A Framework for Creativity in Search Results

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***Abstract*—Although trying to define creativity has been a hot area of research in many fields, the field of information retrieval has remained under developed. Over the report we attempt to define a structural definition of creativity which could be applied to search results in order to aid users in their creative endeavours. After defining creativity for search, we have then devised a simple metric based upon it, to show that there is a need for this research. The results, whilst positive, could be interpreted as a poor definition of creativity, and as such this is a sounding paper for future work.**

***Index Terms*—information retrieval; computational creativity**

I. Introduction

Over the past decade search has been focused on returning the smallest number of results which correlate to the user's information need. This has been a logical trend to pursue, as 92% of people use the internet as their first port of call when looking for everyday information [1].

However, this has meant that the creativity inspired by 'surfing the web' has over time slowly diminished. This research is not advocating the end of document based search; however, we propose that a new search engine architecture, which aims to inspire the creativity of its users, can only be beneficial to the landscape of the world wide web.

Over the course of the paper, we define what we mean by the creativity of a search result, with respect to a single result as well an entire set. The concepts presented in this paper, are inspired by 'Pataphysics, a pseudo-philosophy defined as "the science of imaginary solutions, which symbolically attributes the properties of objects, described by their virtuality, to their lineaments" [2].

The rest of the paper is organised as followed. Section 2 explores definitions of creativity from both computer science and psychology. In Section 3, we outline a general definition of creativity in search, which can be used to create a metric. Section 4 will see a simplistic metric to be used for the purpose of evaluating the concept as well as some experimental data.

II. Definition of Creative Search

A. A Framework to Base Creativity Upon

Creativity is a subjective topic, with different people defining the creative worth of a piece of information differently; however, Newell, Shaw and Simon [3] devised a definition based upon four criteria to categorise the creativity of a given solution or answer.

1) The answer is novel and useful (either for the individual or for society)
2) The answer demand that we reject ideas we had previously accepted
3) The answer results from intense motivation and persistence
4) The answer comes from clarifying a problem that was originally vague

Each of these criterion for creativity approach a definition from a different perspective. Whilst trying to relate this to information retrieval, it should be simple to see that criterion 1 relates to the goal of the search, whilst criterion 4 relates to the information need, or starting point. What may be less obvious however, is that criterion 3 relates to the scale of the search and hence the number of dead ends that may be encountered and that criterion 2 suggests which search paths should be avoided whilst looking for creative results.

Whilst this framework gives us a very high level definition of creativity, it is hard to apply it in its current form. Through applying some of the more prevalent techniques used in the field of computational creativity, we can attempt to reduce this down into a more precise definition.

B. P-Creativity and H-Creativity

Boden [4] defines that there are two forms of creativity, P-creativity and H-creativity. P-creativity or *'psychological'* creativity, is an idea or solution that is new to the person who came up with it. An idea that represents *'historical'* creativity, H-creativity, on the other hand, is one which has not been thought of by anybody before and can therefore be deemed a historical-sociological category [5]. H-creativity is subsequently a special case of P-creativity which many people consider to be the more important of the two, as this is what drives forward human knowledge.

When we relate these concepts to search results we end up with some interesting outcomes.

1) Single Search Result: A single search result is most likely to be P-creative or neither. This is because, for it to be H-creative, there must be some logic in the document that nobody else has noticed, or drawn the same conclusions from different information. For the single result to be neither P-creative or H-creative, the user must have a thorough understanding of the topic, and the result must add no new information.

2) Set of search results: A set of search results is most likely to be P-creative. It is highly unlikely that a user would

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have explored every possible creative avenue over a set of results, unless the set is not of a trivial size. But by the same logic, if a large range of ideas are contained, it is unlikely that the set will be H-creative, as somebody is likely to have linked them together.

The question becomes, is there a link between maximising the chance of something being P-creative and H-creative or is the link more subtle. Or is it enough for a search engine to try and improve the chances of P-creativity for a user.

