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HyperJoseph: The Hypertextual Organization. Epistemological Considerations

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HyperJoseph combines hypertext, information retrieval, literary studies, Biblical scholarship, and linguistics. Dialectically, this paper contrasts hypertextual form (the extant tool) and AI-captured content (a desideratum), in the HyperJoseph project. The discussion is more general and oriented to epistemology.

(Authors)

1. Introduction
1.1 The project and its goals

The web of links inside a hypertext is just one mode of support, by which human cognition can organize and navigate throughout a body of knowledge reflected in a textual corpus. Artificial intelligence and computational linguistic techniques — devised for representing or manipulating meaning or knowledge — are the other pole in a contrast that this paper discusses, in the context of the conception underlying our tool: HyperJoseph.

This hypertextual system supports an array of different ways to analyze, or otherwise approach, the text of a particular Biblical narrative: Joseph in Potiphar's house (Genesis 39). It also stores and analyzes the respective exegetic traditions, in any of a number of cultures, and also the extended narratives of legendary homiletics, and other literary derivatives. Also supported are data such as references to modern scholarship.

The purposes of the tool are:
(I) to assist scholarship (based on our experience with developing and using the Agnon hypertext), and
(II) to support education (which is the goal of a spin-off of: HyperJoseph: HyperIsaac, a hypertext on the sacrifice of Isaac).
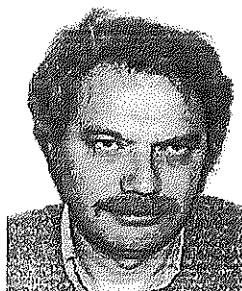
The knowledge-representation we have been developing in view of an "intelligent" version of HyperJoseph, is laden with social and behavioral background-knowledge, given the nature of the narrative, that involves adultery, threat, role reversal, etc. Instead, the extant, node-and-link version of: HyperJoseph deals with these aspects of the story in terms of narratological patterns, this being one of the kinds of analysis supported by the present system.

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Prof. Hillel Weiss is full professor at Bar-Ilan University, Ramat-Gan, Israel. He is the editor of *Criticism & Interpretation*. Areas: Projects in computing for the humanities: indexing and dynamic analysis, hypermedia and multimedia for Agnon studies (language, poetics, themes and motifs, reception, etc.), Biblical narrative and exegesis in relation to the traditional and legendary homiletics of Midrash and Aggadah (HyperJoseph, Hyper-Isaac).

Mr. Avraham Yossef is the programmer who at Bar-Ilan University, has been coding the data into the hypertextual system, by customizing the Ize hypertext shell.

1.2 The domain and the paper's goals

The hermeneutic traditions of the Bible text evolved within several cultures throughout history. Textually, this took the form of commentaries and supercommentaries, conceptual and idiomatic borrowings, and generally an array of influences that shaped each culture in turn. Biblical narratives in particular provided a powerful stimulus for mythopoiesis, with etiological, fabulatory, or other purposes. Influences may be as thick as extended narrations, or as thin as intertextual overt or covert allusions.

Out of the conviction that hypertext is an appropriate paradigm for supporting both scholarship and instruction on these subjects, we selected a particular narrative, defined an architecture within a diverse corpus of related texts, defined a hierarchy of hypertextual links, and obtained an archetype that can be emulated for other original Biblical narratives and the textual (and iconographic) traditions they respectively support.

HyperJoseph is a multifaceted, eclectic project in hypermedia and AI-based knowledge representation. The latter two technologies capture differently the material. The first is already an implemented application, the second a generally designed one to the Biblical story of

Joseph in Potiphar's house (Genesis 39), to its traditional commentaries and supercommentaries, to the associated legendary tradition and literary or otherwise artistic renditions, and to modern scholarship.

In this paper, we discuss the ergonomic and epistemic principles of HYPERJOSEPH: i.e., respectively, the modalities of development or use, and the allocation or possession of knowledge in the tool or interacting humans. We focus on epistemological aspects of the node-and-link hypertextual structure as implemented, as opposed to the planned "intelligent" version and to the formalism we designed for the representation and manipulation of meaning and knowledge. Basically, the contrast is one by which the conception of the two versions is oriented, in the order, to form (through node-and-link access) vs. to content (through AI techniques).

A dense web of pointers has been superposed on the textual material. Elaborations accessed are linguistic, narratological, etc., and are linked to either specific (sub)strings (or sets thereof), or to any of, e.g., linguistic features, particular threads of exegesis, motif occurrences, narrative units, the characters, the story itself, and contexts in which the story can meaningfully fit, from either the narratological viewpoint, or the coign of vantage of teleological or otherwise religious hermeneutics.

From the viewpoint of hypertext, access links are implemented by explicit definition. However, the HYPERJOSEPH project is also special in that a more general conception of access is adopted: in general, access can be considered to be the result of query processing. The simplest case is just following predefined links, whereas more complex access should be yielded by selecting such data that match a query, that in turn can be just one step involved in reasoning by symbolic manipulation as based on common-sense knowledge on social or cultural norms or on genre conventions.

2. Hypertext Authoring versus Knowledge Engineering: the Burden of Representational Micro-Decisions, Authors as Users, and Ergonomic Knowledge

An analogy can be drawn between expert systems and hypertext, in that in order to suitably apply the (respectively) inferential and navigational capabilities of the tool, there is a huge burden on the author/expert to provide inherently idiosyncratic information not only from the descriptive ('what') viewpoint of the application domain, but also from the operational ('how') viewpoint of the specific configuration of the projected items of knowledge inside the universe of the tool itself.

