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The Penumbra-line: Ranganathan’s journeys and the genesis of the APUPA pattern

Abstract
This paper studies the background that may have influenced how the APUPA pattern was defined. It reveals how Ranganathan developed relationships with protagonists in the pragmatist movement and companies looking for answers to the problem of information overload. This work thus refines our understanding of the APUPA pattern, allowing it to be placed among the archetypes of new digital media, besides offering ideas for renewing information retrieval.

1. Classification and Communication
S.R. Ranganathan’s book, Classification and Communication, highlights how “container modularity”, which characterizes media like books, complicates their perceptibility (Ranganathan 1951, sect. 22-27 and 31).

Enlosing communication in containers guarantees the best transmissibility and storability, but, at the same time, requires a decoding activity, thus creating conditions for a paradoxical risk:

The quantitative strengthening of the channel transmits a large amount of information that, however, is not effectively usable; this ends up overloading the capacity for human processing (Ranganathan 1951a).

Ranganathan adheres to John Dewey’s analysis that the solution to overload risk is in large part a matter of depth; how deep we are willing to penetrate the bottomless pit of information:

Sometimes slowness and depth of response are intimately connected. Time is required in order to digest impressions, and translate them into substantial ideas. “Brightness” may be but a flash in the pan (Dewey 1910, 37).

Ranganathan’s proposal is based on an acute analysis of the articulation of user interest at different levels:

The boundary-line between irrelevant and relevant records is not sharp and clear-cut. Various degrees of intensity are possible...A totally or intimately relevant record may be called “Umbral Record” A partially irrelevant. “Penumbral Record” ... A totally irrelevant... “Alien Record.” (Ranganathan 1951a).

He imagines that a renewed classification can produce the decisive “transformation” from an indistinct flow to a deeply personalized one; it can do so by arranging records in an APUPA order:
should be arranged in a helpful order—i.e., in the order Alien, Penumbral, Umbral, Penumbral, and Alien so that all the most relevant records are in the centre and the others records stand fanned out on either side of the centre in decreasing order of their relevance (sect. 321).

Figure 1: APUPA is often imagined as a bell curve

The title of section, “Classification will have a future as a means of communication” (1951a, sec. 325), summarizes this vision: classification activity as a medium.

Classification is thus a transformation of thought. This change in arrangement from accession or random order to APUPA order is itself a subsidiary transformation. It is the first use of classification in the process of communication. The transformer is the classifier. The means is the Classification Scheme. (sect. 3212)

The communication flow of the new medium is schematized in Figure 2, recalling Shannon and Weaver’s model of communication.

Figure 2: Ranganathan’s communication model

We will now study the development of the issues which seem to have played a role in the genesis of the APUPA pattern.

2. Education in an accelerating society: Dewey

In 1920 John Dewey visited Madras and met the secretaries of the Madras Teachers’ Guild; Ranganathan was among them, working as a young math teacher.
In the early 20th-century, India experienced strong productive growth; accordingly, Ranganathan reported a very substantial list of new media reaching Indian students (1973 para. CB2).

In *How We Think*, Dewey (1910) repeatedly highlighted the risk of “overloaded curricula.” The book “New Education and School Libraries”, first published in 1942, is the clearest proof of the importance Ranganathan gave to Dewey’s new education ever since *School and Society* (Dewey 1899). It is a work that Ranganathan calls an “epoch-making book”, from which he reproduces – and is proud to republish (1973, chapt. DH) – the map of an ideal school (1899, 95); significantly, the library is at the center of the school, close to daily processes, where cognitive needs emerge.

![Figure 3: Map of a school (Dewey 1973, 95)](chart3.png)

Ranganathan adopted Dewey’s “individual education” methodologies in the classroom, with very good results (Bianchini 2006, 14), but he was essentially misunderstood by his superiors, who judged the endless lists of books he required for his students to be “extravagant”.

Ranganathan’s sudden change of profession, abandoning teaching to become a librarian, can also, to some extent, be attributed to the context of a movement to reestablish schools and libraries, based on “individual education” and “autonomous learning”.