C. Exploratory and Transformational Creativity

Boden [4] goes on to define the concepts of exploratory and transformational creativity. She defines exploratory creativity to be the exploration of a space of partial and complete possibilities. This therefore suggests that there are rules that confine this space. If we were therefore to alter the rules that define the space, and subsequently alter the space that we are exploring, this is defined as transformational creativity [6].

Whilst this does give us a nice slant to look at creativity, comparing the trade-off of traditional problem spaces compared to augmented ones, this is very difficult to model, combined with the fact that the solutions found by tweaking the rules that confine the space can easily rule out the solution in the traditional space [7].

D. Bisociation

Bisociation makes a distinction between the routine skills of thinking on a single 'plane', and the creative act, which operates on more than one plane [8]. This means, with Koestler's definition, that we must define creativity as a set of results such that they are simultaneously associated with two habitually incomparable contexts.

It is clear to see how this model extends from that of Boden's theory of exploratory and transformational creativity. The fact that more than one 'plane' must be considered will force a transformational process to occur. However, unlike transformational creativity, both processes must be considered, the exploratory and transformational. Subsequently, we should not end up with a solution that can't exist within the rules defined by the original problem, even if we transcend into transformational creativity, as long as we finish the process in the plane that we started in.

E. Conceptual Blending

The idea of combining different thought processes, whilst more elegant than transformational creativity, does not give us a nice definition that applies to search results as well as tying in with our underlying philosophy. Conceptual blending is a step closer. This general theory of cognition, formally called Conceptual Integration Networks [9], allows us to look at a number of different dataspaces, and attempt to 'blend'/merge them in such a way that the new dataspace tries to simulate how we use large amounts of information and bring it together to form new ideas.

F. Combinatorial Creativity

Both of the above concepts fall into the general category of combinatorial creativity. This is a logical assumption of modelling creativity, as people tend to come up with solutions by first looking at new combinations of currently existing ideas. This therefore allows us to consider the idea of creativity as a search process through the space of all possible combinations, therefore this fits into the idea of search engines.

Whilst conceptual blending explores the idea of combining different thought processes and bisociation, looking at different planes of creative thought; let us consider the idea of placing the data itself into different concepts, enabling us to get the following areas of combinatorial creativity to explore with respect to creative search based upon philosophical.

- Placing a familiar object in an unfamiliar setting or placing an unfamiliar object into a familiar setting.
- Blending two superficially different objects or concepts
- Comparing a familiar object to a superficially unrelated and semantically distant concept
- Searching through a number of different concepts that are related to each other but could be considered as swerving away from the original concept. This is based upon Epicurus's theory of clinamen from his doctorine of atomism [10].

III. Definition

The above definitions, allow us to define creativity in search results with pre-existing concepts agreed by the academic community.

It is clear, that in the case of search results, we still have the issue of a group of results providing greater creative inspiration to one user than another. This tends to be a problem with most metrics, the problem of objectiveness vs subjectiveness. With subjectiveness being a quality that is important, it means that we have a problem getting repeatable results. We therefore need to build a definition that is as objective as possible, whilst not overlooking some of the dynamic properties that it may be possible to model.

At this stage it is important to stress that this is not an attempt to model the creative process, but to give a model for how useful a set of results might be in inspiring creativity.

A. A Single Result

It is intuitive for us to start with a single result. Whilst maximising the possibility for a single result being H-creative, it is very unlikely that this will be the case with a full set of results. The issue becomes, measuring how P-creative an individual result is to a search result.

It seems sensible to assume, that if a result has no relevance to the search request, then the result will have no chance of inspiring P-creativity. The more information about the search request a single result has, increases the chance of a result inspiring P-creativity, therefore using relevance metrics.

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B. Set of Results

To improve the chances of inspiring creativity, a group of related results which discuss a number of different areas of the topic would logically improve the quality of the results. As stated, if we maximise the breadth of information of a single result it would improve creativity, we should therefore attempt to do the same across the entire set.