Namely, in knowledge acquisition into expert systems, the domain knowledge of the expert practically cannot be separated from knowledge-representation choices: the professional role of the knowledge engineer enables delegating those decisions that more blatantly, so-to-speak, smack of technology; yet the need for the expert and the knowledge engineer to interact closely (even painfully) bears witness to the interpenetration of knowledge and

representational issues. In a sense, your knowledge of the terrain must be reflected in proficient knowledge at mapping — if a map is to be made at all — even though you may delegate the professional drawing.

Similarly, the author of hypertext or hypermedia systems with innovative content (as opposed to rote compilations), is like the domain-expert in knowledge engineering, yet he or she is more often than not called to contribute time-consuming nitty-gritty micro-decisions such as explicit, "authored" links in the navigational web.

The programmer, analyst, or hypermedia technician —acting in a role parallel to that of a knowledge-engineer — can at most ease, not relieve altogether the burden from the expert. A body of operational know-how builds up: complex, ambitious expert systems are likely to be accompanied, as they develop, by a growing body of esoteric know-how about how to use the system; the more you know about representation-dependent modalities of use, the more you can get from the tool.

These ergonomic features of the tool, pertaining to use and its environment, are not necessarily negative. In AI, Woods (1986) focuses on the joint human-machine cognitive system, instead of just on the artificial tool. It is often the case that the domain expert is the main user, who is enabled by the tool to enhance his or her scholarly work: be it in the humanities — as the case is of HYPERJOSEPH — or in engineering, which is the case of the FUELCON expert system (Galperin, Kimhi and Nissan, 1993, Sec. 13), that discovers configurations for a certain task, based on embodied knowledge that the expert can test, augment, or modify. However, multiple perspectives of use can be envisaged for the same tool: in the case of FUELCON, as a discovery-assistant for the expert, and as a design tool for the practitioner; or, in the case of HYPERJOSEPH, as a support for research, and as an educational tool.

Accordingly, ergonomic realism as outlined above must not stifle the ambition to develop a very different operational setting and environmental niche for the same tool. For example, the discovery-mode ergonomics of the engineering tool, FUELCON, has no longer a *Sitz im Leben*, so-to-speak, and is replaced altogether in the architectural conception of one of the sequel projects, that envisages a more complete automation of knowledge revision with the integration of neural networks (Nissan *et al.*, 1994).

The (loose) analog in our HYPERJOSEPH project (as implemented) in hypertextual literary analysis, is relieving part of the burden of defining explicit hypertextual links, as a side-effect of the long-term goal of incorporating (on top of the extant system) common-sense knowledge, and a computational-linguistic internal representation of content. Whereas the design of the expressive formalism for this „intelligent" version of the system is at a fairly advanced stage (Nissan & Weiss, 1995a,b), it does not affect the current "ergonomic culture" of the project, as meant for scholarship-assistance and, alternatively, as support for higher education.

Not that either task would have no use for enhanced capabilities, of course: cf. in Nissan (1987) an outline for ambitious roles for AI tools in assisting exploration in higher education. However, the extant ergonomics of HYPERJOSEPH is viable and thriving, conceived as it is within the boundaries of conventional hypertext technology as combined with the record of Weiss's past research in literary indexing into the Hebrew works of the novelist S.Y. Agnon.

Agnon's language draws heavily on Rabbinic and Midrashic Hebrew, and some of his work even recreates legendary homiletics, emulating the Midrashic literature (Weiss, 1985). Considering Agnon's flavor and background, our undertaking the development of HYPERJOSEPH — considerable part of which analyzes a sample of the Midrashic literature itself — was quite a natural choice.

Kaddari's (1980) inquiry into Agnon's style is a classic of Hebrew stylistics; its data were sifted by the computer. Weiss, however, developed a very dense hypertext for Agnon's writings and their reception; the indexing (Weiss, 1989-1992) lends itself to interpretation for the purposes of stylistic and literary analysis on the part of the users, especially Weiss himself, the author of the Agnon hypertext. Both the Agnon hypertext HYPERJOSEPH were developed by using a customized interface of the IZE hypertext shell (Persoft, 1988), which requires all links to be stated explicitly. Of course, concepts from the Agnon project were reused in HYPERJOSEPH. Whereas the link-and-node, conventional hypertext tool, as intended (like the Agnon hypertext) for scholarly use, is devoted to Joseph in Potiphar's house, a version for primarily educational purposes of this approach to exegesis has also been developed (by Isaac Ressler under the direction of Weiss): it's on another narrative from Genesis, the story of the sacrifice of Isaac. Basically HYPERISAAC is an emulation of HYPERJOSEPH, as it replicates the conception of the latter as implemented.

It is the ergonomics and respective epistemological implications of this (just-) link-and-node, down-to-earth, present-day, brute-force face of HYPERJOSEPH that we have set to discuss, in this article. Instead, our other works (Nissan & Weiss, 1995a,b) focus on the representation formalism for the next, "intelligent" version. The extant tool's requirement that all links be stated explicitly — thus, an epitome of "muscular", data-encoding hypertext authorship — involves also the author indicating which kind the link is: a luxuriant panoply of navigational attributes, i.e., kinds of links, provides the user with the opportunity to use his or her own cognitive abilities to profit best from the tool. This kind of hypertext authoring is basically different from the analysis (an evisceration of the structures of knowledge) required for producing the "intelligent" version: the bulk of authoring the latter, consists in designing the representation, upstream of coding the actual instances, on top of the extant hypertext.

The intended effect, on the tool, is its containing not only the data (from which users are to derive information according to their goals and to the knowledge they possess themselves), but also a representation of information or knowledge about those data[1] (and about the respective upper hermeneutic levels: information and knowledge that human culture, and reasonably schooled human readers, are expected to possess or to derive from those very data). That is to say, the tool would carry the bag and also know (to some extent of practical utility to users) what the bag's content is, and is for. Or, then: instead of Atlas carrying the Earth on his back (he's got no eyes in his neck), the ambition is also (asymptotically, saith the mathematician) to endow Atlas with a good grasp of what is it he is carrying. Cognitive 'grasp', that is.

