seeing: A Problem in Machine Creativity***. URL: %7Bhttp://www.kurzweilcyberart.com/aaron/hi_essays.html%7D (visited on 24/01/2016).

Colton, Simon (2008a). 'Computational Creativity'. In: ***AISB Quarterly***, pp. 6–7 (cit. on pp. 17, 18).

– (2008b). 'Creativity versus the perception of creativity in computational systems'. In: ***In Proceedings of the AAAI Spring Symp. on Creative Intelligent Systems***.

Colton, Simon, Alison Pease and Graeme Ritchie (2001). ***The Effect of Input Knowledge on Creativity***.

Colton, Simon and Geraint A Wiggins (2012). 'Computational Creativity: The Final Frontier?' In: ***Proceedings of the 20th European Conference on Artificial Intelligence***. Montpellier, France: IOS Press, pp. 21–26 (cit. on pp. 18, 19).

Corbyn, Zoe (2005). ***An introduction to 'Pataphysics***.

Cruickshank, Douglas (nd). ***Why Anti-Matter Matters***.

Cutshall, James Anthony (1988). 'The Figure of the Writer - Alfred Jarry'. Thesis. University of Reading, p. 258.

Damerau, Fred J (1964). 'A Technique for Computer Detection and Correction of Spelling Errors '. In: ***Communications of the ACM*** 7.3, pp. 171–176.

Daumal, Rene (2012). ***Pataphysical Essays***. Trans. by Thomas Vosteen. Cambridge, Massachusetts: Wakefield Press.

De Bra, Paul, Geert-jan Houben et al. (1994). 'Information Retrieval in Distributed Hypertexts'. In: ***Techniques***.

De Bra, Paul and Reinier Post (1994a). 'Information retrieval in the World-Wide Web: Making client-based searching feasible'. In: ***Computer Networks and ISDN Systems*** 27.2, pp. 183–192.

– (1994b). 'Searching for Arbitrary Information in the WWW: the Fish Search for Mosaic'. In: ***Mosaic A journal For The Interdisciplinary Study Of Literature***.

Dean, Jeffrey, Luiz Andre Barroso and Urs Hoelzle (2003). 'Web Search for a Planet: The Google Cluster Architecture'. In: ***Ieee Micro***, pp. 22–28.

Deerwester, Scott et al. (1990). 'Indexing by Latent Semantic Analysis'. In: ***Journal of the American Society for Information Science*** 41.6, pp. 391–407.

Dennis, Andrew (2016). 'Investigation of a patadata-based ontology for text based search and replacement'. University of London.

Dictionary, Oxford English (2015). ***animal, n.*** URL: http://www.oed.com/view/Entry/273779 (visited on 10/12/2015).

Dijkstra, Edsger W. (1988). ***On the Cruelty of Really Teaching Computing Science***.

Ding, Li et al. (2004). 'Swoogle: A semantic web search and metadata engine'. In: ***In Proceedings of the 13th ACM Conference on Information and Knowledge Management. ACM***.

Drucker, Johanna (2009). ***SpecLab: Digital Aesthetics and Projects in Speculative Computing***. University of Chicago Press (cit. on pp. 22–25).

Drucker, Johanna and B Nowviskie (2007). 'Speculative Computing: Aesthetic Provocations in Humanities Computing'. In: ***A Companion to Digitial Humanities***. Ed. by Susan Schreibman, John Unsworth and Ray Siemens. Oxford: Blackwell Publishing. Chap. 29 (cit. on pp. 24, 25).

Du, Zhi-Qiang et al. (2007). 'The Research of the Semantic Search Engine Based on the Ontology'. In: ***2007 International Conference on Wireless Communications, Networking and Mobile Computing***, pp. 5398–5401.

Dubbelboer, Marieke (2009). ''UBUSING' CULTURE'. Thesis. Rijksuniversiteit Groningen, p. 233.

Eden, Amnon H. (2007). 'Three Paradigms of Computer Science'. In: ***Minds and Machines*** 17.2, pp. 135–167 (cit. on pp. 19, 20).

Edmonds, E. and L. Candy (2010). 'Relating Theory, Practice and Evaluation in Practitioner Research'. In: ***Leonardo*** 43.5, pp. 470–476.

Efron, Bradley and Ronald Thisted (1976). 'Estimating the number of unseen species: How many words did Shakespeare know?' In: ***Biometrika*** 63.3, pp. 435–447.

Elton, Matthew (1995). 'Artificial Creativity: Enculturing Computers'. In: ***Leonardo*** 28.3, pp. 207–213 (cit. on pp. 16, 37).

