A COMPUTATIONAL ANALYSIS OF IMAGERY IN JAMES JOYCE'S A PORTRAIT OF THE ARTIST AS A YOUNG MAN

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This paper describes an attempt to analyze as comprehensively as possible the imagery of James Joyce's A Portrait of the Artist as a Young Man. In addition to pointing out esthetic, thematic, and structural patterns of imagery in the text, the analysis argues 1.) that there is a definite quantitative relation between the "richness" of imagery in passages of text and the moments of epiphanal transition in the development of Stephen's personality and 2.) that the evolution of his mind can be traced by defining the changing patterns of associations among images over the course of the novel.

The work described in this paper represents an attempt to use the computer as an aid in approaching a major work of literature as comprehensively as possible. Although the computer has been used for humanistic research with success before, most applications have focused either on minute aspects of the work - such as the distribution of function words over several passages of text for the purpose of author identification - or on gross patterns of style or content - Hannan Selvin's and Josephine Miles' innovative work in factor analysis of vocabulary is a good example of this approach. My own work differs in that it attempts to establish an hypothesis through traditional, literary-critical methods, translate that hypothesis into a set of quantitative models and procedures, perform the analysis and interpret the results within the terms of the models, and, finally, present those results in a statement that is once more understandable to the community of literary scholars. Too often the computer has been used to count the occurrences of a particular word or a particular pattern just because it could count them. The reports of such work inevitably lacked a context for the traditional humanistic scholar and they have been ignored or rejected by them as distasteful and meaningless. If the computer is to be used widely in these areas, the computational procedures must be carefully fitted to the substantive questions that interest this group--gradually the questions will change but only after the machine has attained the full respectability that is just beginning to emerge in the Humanities. Thus, my own efforts are likely to have more impact on the humanistic disciplines; however, there are ramifications that may be of interest in the fields of information retrieval and content analysis. In the remarks that follow I will describe briefly the methodology and models that were used and examine some of the more general implications.

James Joyce is a particularly apt author for a computational analysis. In addition to the obvious and undeniable surface intellectuality of his prose we know that he used a number of charts and diagrams of image relations during the composition of Ulysses. Thus the critic is justi-fied in drawing structural and thematic inferences from the patterns of words on the page. I chose the Portrait to work with because it is the first of Joyce's novels and a natural place to begin, less massive and more manageable than Ulysses or Finnegans Wake, and interesting in its own right. To analyze these latter works of Joyce, one would probably have to focus his study at the level of word and syllable, respectively; however, the Portrait deals largely with the developing psyche of Stephen Dedalus in its relation to its physical and social environment. It is reasonable, therefore, to use the image as the fundamental unit or atom for analysis. This choice is further substantiated by the discussion in Chapter V of the novel in which Stephen develops an esthetic theory in terms of the three stages of sensual perception and relates them to a definition of Image.

Although Stephen defines the term, Image, as essentially an epiphanal experience -- he uses this term for the phenomenon in the earlier Stephen Hero -- only a few critics, such as Frank Kermode, have followed his lead. Others, Caroline Spurgeon, for example, have defined it as any word or detail of sensual experience -- such as red, or loud, or bitter. Between these two extremes there are numerous other definitions of image that exist within the tradition of literary criticism. Perhaps the most immediate implication of undertaking a computational analysis of this sort is that the researcher must define explicitly his assumptions and resolve such conflicts that exist within his discipline. I felt no necessity to accept Stephen's definition; however, I found that through a close, conventional literary-critical examination of the esthetic theory I could develop an hypothesis that would resolve the conflict concerning the definition of the term but which would need to be verified empirically in the novel.

Very briefly, the argument goes like this. The common ground between the experiences of the artist and that of the reader is the phenomenological interface between subjective experience - continuity of the personality at the moment of apprehension - and objective experience - the psychological level of sensual perception.