The issue however, is that the majority of users do not look past the top 10 search results [11]. Whilst this is unlikely to be the case for people using a search engine targeted at inspiring creativity, it does make sense to try to reduce the overall amount of data provided. We must therefore penalise repetition in the results provided, forcing a more diverse set of results.

This can be taken a step further by only considering a certain number of results and ignoring the ordering, because there is no simple way to define how ordering affects the creative process. With a lack of defined ordering, it means that having endless results would be tedious and counter-productive. Whilst we have no strong view on the exact number of results that should be considered, we believe that it should not be substantially greater than 10, for the reason discussed above.

The way that each result is provided to the user will affect how the user perceives the results. A diversity of different document types, e.g., text, images, sound, we believe would improve the quality of creativity inspiration.

C. Results as a Set of Sets

We could extend this concept to the next logical step of returning results as a set containing multiple related sets of results. In this analogy, each of the inner sets could relate to an individual concept related to the information need, and a clearer relationship between concepts, how they relate to each other and how the results represent the concept they are contained within would exist.

The question becomes how we measure the creative quality of this type of result. Due to the structure of the results, we can attempt to model the creativity in different levels allowing us to try and abstract the problem as much as possible.

Due to the fact that this is not a method that is currently used to return search results, we shall not explore it further at this point in time. However, we believe that this would be a logical way to return results in the future.

IV. Example Metric

As the above definition is meant as a guideline for defining creativity, this section attempts to give a real world example. The metric defined below is a contrived example to show how it could be applied with current search results.

A. Algebraic Definition

Taking the definition defined in Section III-B, we have derived the following abstract metric.

Let us define a query as q, a set of results as r and an individual result as d. As such $r = \{d_1, d_2, d_3, ..., d_i\}$ where i is the number of results examined.

For the quality of a single result, we shall define $P(q, d)$ as a measure between 0 and 1, where 1 is the optimal value.

To reduce the amount of data duplication in the returned results, we shall define $D(r)$ which has to return a value between 0 and 1, where 0 means that no data is duplicated.

Let us define $T(r)$ as a way to weigh the final outcome of the metric to ensure that a diverse set of document types are returned. This metric will return 1 if a satisfactory balance is returned, and 0 if only a single document type is returned.

We can therefore compile these measures into a single metric, the Search Creativity Metric or SCM:

$$SCM = T(r) \cdot \tfrac{1}{i} \sum_{j=1} P(q, d_i) \cdot (1 - D(r))$$

As such, this metric will always return a value between 0 and 1, with 1 being the optimal value.

B. Fleshing Out the Metric

To enable us to apply any experimental data to the metric, we must first give definitive definitions to each of the functions provided above, $P(q, d)$, $D(r)$ and $T(r)$.

1) D(r): As this measures the number of duplicate results in a return set, we can easily define it as the number of results that have a majority of information that is contained within another article. This allows the following definition

$$D(r) = \frac{Numberofresultswithdatainpreviousresults}{Numberofresults}$$

As we relate each result to the previous results in the list, the results must always be $0 < D(r) \leq 1$. This makes sense, as even if all of the results are identical, there may still be some creative inspiration contained in the first result. This also allows us to penalise results heavily for leaning too much on one area of information.

2) T(r): As with $D(r)$, we need to define this measure so that we penalise for a lack of diversity, but do not eradicate all results, as this would not reflect the possible creative quality of the information returned.

For this definition, we will need to leverage on the definitions provided earlier. Let i is the number of results within the result set r. We can therefore define n to be the number of different result types that are returned, and σ to be the standard deviation of the number of results for each media type. It is interesting to note that $0 \leq \sigma < \frac{i}{2}$, such that $\sigma = \frac{i}{2}$ means that the results are biased to only one result.

$$T(r) = \begin{cases} 1 - \frac{2 \cdot \sigma}{i} & : n > 2 \\ 0.1 & : n \leq 2 \end{cases}$$

For the case of this sample measure, we have defined that for a result set to be considered to be broad enough, that it must contain at least 3 different media types. This measure has no empirical backing.