It would be all too easy to ironize about this Cervantine dichotomy into a dreaming Quixote and this-worldly Sancho. Or — to pick instead Italo Calvino's novella *Il cavaliere inesistente* ('The nonexistent knight') — the unabashedly material servant and the lofty but, alas, incorporeal knight Agilulfo. On the other hand, both ethereal ambitions and sanguine tool-making are legitimately intertwined endeavors, at the forefront of knowledge-representation research: ultimately, this just reflects the epistemological dichotomy of science and technology in artificial intelligence (Nissan 1991).

3. Navigating the Body of Knowledge: Where does Cognition Reside?

The non-AI hypertext system is about linking items or positions, according to various attributes. Instead, the AI schema of access incorporates a mapping of a subset of knowledge possessed by the author's or user's general commonsense or specific cultural competence, onto conventionally isomorphic structures, i.e., projections intended to reproduce them in a form suitable for the tool to manipulate them symbolically, thus reaching for more when navigating, because it is the artificial agent itself that is delegated part of the decisions about access steps, based on its own assumptions as to the determination of a relevant set of items to be accessed. Such intelligent query-processing is a generalization of links; explicitly authored, straightforward links are just a particular case of the enhanced schema of access.

In a mathematical sense, non-AI hypertext imposes a set of links, $L \equiv \{ \lambda_1, \lambda_2, \ldots \}$, on the collection of textual (or other data) items $X \equiv \{ x_1, x_2, \ldots \}$, where each link λ_i is either (typically) binary, i.e., an arc in a graph, connecting two nodes x_i and x_j, or even (which is a mode we chose not to implement) an n-ary relation (e.g., a triangle of three nodes), or an ordered set of links (i.e., a "guided tour"). We stated X may include data other than chunks of text, but these data are intended in the sense of data as stored in a database, or computed therefrom. It is the user that ascribes meaning to the elements of X that he or she accesses or looks for, to the authored links, and to the attributes by which they are classified.

Instead, when access is (also) by intelligent query-processing that incorporates commonsense about being human, being a user, or making sense of the application domain of the tool (Joseph in Potiphar's house, in the

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Bible and in all traditions attached), we have a situation where an overall, very complex set of n-to-m relationships, $R \equiv \{ r_i \}$, between elements of X and their culturally contextualized meanings, $M \equiv \{ m_j \}$, is explicitly (though only partially) projected in the access-regulating devices of the tool: these devices constitute a set $D \equiv \{ \delta', \delta'', \dots \}$, that comprises L along with relationships between two or more elements of $X \cup M \cup R \cup D$. That is to say, the general conception is extremely flexible as to expressiveness: the devices of access can reason on the textual elements or relevant data, or on the meanings, or on the text-to-meaning relationships, or on the very devices onto which these relationships are projected, or on any combination of them.

Clearly, such definitional and representational liberality calls for strict delimitations of subsets relevant for the practical purposes of a tool implemented in order to be used effectively. The blueprint for upgrading the hypertext with "intelligent" capabilities is a plan for a leap, not just a hop. However, even a leap needs a clearly set point of landing, and discarding the possibility of a sequence of small hops is a luxury that project management clearly cannot afford. For the time being, the blueprint is the definition (by exemplification) of a representation method. Operationalization requires it to undergo practical transformations (typically, selection and working out the details of processing down to retrieval), to bridge our present hypertext system to the culturally pseudo-competent artificial retrieving agent we postulate as a desideratum. The Sancho and Quixote metaphor from the previous section can be expediently extended with Chevalier's claim (1990: 843) that Sancho — who is eventually appointed to governor of Barataria — becomes like his master, but in the sense that Sancho is Quijanified, not Quixotified: it is Don Alonso Quijano (i.e., Quixote's sane self) he gets to resemble (cf. Hart (1995: 372). Nissan (1995: Sec. 4.2) provides a formal discussion).

This metaphor differs — in that it additionally conveys a colorful, evaluative connotation — from likening the contrast considered to the opposition, taken from biology, of a genotype (i.e., the inborn blueprint for development of a living individual) and its context-dependent materialization as a phenotype (i.e., the individual as shaped within an environment through a biography). In turn, the genotype vs. phenotype metaphor introduces a temporal, diachronic dimension into a possible abstraction in terms of an emic vs. etic opposition, which captures the notion of contextual realization.

Conventional hypertext is an organization that consists in making explicit the interrelation of form (whatever it is), instead of content. Fittingly, here is a reversal of the Agilulfo metaphor from the previous section. Kampis (1995) is concerned with Rosen's relational metamodel of the cyclical chains of living systems, in mathematical biology. Kampis states that in general, "relational 'models' establish static structural correspondence between system components" (*ibid.*: 95), these being abstract categories that can be just anything. It is not an approach that directly translates into computation. It is form, not content: "the relational approach is purely functional, whereas reductionism is purely material. They can be likened to the chief characters in Italo Calvino's 'The nonexistent knight': Aguilulfo (*sic*), pure spirit, and his servant Gurdulu, pure flesh": (*ibid.*: 95; Kampis is based in Spain and apparently, the names are from the Spanish translation of the Italian novella). In Calvino, Agilulfo, the spirit, takes on a concrete nature in virtue of his never taking off his armor. We will not relate the story here; let is suffice to recall that if the matter-of-factly lady of the manor finds him as eminently satisfactory as her maids find his servant, it's because Agilulfo successfully delegates his relevant functions to her cognition and initiative, without her knowledge of there being no man inside the armor. In a sense, Agilulfo's passive agency (an oxymoron?) and empty armor are like the capabilities of a conventional hypertextual tool, leaving it to the user's cognition to perform those actions that the tool cannot provide, in the pursuit of the user's goals. Agilulfo has a mind but no body for bodily functions; hypertext has no cognition, but the user's would make. This malleability of the tool and of the conception underlying it, is part of the explanation for the current rush, in literary studies, to embrace the paradigm, to the extent that papers and calls for papers can be taken to bear witness to that.