All perceptions of objects include three steps: the isolation of the object from the non-subject, the analysis of the parts of the object both among themselves and in relation to the whole, and finally the stage of recognition and awareness of what the object is. These three steps, which Stephen categorizes as wholeness, harmony, and radiance, are present in all acts of perception; but clearly all acts of perception do not involve the same level of emotional intensity. From the context, we can infer that the greater the complexity and diversity of the components of the object the greater the impact on the personality when they are "seen" to fit into a composite. Often in actuality the process is organic: the perceiver responds to his experience and focuses more attention on it which, in turn, emcompasses a greater diversity of material, which develops greater emotional response and involvement, etc. until the experience climaxes in an epiphanal experience. The results of this argument can be summarized in the following hypotheses: 1) there should be a quantitative relation between the density in the text of "important" images of sensual detail and the moments of epiphanal development in Stephen's personality; and 2) we can essentially trace the development of Stephen's mind in a schematic-like way by tracing among these sensual images the changing patterns of associations that develop over the course of the novel. Clearly, if substantiated, the first hypothsis resolves the conflict between the two major poles of thought concerning imagery in literary criticism, and the second gives us a model for Stephen's mind that can be verified empirically. Before discussing the process of translating these hypotheses into viable computer models and procedures I will describe briefly the major "housekeeping" steps that were taken.

The novel was keypunched in its entirety virtually as it appears in the text, one line of text per card, except that blanks were inserted between words and succeeding, syntactic marks of punctuation to facilitate scanning. The text was then scanned and separated into records with one text word per record along with a number that indicated its linear position within the text. (The first word was numbered one, the second two, etc. until 98,000 and some odd.) These records were sorted alphabetically and grouped according to root form so that words such as burn, burning, burned, etc. could be considered the same basic image. (Modified versions of S. Y. Sedelow's INDEX and SUFFIX programs were used to perform these steps; all programs that follow, except for statistical utilities, are original.) From a printed listing of this data set I selected the words that I considered to have sensual or known thematic value; admittedly, my selections are arbitrary, but the list is available, it has been considered reasonable by other literary critics, and it exists axiomatically for the study. These words or images along with the index information for each token or occurrence were built into the following data organization, as in Figure 1. By using this organization, images could be grouped thematically, and all occurrences of an image are conveniently avail-
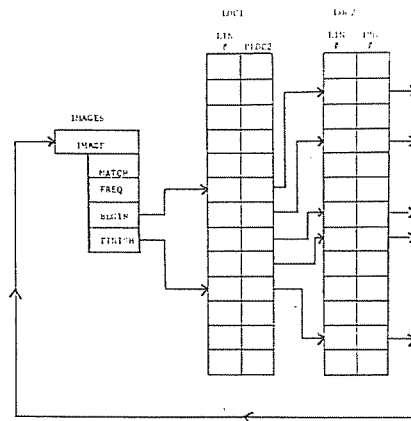

Figure 1: Basic data structure for images.

able for analysis of distribution along with their textual context. With the imagery of the novel represented accordingly, I was ready to begin the actual analysis.

To evaluate the hypothesis that there should exist a quantitative relation between density of "important" sensual images in the text and the moments of epiphanal transition in Stephen, I developed the following model. For a measure of "importance" it was asummed that images that occur more frequently in the text are generally or statistically more important than less frequent images; consequently, a weight of the total text frequency of an image type was assigned to each occurrence or token of that image. To quantize the density a geometric model was used. Each image type was associated with a vector orthogonal to all other image vectors. For the 1312 image types in the novel this resulted in a space of dimensionality 1312 -- awkward to visualize but easily manipulated algebraically. For each section of text for which the density of richness of imagery was to be measured, a point in this hyper-space could be defined by the n-tuple $(a_1, a_2, ..., a_{1312})$ where a_i is the number of times image (i) occurred in the section of text. To keep the dimensionality of the space from collapsing for text sections where some images do not occur and to include the "weighting" factor, a mapping function was defined as follows:

$$(a_1, a_2, ..., a_{1312}) \rightarrow (f_1{}^{a_1}, f_2{}^{a_2}, ..., f_{1312}{}^{a_{1312}})$$
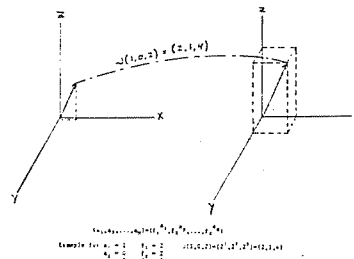