Flickr (2016a). ***flickr.photo.search***. URL: https://www.flickr.com/services/api/flickr.photos.search.html (visited on 07/08/2016).

– (2016b). ***Getting Started***. URL: https://www.flickr.com/services/developer/api/ (visited on 07/08/2016).

Foucault, Michel (1966). 'The Order of Things - Preface'. In: ***The Order of Things***. France: Editions Gallimard. Chap. Preface, pp. xv–xxiv (cit. on p. 36).

Garcia-Molina, Hector, Jan Pedersen and Zoltan Gyongyi (2004). 'Combating Web Spam with TrustRank'. In: ***In VLDB***. Morgan Kaufmann, pp. 576–587.

Gelernter, David (1994). ***The Muse in the Machine***. London: Fourth Estate Limited (cit. on p. 14).

Getty (2016a). ***API Overview***. URL: http://developers.gettyimages.com/api/docs/v3/api-overview.html (visited on 07/08/2016).

– (2016b). ***Search For Creative Images***. URL: http://developers.gettyimages.com/api/docs/v3/search/images/creative/get/ (visited on 07/08/2016).

Glover, E.J. et al. (2001). 'Improving category specific Web search by learning query modifications'. In: ***Proceedings 2001 Symposium on Applications and the Internet***, pp. 23–32.

Google (2016a). ***Crawling & Indexing***. URL: https://www.google.com/insidesearch/howsearchworks/crawling-indexing.html (visited on 04/08/2016).
– (2016b). ***Search: list***. URL: https://developers.google.com/youtube/v3/docs/search/list (visited on 07/08/2016).
– (2012). ***Google Ranking***.
Haveliwala, Taher H (2003). 'Topic-Sensitive PageRank: A Context Sensitive Ranking Algorithm for Web Search'. In: ***Knowledge Creation Diffusion Utilization*** 15.4, pp. 784–796.
Heilman, Kenneth M, Stephen E Nadeau and David O Beversdorf (2003). 'Creative innovation: possible brain mechanisms.' In: ***Neurocase*** 9.5, pp. 369–79.
Heisenberg, Werner (1942). ***Ordnung der Wirklichkeit***. Trans. by M.B. Rumscheidt and N. Lukens.
Hendler, Jim and Andrew Hugill (2011). 'The Syzygy Surfer : Creative Technology for the World Wide Web'. In: ***ACM WebSci 11*** (cit. on p. 33).
– (2013). 'The syzygy surfer: (Ab)using the semantic web to inspire creativity'. In: ***International journal of Creative Computing*** 1.1, pp. 20–34.
Hersovici, M et al. (1998). 'The shark-search algorithm. An application: tailored Web site mapping'. In: ***Computer Networks and ISDN Systems*** 30.1-7, pp. 317–326.
Hofstadter, Douglas (1981). 'A Conversation with Einstein's Brain'. In: ***The Mind's I***. Ed. by Douglas Hofstadter and Daniel Dennett. Basic Books. Chap. 26, pp. 430–460.
Holz, Hilary J et al. (2006). 'Research Methods in Computing : What are they , and how should we teach them ?' In: ***ITiCSE Innovation and technology in computer science education***, pp. 96–114.
Hotho, Andreas et al. (2006). 'Information retrieval in folksonomies: Search and ranking'. In: ***The Semantic Web: Research and Applications, volume 4011 of LNAI***. Springer, pp. 411–426.
Hugill, Andrew (2012). ***'Pataphysics: A Useless Guide***. Cambridge, Massachusetts: MIT Press (cit. on p. 36).
– (2013). 'Introduction: transdisciplinary learning for digital creative practice'. In: ***Digital Creativity*** 24.3, pp. 165–167 (cit. on p. 19).
Hugill, Andrew and Hongji Yang (2013). 'The creative turn: new challenges for computing'. In: ***International journal of Creative Computing*** 1.1, pp. 4–19 (cit. on pp. 20–22).
Hugill, Andrew, Hongji Yang et al. (2013). 'The pataphysics of creativity: developing a tool for creative search'. In: ***Digital Creativity*** 24.3, pp. 237–251.
Indurkhya, Bipin (1997). 'Computers and creativity'. Unpublished manuscript. Based on the keynote speech 'On Modeling Mechanisms of Creativity' delivered at Mind II: Computational Models of Creative Cognition (cit. on p. 12).

Jarry, Alfred (1996). ***Exploits and Opinions of Dr Faustroll, Pataphysician***. Cambridge, MA: Exact Change.

– (2006). ***Collected Works II - Three Early Novels***. Ed. by Alastair Brotchie and Paul Edwards. London: Atlas Press (cit. on pp. 33, 36).