In the sense of sticking to the mere form, conventional hypertext is quite the opposite of Nissan's (1992) approach in a combined representation schema for Italy's regional constitutions, that are rather similar to each other. The schema is about meaning: the "pine" of the representation is what the regional laws share; differences are stated with respect to that core. Yet, as in practice the letter of the law is necessary, such a schema could only be useful if intertwined with a hypertextual web of pointers to each relevant locus in the textual corpus.

One must admit, however, that these statements of contrast shouldn't be that crisp. We were forced to base this kind of dialectics on idealized opposites, and had to resort to descriptors such as 'conventional hypertext'. What we have in practice, is tendencies. True, hypertext organizes just the signifying texts, yet it scratches the surface of the signified content through the hierarchy of attributes into which the various kinds of authored links are classified. The semantic-network conception of upgrading we devised for HYPERJOSEPH is amenable, after all, to a structure imposed on these attributes: a structure more meaningful, more capable of capturing content, than a mere hierarchy about which the tool itself cannot reflect. The author of the conventional hypertext encapsulates a taxonomy squeezed out from the meaning that his or her human cognition associates with the text(s), and this makes for the machine being much less than an artificial agent endowed with representational data and inferential patterns letting it into the minutiae of (relevant kinds of) meaning. This is what the desideratum, the AI tool, is about, instead.

Relevant for this distinction is what Lenssen-Erz — the cataloguer (1989) of Namibian rock art (Pager, 1989) — states about that project's methodology for administering and retrieving the data on images: 12,000 figures with more than 1,400 scenes. Shared motif is one criterion of retrieval, in that project. However, the

> standardized descriptive system [...] though still abstract and avoiding interpretation of meaning, allows the painting to be administered (i.e., arranged, sorted, classified, or filed) on a structural level that assigns the same relative importance (or rank) to activities as to the physical features (Lenssen-Erz, 1994: 170)

i.e., to what the human or animal individual depicted seems to be engaged in. This level of analysis is classificatory, and also pertains to our hypertextual link typology as implemented. It is class-oriented. Instead, our AI analysis as designed is oriented to unique individuals, as the wealth and compositionality of attributes makes it affordable to rough-hew its way to adequate access as tailored for complex queries and complex items of knowledge. Conceptually, the minutiae of content, associated with a particular object of analysis (textual locus, or cultural notion) are far too rich for a privileged classification of attributes to emerge, such as the hierarchy of attributes in HYPERJOSEPH as presently implemented: the "intelligent" version would also process elaborate taxonomies, but it would do it internally, to some extent by itself, and "reflectively" (i.e., by reasoning about itself)[2], instead of delegating all cognitive functions to the user[3].

4. HyperJoseph in the Context of Hebrew Information Retrieval

The Hebrew morphological analysis capabilities of HYPERJOSEPH — that are not innovative *per se* (cf. Choueka, 1979, 1966; Choueka & Shapiro, 1964) — constitute the connection to the approach to Hebrew computational linguistics traditionally associated with Bar-Ilan University (Attar *et al.*, 1983; Choueka, 1980).

At the same time, it is an example of calculated access, instead of direct hypertextual link. This fits in the framework of the class of hypertextual systems that incorporate text retrieval (Li *et al.*, 1992; Frisse, 1988):

> This technique effectively supplements the pre-authored link information embedded within a hypermedia application. Instead it uses the inter-node relationships provided by text-analysis of the document content. The user is provided with a system[-]calculated relevant information in addition to that provided by authored links (Hill *et al.*, 1993: 110).

Conceivably, the same morphological tools for information-retrieval that HYPERJOSEPH makes it possible to run on the Hebrew text of the Bible, could be applied to the Hebrew text of traditional commentaries and homiletic anthologies. And indeed, part of information retrieval tools can be used with all Hebrew text (Biblical, Medieval, and modern) coded into HYPERJOSEPH. Nevertheless, as the Biblical text is either with or without vowel diacritic marks, and later relevant texts are vowel-less (in the so-called *scriptio plena* of Hebrew)[4], those tools that can run on the latter are those that can do with just the strings as spelt, with no reconstruction of vowelling. Instead, the linguistic tools that access the Biblical text make use of the vowels, as they are stored online. No effort was made, in HYPERJOSEPH, to reinsert the vowels in unvowelled text, as this makes little sense for most practical purposes. On the other hand, HYPERJOSEPH makes no use of Choueka's NAKDAN system, available from the early 1990s (e.g., Choueka & Ne'eman, 1995), and that constitutes a major breakthrough for Hebrew computational linguistics: by means of statistical linguistics and disambiguation in the short context (based on syntax and usual lexical co-occurrences), NAKDAN puts back the vowels (as vowel diacritic marks) in unvowelled text, quickly and reliably[5]. Potentially, this enables future work on automated linguistic analysis in HYPERJOSEPH to go directly from the text to internal representation, bypassing the bottleneck of coding the representation manually.

Meanwhile, a hypertextual version of the Babylonian Talmud and its commentaries between (HYPERTALMUD) has been developed by Choueka at Bar-Ilan, but there is no mutual connection or accessibility HYPERTALMUD and HYPERJOSEPH. The visual feel of the two systems is notably different, and so is the conception behind them. Also in respect of content, there is little reason to connect the two pieces of software, as the bulk of the homiletic traditions of the Joseph stories is outside the Talmud, even though it belongs in the more or less coeval Midrashic literature. The Medieval hermeneutic traditions on, respectively, the Talmud and Genesis, are also coeval, or even by the same authors, but, again, the difference of focus makes for just little overlapping.