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TABLE I: Example Results

URL	$P(q,d)$	Reason
www.unicorn-darts.com	0.3	Company called Unicorn due to the single point on a dart
en.wikipedia.org/wiki/Unicorn	1.0	Contains mythology as well as related animals
www.unicorn-grocery.co.uk	0.0	No relation to unicorns
www.unicorn theatre.com	0.25	Uses the mythology of unicorns to draw children into theatre
http://katemckinnon.files.wordpress.com/2008/07	0.7	Image of a unicorn but purely as a distraction from the rest of the article
http://www.unicorncentre.co.uk/	0.9	Unicorn mythology about the soul applied to a spiritual ideal including image
http://31st-and-chi.blogspot.com/2010/07/bunch-of-pictures-of-unicorns.html	0.9	Large array of unicorn pictures. One is identical to result 5.
http://disgrasian.com/2010/09/unicorns-really-do-exist-and-theyre-asian/	0.9	Picture of unicorn and asian 2 horn unicorn.
http://www.youtube.com/watch?v=Q5im0Ssyyus	0.4	Comedy cartoon video about unicorns.
http://www.youtube.com/watch?v=v25MaXwopNI	0.8	Music for a cartoon character.

3) P(q, d): With respect to the relevance of an individual result compared to the information need, there are a number of different methods that could be used. For example, keyword analysis in text documents and image recognition in images, it is clear that a separate method would be needed for each media type that is returned.

With this in mind, for the example below, the individual relevance of a given result will be manually determined and a brief explanation given. The focus will be more on the relevance of the result to the information need, with some weighting given if there is a creative link.

C. Experimental Data

To show this metric in practice we will need to get real world data about a topic. We have used Google to search for results on the following creative need - unicorns from Greek mythology.

The search term input into Google on Thursday 12th May was 'unicorn'. Below is a table of a url to each result, their assigned P rating and a brief description of the reason why. We have taken the top 10 results including the first 4 images and videos.

Due to the repeated result in result 4 and 6, $D(r) = 0.1$ and $T(r) = 1 - \frac{2 \cdot 0.94}{10} = 0.812$. If we then feed these results into the SCM metric we get.

$$SCM = 0.812 \cdot \tfrac{1}{10} \cdot 6.15 \cdot (1 - 0.1) = 0.449$$

A 0.449 result for us represents a set of results that contain some creative merit, but which also could be improved. This result could be enhanced, based on this metric, if four of the results were to have been replaced with more relevant results.

We still need to understand whether the low result is due to the fact that the results are not inspiring creativity as we presume, or that the definition that we have provided is not complete and that we need to extend it further. It is planned, that we take this research further to answer the question using in-depth empirical analysis.

V. Conclusion and Future Work

Over the course of the report, we have attempted to define what we mean by creativity with respect to search engine results using the concepts from computational creativity. The definition is focused more on the structure and relationship between the results returned than the content of the results themselves. This will allow us to define this separately after carrying out further experiments.

This is evident from the metric that we generated to show how the definition could be used. We believe that the low result shows that the return set does not have a high creative merit; however, more testing will be needed to check whether this is the case, or whether the definition needs to be redefined.

We believe, that whilst this paper has little empirical backing, it has highlighted a short fall in the information retrieval domain, namely that of creative search. Even from the simple test that was conducted, it is apparent, that even when we reach a metric for measuring the creative quality of results, a new form of search engine will be required to achieve top quality results consistently.

The next stage of the research will focus on applying what we have learnt and combine quantitive and qualitative analysis to try and develop a new metric with a strong empirical backing. This means that our definition of creativity will likely need to be adapted over time; however, this could allow us to develop a metric that evolves over time to adapt to what the users consider to be creative search.

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