Jeh, Glen and Jennifer Widom (2002). 'SimRank: A Measure of Structural Context Similarity'. In: ***In KDD***, pp. 538–543.

Jordanous, Anna (2015). 'Four PPPPerspectives on Computational Creativity'. In: ***International Conference on Computational Creativity***.

Jordanous, Anna Katerina (2011). 'Evaluating Evaluation : Assessing Progress in Computational Creativity Research'. In: ***Proceedings of the Second International Conference on Computational Creativity***.

– (2012). 'Evaluating Computational Creativity: A Standardised Procedure for Evaluating Creative Systems and its Application'. PhD thesis. University of Sussex.

Jordanous, Anna Katerina and Bill Keller (2012). 'Weaving creativity into the Semantic Web: a language-processing approach'. In: ***Proceedings of the 3rd International Conference on Computational Creativity***, pp. 216–220 (cit. on p. 5).

Jorn, Asger (1961). 'Pataphysics - A Religion In The Making'. In: ***Internationale Situationniste*** 6.

Jurafsky, Daniel and James H Martin (2009). ***Speech and Language Processing***. London: Pearson Education.

Kamps, Jaap, Rianne Kaptein and Marijn Koolen (2010). ***Using Anchor Text , Spam Filtering and Wikipedia for Web Search and Entity Ranking***. Tech. rep. ?

Kaufman, James C. and Ronald A. Beghetto (2009). 'Beyond big and little: The four c model of creativity'. In: ***Review of General Psychology*** 13.1, pp. 1–12 (cit. on p. 7).

Kim, Youjeong and S. Shyam Sundar (2012). 'Anthropomorphism of computers: Is it mindful or mindless?' In: ***Computers in Human Behavior*** 28.1, pp. 241–250.

Kleinberg, Jon M (1999). 'Authoritative sources in a hyperlinked environment'. In: ***journal of the ACM*** 46.5, pp. 604–632.

Kleinberg, Jon M et al. (1999). 'The Web as a graph : measurements, models and methods'. In: ***Computer***.

Koestler, Arthur (1964). ***The Act of Creation***. London: Hutchinson and Co (cit. on pp. 6, 8, 9).

Kurzweil, Ray (2013). ***How to Create a Mind***. London: Duckworth Overlook.

Levenshtein, Vladimir I (1966). 'Binary codes capable of correcting deletions, insertions, and reversals '. In: ***Soviet Physics Doklady*** 10.8, pp. 707–710.

Go to TOC

Luo, Fang-fang, Guo-long Chen and Wen-zhong Guo (2005). 'An Improved 'Fish-search' Algorithm for Information Retrieval'. In: ***2005 International Conference on Natural Language Processing and Knowledge Engineering***, pp. 523–528.

Macdonald, Craig (2009). 'The Voting Model for People Search'. In: ***Philosophy***.

Maeda, John (2001). ***Design by Numbers***. MIT Press.

Manning, Christopher, Prabhakar Raghavan and Hinrich Schuetze (2009). ***Introduction to Information Retrieval***. Cambridge UP.

Marchionini, Gary (2006). 'From finding to understanding'. In: ***Communications of the ACM*** 49.4, pp. 41–46.

Marchionini, Gary and Ben Shneiderman (1988). 'Finding facts vs. browsing knowledge in hypertext systems'. In: ***Computer*** 21.1, pp. 70–80.

Marcus, Mitchell P, Beatrice Santorini and Mary Ann Marcinkiewicz (1993). 'Building a Large Annotated Corpus of English: The Penn Treebank'. In: ***Computational Linguistics*** 19.2.

Mathews, Harry and Alastair Brotchie (2005). ***Oulipo Compendium***. London: Atlas Press.

Mayer, Richard E (1999). 'Fifty Years of Creativity Research'. In: ***Handbook of Creativity***. Ed. by Robert J Sternberg. New York: Cambridge University Press. Chap. 22, pp. 449–460 (cit. on pp. 4, 5).

McBride, Neil (2012). 'A Robot Ethics: The EPSRC Principles and the Ethical Gap'. In: ***AISB / IACAP World Congress 2012 Framework for Responsible Research and Innovation in AI***. July, pp. 10–15.

– (2013). ***Robot Ethics: The Boundaries of Machine Ethics***. Leicester (cit. on p. 32).

Microsoft (2016a). ***Bing Search API***. URL: http://datamarket.azure.com/dataset/bing/search#schema (visited on 07/08/2016).

– (2016b). ***Image Search API Reference***. URL: https://msdn.microsoft.com/en-us/library/dn760791.aspx (visited on 07/08/2016).