From the viewpoint of the Massoretic tradition of the Hebrew text of the Bible, it makes sense to account, in text retrieval, for the diacritic marks of vowels (the usual, Tiberian marks, as well as the obsolete Babylonian diacritic system and morphological tradition), as well as for the syntactic/prosodic diacritic marks of cantillation, i.e., traditional chanted declamation (Dresher, 1994; Rosowsky, 1957). This, in turn, calls for storing audio recordings of the oral performance of cantillation according to the melodic traditions that are part of the various communal traditions of Jewish liturgy.

Nissan (1995) is concerned with linguistic prototypes of form vs. content. Nissan (*ibid.*, Sec. 8) discusses sporadic discrepancies between the use of pausal (vs. contextual) forms of words in the Biblical text, and the co-occurring cantillation prosody marks: passages considered are narrative, and include quoted direct speech, which provides the opportunity to explain out those irregular co-occurrences in terms of the pragmatics of conversation, speakers' planning of utterances, and the emotional make-up of motivation behind planning.

Needless to say, in the present version of HYPERJOSEPH — deprived as it is of semantic (let alone pragmatic) capabilities — it is only the human user, not the artificial

tool, that could possibly carry any reasoning of that kind: namely, about how regular the match is, of the morphology of the Biblical narrative (as embodied in the phonetics and thus phonemics expressed in the vowel diacritic marks), and the corresponding sequence of cantillation diacritic marks visualized (on paper or on the screen) above and under the letters of the Hebrew text.

5. Cognitive Competence in Retrieval

A relatively simple problem involving a role for "intelligence" in retrieval, is the problem of reference. It's usually straightforward for human cognition, though it sporadically challenges scholars, or detectives, or anybody faced with homonyms in a phone book: in which cases, humans resort to further information to attempt proper identification.

Because of the theme of our hypertext, we are concerned with just a particular person named Joseph. However, some author cited may happen to also bear that name. Moreover, there is a particular locus in Midrashic legends about Joseph, whose point is in questioning the very identity of Joseph: a certain character is represented as potentially retorting, "How many Joseph[s] are [to be found] in the market!" The cognitive effort required from humans to solve, in everyday life, the problem of specifying, or recognizing, the referent of proper names, should not be overlooked. In information retrieval and in concordancing, polysemy is a well-known problem, but it involves different kinds being meant: it's different from the problem of reference, where different possible individuals are the candidate referents of the same term as meaning just one semantic category (the problem of reference), or of the same proper name (a problem known in database design, where it is solved by means of supplementary attributes).

Biblical names are almost unique, in the Biblical corpus, yet Joseph's name in Hebrew is also an inflected verbal form that occurs in the corpus. The onomasticon of the Talmudic literature reflects a historical reality where some proper names were very common, and the name 'Joseph', too, was frequent, but in the form *Yossey* instead of *Yossef;* the latter form, as a first name, can be assumed to refer to the Joseph of Genesis. Name variants are also a cross-linguistic phenomenon. Consider Ruozzi Sala's (1974) analytic list of anthroponyms of Semitic origin found in Greek papyri from Egypt, dated between 323 BCE and 70 CE. The Greek forms *Ἰωσῆπις, Ἰωσῆπος* and '*Ἰωσηφος*' are found in this (*ibid.*: 22-23), possibly inflected: e.g., one entry from Edfu, of 70/71 CE, is the receipt released by a certain tax-collector, 'Ἰσχυλος 'Ἰωσῆφου, for collecting the tax called βαλανευτικον. A document from Thebes, of July I, 154 BCE, certifies that the farmer '*Ἰωσῆπις* paid the land tax. This way, just the intersection of 'tax' (or hyponyms) and 'Joseph' (in any form of the name) may retrieve instances relating to several individuals (in both roles: paying or collecting a tax), for the same (broad) locale, Egypt. Explicit datation of the documents of Ruozzi Sala's corpus prevents the

Joseph of Genesis from qualifying, even though his case, as a Vice Roy, is the *locus classicus* of the intersection *Joseph ∧ Egypt ∧ taxation*. Nevertheless, in principle, there is nothing to prevent a document from time (or time interval) t_i from mentioning (e.g., as an element from the cultural or literary repertoire) an event or a character from a previous time (or time interval) t_1: it is our fairly complex set of assumptions about the documents in Ruozzi Sala's corpus that has us discard occurrences of Joseph from, e.g., the Septuaginta[6]. This is an example of the transition from mere information retrieval to cognitively competent processing. Not even our AI schema for upgrading HYPERJOSEPH is expected to handle referent identification, other than by very shallow assumptions. This is the well-known problem of anaphora, and, more in general, of reference, in linguistics and computational linguistics (e.g., Allen, 1987: Ch. 12). A widespread, simplistic solution is: "Identify the referent with the referent of the latest occurrence thus far, unless told (or proven to be) otherwise".

6. Across Cultures, Genres, and Media

James Kugel's book (1994) is a major piece of research on the Biblical story of Joseph in Potiphar's house, and on the legendary traditions built up on top of it. Cf. Aycock (1992), that attempts a structuralist analysis of this Biblical narrative. Kugel's inquiry is mainly into the reception of the story in Midrashic legends (i.e., in the Jewish homiletic literature starting in the Talmudic period down to the Middle Ages).

The Midrashic tradition is a major source for, e.g., Islamic traditions on Biblical characters: the Sura of Joseph is the longest in the Koran (even though a Baghdadi proverb about making a long story short, summarizes it thus: "A fellow lost his son and found him"). The Joseph and Zuleika legends and literary works of Islamic cultures are its derivatives, with some ongoing interaction possibly reflected in a particular work from Judeo-Persian literature (e.g., as it names Potiphar's wife *Zuleika*).