In this way, we can imagine the spirit with which he left India. The principal biographers of Ranganathan highlight the intercontinental journeys (1923-25 and 1948-50) as turning points in his life, presenting many common traits, masterfully synthesized in the conspectus of the book *Philosophy of Library Classification* (Ranganathan 1951b):
• two radical changes in his vocational life (from mathematician to librarian and arrival at retirement);
• two long sequences of visits to innovative projects such as community reading centers and business documentation centers;
• two great crises due to awareness of the inadequacy of the available classification theory for the demands of innovative experiences and of post-war economies:
• two great visions allowing him to overcome these crises, revolutionizing his classification theory: Colon Classification and APUPA pattern;
• two or three decades of patient work after each journey to turn such insights into true classification theories;

The two World Wars changed information flows:

From several sides we tried to deal with information flows increasing for quantities, specialization and diversity that followed the acceleration triggered by the World Wars and by a growing post-war “economy of team-work on a large scale” (Ranganathan 1951, sect. 286).

The book *MicroThought and his Service* (Ranganathan 1957) reports difficulties that Frits Donker Duyvis (president of the International Federation of Documentation) encountered in proposing the new classification logic to those who could implement them in new electronic systems.

Duyvis asked for Ranganathan’s help in the search for solutions to the problem of micro-document information overload.

In particular “micro subjects embodied in articles in periodicals or scientific reports” (Ranganathan 1967a, sect. XG14).

Ranganathan’s experience in the United States in 1950 seems equally fundamental. Here too he was invited by UNESCO and the United Nations, as well as by a very large private company, The Rockefeller Foundation. With precise objectives Ranganathan specifies explaining why he accepted the invitation:

It was accepted chiefly to observe documentation in action at close quarters in several industries in the USA. But it was learnt that the purpose of the Foundation inviting me was to explore the role of classification in communication (Ranganathan 1963, 18).

From these elements we can try to make another significant leap in our understanding the APUPA pattern: we now attempt to follow a logical-philosophical plan, adopting an intuitive approach, based on two lexical hints.

**3. Penumbra in Philosophy and Psychology: Whitehead, James, Wundt, Leibniz**

The first hint is the choice in the APUPA acronym of the *Latin calque* "umbra" instead of the primary form "shadow". As a classification expert, he was surely aware of the connotation of such a word, which was preserved in the context of specific scientific disciplines.
Two decades earlier, Alfred North Whitehead had built on the term “penumbra” a system of metaphors overturning the representation of consciousness, putting in the center what was usually present only "in shadow";

there is a small focal region of clear illumination, and a large penumbral region of experience which tells of intense experience in dim apprehension….consciousness is the crown of experience, only occasionally attained, not its necessary base (Whitehead 1929, 267).

Thus, he re-issued the challenge of the pragmatist renewal, which four decades earlier William James had issued to the "empiricist" creed of the motherland:

the ridiculous theory of Hume and Berkeley that we can have no images but of perfectly definite things…whilst simple objective qualities are revealed to our knowledge in subjective feelings, relations are not.

On page 258 of "Principles of Psychology" James had written:

If we then consider the cognitive function of different states of mind, we may feel assured that the difference between those that are mere acquaintance…is reducible almost entirely to the absence or presence of psychic fringes or overtones. Knowledge about a thing is knowledge of its relations. Of most of its relations we are only aware in the penumbral nascent way of a fringe of unarticulated affinities about it. The traditional psychology, talks like one who should say a river consists of nothing but pailsful, spoonsful, quartpotsful, barrelsful, and other moulded forms of water. Even were the pails and the pots all actually standing in the stream, still between them the free water would continue to flow. The significance, the value, of the image is all in this halo or penumbra that surrounds and escorts it. Represented by a curve, the neurosis underlying consciousness must at any moment be like this:

![Figure 4: The height of the curve above the line stands for the intensity of the brain processes](image)

4. Penumbra in Optics and Astronomy: Kepler, Wundt, Helmholtz

The second hint is based on a counterintuitive pattern: the choice of a progression "from penumbra to umbra", unusual when compared to progression “from shadow to light.” Ranganathan himself often uses "enlightening analogies.” Pragmatist representation also contemplates progression "from umbra to penumbra", but the fruit of the “concrescence process” is the production of something new (named “actual entity”), rather than the recognition of something already existing and its fruits, i.e. “clarification”, “enlightening”.