– (2016c). ***Microsoft Translator - Text Translation***. URL: https://datamarket.azure.com/dataset/bing/microsofttranslator (visited on 07/08/2016).

– (2012). ***Bing Fact Sheet***.

Miller, George A. (1995). 'WordNet: a lexical database for English'. In: ***Communications of the ACM*** 38.11, pp. 39–41.

Minsky, Marvin (1980). 'K-Lines : A Theory of Memory'. In: ***Cognitive Science*** 33.4, pp. 117–133 (cit. on pp. 14, 15).

– (1988). ***The Society of Mind***. Simon and Schuster, p. 336 (cit. on pp. 14, 15).

Miyamoto, Sadaaki (1988). ***Information Retrieval based on Fuzzy Associations***.

– (2010). ***Fuzzy Sets in Information Retrieval and Cluster Analysis (Theory and Decision Library D)***. Springer, p. 276.

Miyamoto, Sadaaki and K Nakayama (1986). 'Fuzzy Information Retrieval Based on a Fuzzy Pseudothesaurus'. In: ***IEEE Transactions on Systems, Man and Cybernetics*** 16.2, pp. 278–282.

Motte, Warren (2007). ***Oulipo, A primer of potential literature***. London: Dalkey Archive Press.

Neeley, J. Paul (2015). ***Introducing the NEW Yossarian***. email communication.

Newell, A, J. G. Shaw and H. A. Simon (1963). ***The Process Of Creative Thinking***. New York: Atherton.

Nick, Z.Z. and P. Themis (2001). 'Web Search Using a Genetic Algorithm'. In: ***IEEE Internet Computing*** 5.2, pp. 18–26.

Nicolescu, Basarab (2010). 'Methodology of Transdisciplinarity - Levels of Reality, Logic of the Included'. In: ***Transcdisciplinary journal of Engineering and Science*** 1.1, pp. 19–38.

Partridge, Derek and Jon Rowe (1994). ***Computers and Creativity***. Oxford: Intellect (cit. on pp. 6, 13).

Pease, Alison and Simon Colton (2011). 'On impact and evaluation in Computational Creativity : A discussion of the Turing Test and an alternative proposal'. In: ***Proceedings of the AISB***.

Pease, Alison, Simon Colton et al. (2013). 'A Discussion on Serendipity in Creative Systems'. In: ***Proceedings of the 4th International Conference on Computational Creativity***. Vol. 1000. Sydney, Australia: University of Sydney, pp. 64–71.

Pease, Alison, Daniel Winterstein and Simon Colton (2001). 'Evaluating Machine Creativity'. In: ***Proceedings of ICCBR Workshop on Approaches to Creativity***, pp. 129–137.

Peters, Tim (2004). ***PEP 20 – The Zen of Python***.

Piffer, Davide (2012). 'Can creativity be measured? An attempt to clarify the notion of creativity and general directions for future research'. In: ***Thinking Skills and Creativity*** 7.3, pp. 258–264.

Poincare, Henri (2001). ***The Value of Science***. Ed. by Stephen Jay Gould. New York: Modern Library (cit. on pp. 5, 21).

Polya, George (1957). ***How To Solve It***. 2nd. Princeton, New Jersey: Princeton University Press (cit. on pp. 6, 21).

Queneau, Raymond (1961). ***One Hundred Thousand Billion Poems***. Gallimard.

Raczinski, Fania (2016). ***Emails***. personal communication. feedback for his bachelor project.

Raczinski, Fania and Dave Everitt (2016). 'Creative Zombie Apocalypse: A Critique of Computer Creativity Evaluation'. In: ***International Symposium of Creative Computing***.

Raczinski, Fania, Hongji Yang and Andrew Hugill (2013). 'Creative Search Using Pataphysics'. In: ***Proceedings of the 9th International Conference on Cre-***

ativity and Cognition. Sydney, Australia: ACM New York, NY, USA, pp. 274–280.

Ramesh, V., Robert L. Glass and Iris Vessey (2004). 'Research in computer science: an empirical study'. In: ***journaltitle of Systems and Software*** 70.1-2, pp. 165–176.

Rhodes, Mel (1961). 'An analysis of creativity'. In: ***The Phi Delta Kappan*** 42.7, pp. 305–310 (cit. on p. 6).

Ritchie, Graeme (2001). 'Assessing creativity'. In: ***AISB '01 Symposium on Artificial Intelligence and Creativity in Arts and Science***. Proceedings of the AISB'01 Symposium on Artificial Intelligence, Creativity in Arts and Science, pp. 3–11.