This provides us with the opportunity to introduce a more general discussion of boundary crossing; it is somewhat relevant to hypermedia (HYPERJOSEPH also supports iconography). The transition of traditions is not just across cultures, but also across genres and media, which involves the respective conventions resulting in "baggage" from one source (such as medium-induced incidents) being possibly carried over to the next version, possibly supported by another medium. Here is an example. Yvonne Friedman (1983) discusses the identification of sculptures (from before 1130) on the facade of the cathedral in Poitiers, Notre-Dame-la-Grande, with Biblical characters (unrelated in the Bible itself). Like previous authors, she finds a parallel with the *dramatis personae* of a religious play, *Ordo Prophetarum*, but not with the sermon of Quodvultdeus, from which the play is known to be derived. Therefore, it must have been the play that provided the inspiration for the sculptures. Friedman deals with the interplay of popular Medieval Western

culture — as reflected in the theater of holy representations — and the texts of erudite theological polemists, in the particular perspective of anti-Jewish controversies in the 12th century. The *Tractatus adversus Judaeorum inveteratam duritiem* by Petrus Venerabilis quotes from prophets and other Biblical characters, and introduces them before the respective quotation, the way *dramatis personae* would be called onstage in the religious plays of its times and culture. Theater, in turn, derived elements not just from texts, but also from local coeval mores, and a reflection of this can be seen in sculpture as inspired by theater (*ibid.*: 187):

> The well-known motif that has Adam and Eve chased from Paradise, was plastically represented in a peculiar way, in the church of Notre Dame du Port in Clermont Ferrand. The sculpted image depicting Adam as he kicks Eve in the butt and pulls her hair, describes not the account given in the Bible, but rather the dramatization in the play *Jeu d'Adam*.

It bears witness to the possible pitfalls, due to cross-medial contamination, of what otherwise is an indicator of how much the reception of a text, e.g., a Biblical narrative, owes to the social and mentality patterns of the culture in which that reception takes place.

The contrast of cross-medial information and knowledge in hypermedia[7] is thus compounded, in view of the trans-medial nature that handing down may take (significantly, 'handing down' or 'moving on' being the etymological sense of 'tradition' and 'translation').

Here is a possible notation. Let p be a path, a sequence, an ordered set of transitions t of a core item x, of information (e.g., an occurrence of a motif), from source (or 'text') u as supported by medium m, to source v as supported by medium n.

We symbolize this instance of transition as

$$\substack{m\\u}t\left(x\right)\substack{n\\v}$$

and have this act as a function symbol

$$T_i \equiv \substack{m\\u}t\left(x\right)\substack{n\\v}$$

that then we employ in: $X_{i_1} = T_i(X)$.

Now, if we are to consider the inverse function, T_i^{-1} then in general we should not take it for granted that

$$X_i = T_i^{-1}(X_{i_1}),$$

but rather assume, to be on the safe side, that

$$X_i = T_i^{-1}(X_{i_1})$$

where $X_i' = X_i$ may hold in particular cases. This is due to the fact that x is just a core of information, and that sources may supplement it in ways partly influenced by the "genius" of the particular medium (e.g., because of traditional repertoires of style and genre as associated with that medium, in given cultures or clusters of related cultures).

Let one instance of the path be

$$p = \substack{m\\u}t_1\left(x\right)\substack{n\\v}t_2\left(x\right)\substack{o\\w} \ldots ,$$

that is:

$$p = \{\, T_1 , T_2 , \ldots \,\} \equiv \{\, \substack{m\\u}t_1(x)\substack{n\\v} , \substack{n\\v}t_2(x)\substack{o\\w} , \ldots \,\}$$

This reflects the trans-source and trans-media handing down of x. More generally, we can conceive of a network, with path ramifications and coalescence. An example of this is the depiction of Adam and Eve we quoted Friedman as relating about.

This kind of meta-representation of the relationship of terms or textual units in the corpus to each other, belongs in a possible formalization HYPERJOSEPH as per its present status, of just node-and-link organization. It would compete to knowledge-based representation in the "intelligent" version, to flesh out this skeleton with details.

Dedication

This paper is devoted to the memory of Rabbi David Schaumann, who was for decades the protagonist of Jewish education in Italy (Nissan, 1975).

Notes

1. In database design, the incorporation of *meta-data*, i.e., data about data, dates from the 1970s. The component devoted to this purpose is the *meta-database*. This does not mean the system also possesses the information based on the data: it's the users who derive the information. Or, then, the latter is explicitly represented in an information system, whose architecture comprises one or several databases, and other programs. Yet one step forward, in terms of complexity, is knowledge (vs. information): the incorporation of knowledge-based processing techniques into information systems yields 'intelligent information systems': which is standard terminology, like 'intelligent databases'. Gal *et al.* (1994) discusses the incorporation, in databases, of knowledge about complex items stored there: "The epistemic dimension associates a knowledge item with a set of viewpoints. Each of these viewpoints is assumed to have access to the knowledge item, possibly under certain conditions": (*ibid.*: 194). Contrast this sense of viewpoints with the merging of extant hierarchical thesauri (these being a particular case of semantic nets), in order to produce a "better" thesaurus (Mili & Rada, 1988).

2. "A computational system is said to be reflective when it is itself part of its own domain. More precisely, this implies that (I) the system has an internal representation of itself, and (II) the system sometimes shifts its 'normal' computation about the external domain to 'reflective' computation about itself" (Maes & Nardi, 1988: VII).

3. Boyle & Encarnacion (1994) describe a tool that enables multiple hypertextual perspectives of the same document, with the interaction being adapted to the individual reader, as opposed to the human reader having to adapt to the document, as with conventional hypertext management systems. That paper describes: METADOC, an adaptive hypertext system that incorporates an interface driven by a *user-model*: based on knowledge that: METADOC has about the document, and on the record of sessions, the tool constructs the model and maintains it dynamically, for each given reader.