Consciousness is only the last and greatest of such elements by which the selective character of the individual obscures the external totality from which it originates and which it embodies.
Hence, such counter-intuitiveness reduces; that is, the selective nature of the individual aim obscures the external totality. This is comparable to what happens with “exclude-filters”, where information is created by exclusion from the whole, by obscuring its possibilities. As in the “subtractive color synthesis” process that was studied at that time to understand how the retina works, white light is given off when a surface (or pigment in a painting) reflects all frequencies, but there is total blackness when no frequencies are reflected, while different colors are produced when surfaces retain different parts of the frequency spectrum. As we will see in the next paragraph, the academic discipline of optics was contemporaneously studying these subjects.

The structure of the prehension-apprehension binomial seems to be a clear reference to the Leibnitian “perception-apperception” binomial, reactivated by the progress that the theories of perception had made during those years in Germany; in the 1860s Helmholtz, Young and Max Schultze introduced the "duplicity theory", the discovery that in the retina there were two basic types of photoreceptors, with separate visual functions:

- cones (photopic vision): many small containers, acuity and color vision in bright conditions; one or a few photoreceptors synapse on one neuron;
- rods (scotopic vision): a few larger containers, less colors; sensitivity in dim light, many photoreceptors synapse on one neuron.

Figure 5: “Bell” distribution of receptors on retina

This pattern recalls that which APUPA uses for a common strategy of message selection. The birth of the discipline “psychology” originates from this context. William James had studied Helmholtz, as had Wilhelm Wundt, who in Leipzig managed the first laboratory devoted to the study of mental processes and experimentally measuring them. In the city of Leipzig, two centuries earlier, Leibniz had anticipated this approach with the concept of “small perception”.
Yet, the continuum influencing development of the penumbra idea seems to go even further back.

In 1604, Kepler had written an important book about the application of optics to astronomy entitled “Ad Vitellionem paralipomena quibus astronomiae pars optica traditur.” The possibility of measuring the trajectories of celestial bodies is strongly linked with the ability to control perceptive distortions.

A penumbra causes a distortion: bodies appear larger than they really are, leading to inaccurate measurements.

Figure 6: Penumbra effect: bodies appear larger

It does not seem a coincidence, but rather another hint, that the English term “umbra” has a secondary meaning, whose presence is also recorded from the beginning of the 1600s: the image of "an uninvited guest accompanying an invited one" – an uninvited larger silhouette, as Kepler might say.

To express the intermediate degree of the shadow on the moon during eclipses and to describe this sort of “relational interference” between macro (celestial giants) and micro (human ocular bulbs), Kepler had coined a new term – *penumbra* – juxtaposing the Latin terms pæne (quasi) and umbra (shadow).

The perceiver’s form and movements can be identified through relations with other bodies in the form of a reported shadow. In lunar eclipses we gather information on the obscuring form of the Earth, whose silhouette becomes visible in so far as it blocks out the blinding sunlight, which, no longer reaching the lunar surface, does not bounce back to the retinal back wall of our "ocular cave.” Moreover, the shadow is indeed a sign not of emptiness, but of the fullness that determines it, and of its relations with other bodies in which we can see ourselves reflected.

And here we return to the importance that these philosophical considerations could represent for those who have tried to tackle the problem of overload.
5. Logics and Mathematics: umbral and relational calculus


Miksa’s (1997) periodization is founded on the role played by mathematics in Ranganathan’s classification theory and particularly the introduction of mathematical tools in classification schemes. He emphasizes how the second period disclosed the flaws of predetermining a rigid facet formula. A new analytical-synthetic model is taken up, with all the potential allowed by the latest mathematical innovations and in automatic and flexible sorting.

Ranganathan tries to connect the philosophical with the mathematical level contained in Russell-Whitehead’s research.

In a certain sense everything is everywhere at all times. For every location involves an aspect of itself in every other location. Thus every spatio-temporal standpoint mirrors the world (Whitehead 1945, 114).