Figure 2: The mapping function, ν

Where f_i is the total text frequency of image(i).
A measure of relative density can now be calculat-
ed by computing the volume of the parallelapiped
formed by projecting this point onto the axes of
the space. Because of the orthogonality of the
space, the algebra is greatly simplified; and the
volumn of this solid is merely the product of the
diagonal elements of the matrix representation of
the projections. Practically, the computation of
this value is just the accumulated product of the
total text frequencies of all occurrences of
images in a section of text.

A distribution of the relative richness of
imagery of the novel was obtained by computing
such a value for each linear segment of 500 words
of text. A logarithmic plot of the results looks
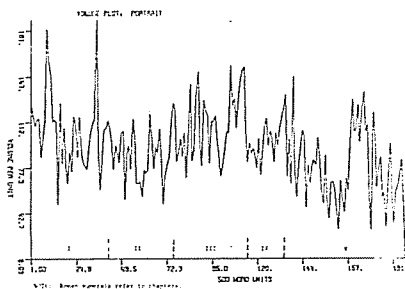like this:

Figure 3: Plot of richness of imagery.

The richest section of the text is the traumatic
pandybat episode of Chapter I where Stephen is
unjustly punished; other high points on the graph
correspond with Stephen's initial experiences with
sex, an emotionally intense religious retreat and
a succeeding experience of religious ideality, the
esthetic experience on the beach in Chapter IV,
and Stephen's dream and the corresponding compo-
sition of the villanelle in Chapter V that marks
his decision concerning his vocation. These are
clearly the moments that mark major transitions in
his development; thus, the close correlation be-
tween them and the marked increases in density of
imagery in the text corroborates the first hypo-
thesis.

To trace the development of Stephen's person-
ality by tracing the changing patterns of associ-
ations among images, a number of models and
computer procedures were used. First, association
was defined as textual proximity. Since the en-
tire novel is developed from the point of view of
Stephen's experience, it was assumed that images
that occur close to one another a number of times
in a chapter or section of text are associated in
terms of his experience. Gross patterns of asso-
ciations and shifts in the matter of experience
were determined by sorting the images in decreas-
ing order of frequency for each of the five chap-
ters. To sharpen the focus and develop more subtle
patterns of associations, the text for each chapter
was divided into 50-75 word intervals, depending
on the length of the chapter, and the occurence of
each of the some 75-100 most important images of

the chapter was computed for each such interval.
This data was fed to a principal component pro-
gram. The factors that resulted reflected the
tendency of certain images to occur close to-
gether over a particular chapter. By examining
the clustering tendency of images in various
factors for each of the five chapters, I could
infer changes in the associative relations among
images. To verify and develop leads suggested
by these procedures, an image concordance was
produced in which each occurrence of each image
was listed with the five images on each side.
With the text representation described earlier,
this was virtually a trivial task, the main logic
consisting of merely three nested do-loops.

A sample of the kinds of patterns found can
be seen in the associative relations of the fol-
lowing four image groups: bird, eye, fire, and
water. From the first page of the novel, eye
and bird are associated in Stephen's mind with a
very strong note of fear and feelings of physical
inadequacy. This pattern is evident in the re-
frain, Pull out his eyes/Apologize, when Stephen
refuses to apologize for some pecadillo. This
association is re-enforced very early in the
second scene of the novel when Stephen, standing
on the edge of the playing field at the boarding
school at Clongowes, looks up and sees a ball
flying through the air "like a bird." Stephen
is unable to join the play because of his weak,
watery eyes.