4. Nowadays, spelling is standardized in European languages; less so in Israeli Hebrew, as one still can choose to omit or insert — as markers for partial phonetic disambiguation — *matres lectionis*, i.e., letters used in context as mute instead of consonantal, to indicate the position of a vowel out of a certain set. As with this role,

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such a letter indicates the presence of any vowel out of a certain subset of vowels, or even (if doubled, i.e., occurring twice consecutively) intervene to resolve ambiguity introduced by the *matres lectionis* themselves. In practice, omission (*defective spelling*) or insertion (*scriptio plena*) oftentimes is not coherent even in the same document (cf. Weinberg, 1975-9). Such variation is usually not considered to be misspelling. Some choices may be perceived as unelegant, and so is incoherence in the same document. The use of *matres lectionis* in Arabic is much more regular. Actually, speakers of Semitic languages resort to knowledge in morphology, to spot some familiar pattern in text as usually written. The amount of resorting to *matres lectionis* in the Hebrew scriptorial traditions kept changing, historically, apart from flexibility even in the same text. A normative standard is encouraged now in Israel, but not really enforced, e.g., in newspapers. The acceptability of orthographic variability inside the same document is testified by an anecdote about the punctiliousness of Martin Buber, the philosopher: reportedly, he had a book typed again before going to the press, for the only reason he required uniformity enforced concerning *the matres lectionis*. Presumably this wasn't the case of the manuscript.

5. Disambiguating Hebrew vowelless text by computer, is a challenge that has been overcome only around 1990, by Choueka's equipe at the Center for Educational Technology in Ramat-Aviv, and about two years later by Ornan's team at the Technion, in Haifa. For a vowelless word in isolation, Choueka's NAKDAN program generates all of the possible vowelled words, but only those that are acceptable in the language, at a 100% success rate. Vowelling in context is much more complex, as it involves disambiguation; the NAKDAN-Text program has a success rate of 95% at vowelling vowelless textual passages.

6. The principal task being the removal of non-relevant data is typical of *filtering* from a stream of data, as opposed to finding data, that in turn is the typical task of information retrieval, as well as of *extraction systems* that extract facts from incoming textual objects: see Belkin & Croft (1992).

7. The contrast of pictorial and textual descriptions, typical of online hypermedia, and of knowledge presentation in general, is usually associated with one corpus, and possibly one document. It's not just about reading or viewing a document, but also about generating a presentation in a document. Given a particular informational content, the *media allocation* problem is the problem of which parts of the information to convey by which medium, with the concomitant media conveying the overall sense intended: (Arens *et al.*, 1992). Cf. in Nissan (1987):

> Let us consider, first, Nowakowska's *theory of multimedial expression*. The starting point is the fact that the same message may be conveyed differently by saying it, or by writing it, or by dancing it, or by performing a pantomime, or by drawing a cartoon. You make different efforts to understand the same message as conveyed by a silent film, or by watching a movie on TV with the sound off. (Nowakowska 86: Sec. 3) proposes a formal theory of expressiveness of communication 'as carried out simultaneously on several media, such as verbal medium (utterances), accompanied by gestures or other body movements, facial expressions, and so on'. *Multimedial Units* of communication are an extension of the role played by words in spoken or written communication. Multimedial units, however, have a number of components corresponding to actions on various media. Units may be *planned* in context, to convey a message with a certain meaning. A future kind of intelligent tool could generate attractive knowledge-presentations, by *selecting suitable media* to convey a given message. For example, the media-selector could resort to a cartoon, and decide whether it should perform a pantomime instead of

having bubbles containing the text of utterances. Gestural expressions of an animated character on the screen, short texts, tables, graphics, the display of objects, etc., may suit given situations, to express contents planned for communication.

References

(1) Allen, J. (1987): Natural Language Understanding. Menlo Park, CA: Benjamin/Cummings.

(2) Arens, Y., Hovy, E.H., Vossers, M. (1992): On the knowledge underlying multimedia presentations. Research Report ISI/RR-93-370. Marina del Rey, CA: Information Sciences Institute of the University of Southern California.

(3) Attar, R., Choueka, Y., Dershovitz, N., Fraenkel, A.S. (1983): KEDMA: linguistic tools in retrieval systems. Journal of the ACM 25: 52-66.

(4) Aycock, A. (1992): Potiphar's wife: prelude to a structural exegesis. Man 27(3): 479-494. London: Royal Anthropological Institute of Britain and Ireland.

(5) Belkin, N.J., Croft, W.B. (1992): Information filtering and information retrieval: two sides of the same coin? Comm. ACM 35(12): 29-38.

(6) Boyle, C., Encarnacion, A.O. (1994): METADOC: an adaptive hypertext reading system. User Modeling and User-Adapted Interaction 4(1): 1-19. Dordrecht: Kluwer.

(7) Chevalier, M. (1990): Cinco proposiciones sobre Cervantes. Nueva Revista de Filología Hispánica 38: 837-848.

(8) Choueka, Y. (1966): Automatic grammatical analysis of the Hebrew verb. Proc.Second National Conference of the Information Processing Association of Israel (IPA'66), Rehovot (pp. 49-67). Jerusalem: IPA. Hebrew. English abstract: The Finite String 4 (1967).

(9) Choueka, y. (1979): Piek-a-Word, or an on-line program for automatic analysis and synthesis of Hebrew words. Proc. Int. Conf. Literary and Linguistic Computing (ALLC'79), Kibbutz Shfayim (Israel).

(10) Choueka, Y. (1980): Computerized full-text retrieval systems and research in the humanities: the Responsa Project. Computers and the Humanities 14: 153-169.