– (2007). 'Some Empirical Criteria for Attributing Creativity to a Computer Program'. In: ***Minds and Machines*** 17.1, pp. 67–99.

– (2012). 'A closer look at creativity as search'. In: ***International Conference on Computational Creativity***, pp. 41–48.

Schmidhuber, Juergen (2006a). 'Developmental robotics, optimal artificial curiosity, creativity, music, and the fine arts'. In: ***Connection Science*** 18.2, pp. 173–187.

– (2006b). ***New millennium AI and the Convergence of history***.

Schuetze, Hinrich (1998). 'Automatic Word Sense Discrimination'. In: ***Computational Linguistics***.

Schuetze, Hinrich and Jan Pedersen (1995). ***Information Retrieval Based on Word Senses***.

Schulman, Ari (2009). 'Why Minds Are Not Like Computers'. In: ***The New Atlantis*** 23, pp. 46–68.

Searle, John (1980). 'Minds, Brains, and Programs'. In: ***Behavioral and Brain Sciences*** 3.3, pp. 417–457.

Shattuck, Roger (1959). ***The Banquet Years***. London: Faber.

Shu, Bo and Subhash Kak (1999). 'A neural network-based intelligent metasearch engine'. In: ***Information Sciences*** 120.

Singh, Push (2005). 'EM-ONE: An Architecture for Reflective Commonsense Thinking'. PhD thesis. Massachusetts Institute of Technology.

Srinivasan, P (2001). 'Vocabulary mining for information retrieval: rough sets and fuzzy sets'. In: ***Information Processing and Management*** 37.1, pp. 15–38.

Stahl, Bernd Carsten, Marina Jirotka and Grace Eden (2013). 'Responsible Research and Innovation in Information and Communication Technology: Identifying and Engaging with the Ethical Implications of ICTs'. In: ***Responsible Innovation***. Ed. by Richard Owen. John Wiley and Sons. Chap. 11, pp. 199–218 (cit. on p. 32).

Sternberg, Robert J (1999). ***Handbook of creativity***. Cambridge University Press, p. 490 (cit. on pp. 6, 8).

– (2006). 'The Nature of Creativity'. In: ***Creativity Research journal*** 18.1, pp. 87–98.

Sutcliffe, Alistrair and Mark Ennis (1998). 'Towards a cognitive theory of information retrieval'. In: ***Interacting with Computers*** 10, pp. 321–351.

Taye, Mohammad Mustafa (2009). 'Ontology Alignment Mechanisms for Improving Web-based Searching'. PhD thesis. De Montort University.

Thomas, Sue et al. (2007). 'Transliteracy: Crossing divides'. In: ***First Monday*** 12.12 (cit. on pp. 25, 26).

Turing, Alan (1950). 'Computing Machinery and Intelligence'. In: ***Mind*** 59, pp. 433–460.

Varshney, Lav R et al. (2013). 'Cognition as a Part of Computational Creativity'. In: ***12th International IEEE Conference on Cognitive Informatics and Cognitive Computing***. New York City, USA, pp. 36–43.

Ventura, Dan (2008). 'A Reductio Ad Absurdum Experiment in Sufficiency for Evaluating (Computational) Creative Systems'. In: ***5th International Joint Workshop on Computational Creativty***. Madrid, Spain.

Vian, Boris (2006). ***'Pataphysics? What's That?*** Trans. by Stanley Chapman. London: Atlas Press.

Vries, Erica de (1993). 'Browsing vs Searching'. In: ***OCTO report 93/02***.

Walker, Richard (2012). ***The Human Brain Project***. Tech. rep. HBP-PS Consortium.

Wallas, Graham (1926). ***The Art of Thought***. Jonathan Cape (cit. on pp. 6, 21).

Walsh, Dave (2001). ***Absinthe, Bicycles and Merdre***.

Wickson, F., A.L. Carew and A.W. Russell (2006). 'Transdisciplinary research: characteristics, quandaries and quality'. In: ***Futures*** 38.9, pp. 1046–1059 (cit. on p. 36).

Widyantoro, D.H. and J. Yen (2001). 'A fuzzy ontology-based abstract search engine and its user studies'. In: ***10th IEEE International Conference on Fuzzy Systems*** 2, pp. 1291–1294.

Wiggins, Geraint A (2006). 'A preliminary framework for description, analysis and comparison of creative systems'. In: ***Knowledge Based Systems*** 19.7, pp. 449–458.

Yang, Hongji (2013). 'Editorial'. In: ***International journal of Creative Computing*** 1.1, pp. 1–3 (cit. on p. 20).

Yossarian (2015). ***Yossarian***.

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