Fire and water carry exactly opposite connot-
ations in the first chapter. Water is indelibly
associated in Stephen's mind with his traumatic
fall into the school cesspool. In direct con-
trast, fire is associated with memories of home
and the security of the hearth. The two appear
in direct contrast to one another a number of
times in this chapter.

All four groups of images converge in the
pandybat scene at the end of the chapter when
Stephen is unjustly punished. When the pandybat
strikes - it was earlier explicitly associated
with the bird image, turkey - "scalding" tears
burst from his eyes. Scalding, of course, repre-
sents a virtual fussion of fire and water. From
this point these images carry not the simple
associations seen until now but much more complex
and diverse connotations. Eye and fire become
the dominant images of Chapter IV and function as
polar opposites just as fire and water did in
Chapter I. In this middle chapter, fire is asso-
ciated with the realistic horrors of hell in the
retreat sermons in direct contrast to the ideal-
ity of God symbolized by light and directly re-
lated to eye images in Stephen's mind.

In Chapter IV we see the other pair, water
and bird, strongly related in the images of
Icarus flying heavenward from the sea just prior
to the esthetic experience on the beach. As
before, this connotatively distanced pair is
literally fused in the image seabird used to
characterize the exact moment of epiphany for
Stephen. With the ultimate resolution of inner
and outer, subject and object that is attempted
abstractly and esthetically in Chapter V we might
see all of these strains converging into one

hyper-complex unity of experience.

   To help demonstrate these patterns of inter-
action, smoothed distributions of major thematic
groups of images were produced. The patterns of
interrelation between fire, water, and religious
imagery is evident in the following:

Figure 4: Fire imagery in Portrait

Figure 5: Water imagery in Portrait

Figure 6: Religious imagery in Portrait

   The final phase of this work that I will de-
scribe concerns an attempt to represent the asso-
ciative structure of images by a thesaural-like
ring structure. In dealing with the first section
of the novel, it becomes evident that there is a
direct, cognitive relation between succeeding
images. By hand, I have fitted these into the
following ring structure, as shown in Figure 7.
The complex clearly consists of three distinct
sections, but the three sections of the narrative
are held together by repeated references to father

and to song. Currently, I am attempting to have

Figure 7: Linear associations of imagery
           in section 1.1 of Portrait.

the computer construct a similar representation
for the entire novel. If this can be done, the
result should be a satisfactory and exact model
of associative structure just as the richness
model discussed earlier is exact and well-defined.

   In closing, let me summarize briefly what I
consider to be the importance of this work. First,
I feel that it is a legitimate effort at literary
analysis that uses the computer as a controlled
and directed tool but which in turn is benefici-
cally influenced by the computer in particular in
the matter of defining of terms and assumptions
and in rigor of methodology in general. If the
work can stand as legitimate literary criticism it
should provide an important boost in incentive in
the effort to educate humanists in the use of com-
puters. The need for such respectability can
hardly be overemphasized at the present time.

   Secondly, some light has been shed on the
problems of text representation, accessing, and
categorizing of elements, to name a few. I hope
to discuss these matters in considerably more
depth soon in a book devoted to techniques and
methodology for computational analysis of language.

   Thirdly, there are implications for informa-
tion retrieval and content analysis in general.
The model of richness is essentially a method of
quantizing "content" according to a fixed set of
weights. This method could easily be extended to
a retrieval system. Computation of the relative
value is extremely easy to program and quite fast.
The system could, then, produce a "distribution"
of document relevance values for a given set of
"content" weights without resorting to the slow
and costly correlation techniques now widely used.

   Finally, I think we can look forward to in-
creasing and, hopefully, productive communication
between disciplines that have formerly maintained
considerable distance from one another. As in-
dividuals begin to span this gap and attempt to
explain the basic assumptions and problems of one
discipline to members of another, the effort and
the feedback should be very stimulating. Such
efforts can only be beneficial for all concerned.