This led Ranganathan to the idea of a “universe of subjects” articulated in infinite dimensions. Ranganathan and the Library Research Circle assiduously studied Whitehead-Russell’s non-metrical projective geometry, in an attempt to bring about a linear mapping of multidimensional knowledge (La Barre 2006), by continuing Otlet’s challenge:

Ranganathan does follow this line of reasoning of successive syntheses in his loops of “micro-thought.” However, whereas Otlet thought that this development could be handled by an update of the UDC from time to time, Ranganathan was convinced that it implied a fundamental change in classification (van den Heuvel 2011, 110).

Ranganathan (1951b, sect. 47) declares:

The representation of any continuum on a continuum of a smaller number of dimensions will admit of alternatives. Take for example the simple case of representing three dimensional space on two dimensional space—the representation of a globe as a plane map.

The mathematical concept of “transformation” recalls the use of the term “transformation” to describe the passages from one phase to another in the model of communication processes represented in Ranganathan (1951a sect. 3212).
In the last quarter of the 19th century, John Hopkins University in Baltimore became the mathematical center of the USA. In 1877 the world-renowned authority James Joseph Sylvester began coordinating the mathematics community. From 1879 until 1884, Charles Sanders Peirce held the position of lecturer on logic, on a recommendation from his great friend William James. In the first half of 1882, the university hosted Arthur Cayley (Murphey 1993). The authority of the professors attracted brilliant students such as John Dewey.

Peirce, in a 1903 article, refers to one of his usual disagreements with Sylvester: a controversy on umbral calculus, a type of mathematical notation that allows description of the properties of a universe of values contained in a matrix through a function that Sylvester first called “umbra”.

Ranganathan uses the concept “universe of subjects” to define the growing number of isolates that the classification formula can select from, combining the values of the multiple facets of a book.

Peirce first criticizes the umbral metaphor:

Sylvester's name umbra...must, I fear, be retained, although ion or radicle would be far better. For who ever heard of two shadows combining together to form a substance! In other mathematics, they have no existence in the universe of quantity. But joined together in sets they do. They are just like chemicals radicals, each having a certain number of unsatisfied wants. When each of these is satisfied by union with another, the completely saturated whole has an existence in the universe of quantity.

Peirce affirms that Sylvester was not the first to use these techniques:

What Sylvester called ‘my umbral notation’ had first been published in 1693 by another man of some talent, named Godfray William Leibniz (Peirce 1997, 125).

An explication of the basic concept of relational calculus (Smith 2012) highlights its
relationship with the theory of “small perception”. Let’s consider two right triangles that have an apex, Z, in common. Since the two triangles are similar, it follows that the ratio \( y/x \) is equal to \( (Y-y)/X \) and it will remain equal to it. Also, if the straight line EI always preserves the same angle Z, it increasingly approaches point F. What happens when the straight line EI passes through F itself? The point Z and E will fall directly on F, then the straight lines x and y will vanish; they will become equal to zero. But they still maintain an algebraic relation to each other, which is expressed in the relation of X to Y.

Figure 8: Leibniz’s divulgative graphic to explain relational calculus

At the end of the 19th century, Gottlob Frege had reached Leibniz’s objective of characteristica universalis, a new language based on ars combinatoria. According to Menon (2008), Ranganathan assumed the challenge:

la détermination des isolats se rapproche d’une recherche des concepts “sémiaux”, ou notions primitives, telle qu’elle était envisagée dans le cadre de la caractéristique universelle.

Srinivasa Ramanujan, one of the greatest exponents of umbral calculus studied in Madras with Ranganathan’s teacher and mentor E. B. Ross (Ranganathan 1967a, DB06). When he died he was working to “mock modular form”, formulas characterized by an associated modular function ("its shadow"). The search for those precious leaves was among the reasons Ranganathan had traveled to England in 1924.

I’m looking for mathematicians for possible future research.

Conclusion

Throughout this research I appreciated the surprising relevance of the analysis that led to the foundations of KO for actual societal challenges; speed, intensity and complexity of workflows experienced during and after the Second World War seems now to have extended to society as a whole.
Ranganathan’s dream when faced with a “Meccano” box a century ago is a piece of our near future: Let’s prepare for the centenary.

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References


Bianchini, Carlo, Giusti, Luca, Gnoli, Claudio (2017) The APUPA bell curve: Ranganathan’s visual pattern for knowledge organization”. Available online at Les Cahiers du numerique, 13(1).