(11) Choueka, Y., Shapiro, Y. (1995): Nakdan-T, a text vocalizer for modern Hebrew. Paper presented at the Fourth Bar-Ilan Symposium on Foundations of Artificial Intelligence (BISFAI'95), Ramat Gan and Jerusalem, Israel, June 20-22, 1995.

(12) Choueka, Y., Shapiro, M. (1964): Machine analysis of Hebrew morphology: potentialities and achievements. Lesonenu 27/28: 354-372 (Hebrew). English abstract: The Finite String 3 (1966).

(13) Dresher, B.E. (1994): The prosodic basis of the Tiberian Hebrew system of accents. Language: Journal of the Linguistic Society of America 70(1): 1-52.

(14) Friedman, Y. (1983): "The culture of the poor" - from literature to the formation of a motif in anti-Jewish controversies during the 12th century (Hebrew). In: Kaddari, M.Z., Katzburg, N., Sperber, D. (Eds.): Bar-Ilan: Annual of Bar-Ilan University Studies in Judaica and the Humanities vols.20/21 (pp. 182-191). Ramat-Gan, Israel: Bar-Ilan University Press.

(15) Frisse, M.E. (1988): Searching for information in a hypertext medieal handbook. Comm. ACM 31(7): 880-886.

(16) Gal, A., Etzion, O., Segev, A. (1994): Representation of highly-complex knowledge in a database. J. Intelligent Information Systems 3(2): 185-203. Dordrecht: Kluwer.

(17) Galperin, A., Kimhi, Y., Nissan, E. (1993): FUELCON: an expert system for assisting the practice and research of in-core fuel management and optimal design in nuclear engineering. Computers and Artificial Intelligence 12(4): 369-415.

(18) Hart, T.R. (1995): Deceit and decorum in Cervantes. Modern Language Rev. 90(2): 370-376.

(19) Hill, G., Wilkins, R., Hall, W. (1993): Open and reconfigurable

hypermedia systems: a filter-based model. Hypermedia 5(2): 103-118. London: Taylor Graham.

(29) Kaddari,M.Z. (1980): S.Y. Agnon's Hebrew Style (Hebrew: Say 'Agnón Rav Sagnón). Ramat-Gan, Israel: Bar-Ilan University Press.

(30) Kampis, G. (1995): Review of *Life Itself. A Comprehensive Inquiry into the Nature, origin, and Fabrication of Life,* Vol. 1, by R. Rosen (Complexity in Ecological System Series). New York: Columbia University Press. Bio Systems: J. Biol. and Inform. Processing Sciences 35(1): 93-98. Amsterdam: Elsevier.

(31) Kugel, J.L. (1994): In Potiphar's House: The Interpretive Life of Biblical Texts. Cambridge, MA: Harvard University Press (1990. 2nd edn.: 1994).

(32) Lenssen-Erz,T. (1989): The catalogue. In Pager (1989): 343-502.

(33) Lenssen-Erz, T. (1994): Facts or fantasy? The rock paintings in the Brandberg, Namibia, and a concept of textualization for purposes of data processing. In: Bouissac, P. (ed.): Special issue on "Prehistoric Signs", Semiotica 100(2/4): 169-200.

(34) Li, Z., Hall, W., Davis, H. (1992): Hypermedia links and information retrieval. In: Proc. 14th British Computer Society Research Colloquium on Information Retrieval, Lancaster University.

(35) Maes, P., Nardi, D. (1988): Preface. In: Maes, P., Nardi, D. (eds.): Meta-Level Architectures and Reflection (pp.VII-VIII). Amsterdam: North-Holland.

(36) Mili, H., Rada, R. (1988): Merging thesauri: principles and evaluation: IEEE Transactions on Pattern Analysis and Machine Intelligence 10(2): 204-220.

(37) Nissan, E. (1975): Ricordo di David Schaumann (6 agosto 1910 — 6 luglio 1975) — Il nostro maestro. Boll. Comunitá Israelitica di Milano 31(1), September: 5-6.

(38) Nissan, E. (1987): Artificial intelligence in higher education. Part II: AI for education. Present trends, as sources for a concept of knowledge-presentation. In: Osthoek H., Vroeijenstijn, T. (Eds.): Higher Education and New Technologies: Proc. Fifth EARDHE Conference, Utrecht, 1987 (pp. 67-98). Oxford: Pergamon (1989).

(39) Nissan, E. (1991): Artificial intelligence as a dialectic of science and technology, and other aspects. Ch. 5 in: Negrotti, M. (Ed.): Understanding the artificial: on the future shape of artificial intelligence (pp. 77-90). Berlin: Springer-Verlag. Also: L'intelligenza artificiale come dialettica fra scienza e tecnologia. Ch. 5 (pp. 119-140) in: Negrotti, M. (ed.): Capire l'artificiale (1990), and in: Capire l'artificiale: dall'analogia all'integrazione uomo-macchina (1993). Torino, Italy: Bollati-Boringhieri.

(40) Nissan, E. (1992): Deviation models of regulation: a knowledge-based approach. Informatica e Diritto, Year XVIII, 2nd Series, 1(1/2): 181-212.

(41) Nissan, E. (1995): Meanings, expression, and prototypes. Pragmatics and Cognition 3(2), in press.

(42) Nissan, E., Siegelmann, H., Galperin, A., Kimhi, S. (1994): Towards full automation of the discovery of heuristics in a nuclear engineering project, by combining symbolic and subsymbolic computation. In: Ras, Z.W., Zemankova, M. (Eds.): Proc. Eighth International Symposium on Methodologies for Intelligent Systems (ISMIS'94), Charlotte, North Carolina, October 16-19, 1994. Lecture Notes in Artificial Intelligence, Vol. 869 (pp. 427-436). Berlin: Springer Verlag.

(43) Nissan, E., Weiss, H. (1995a): The HyperJoseph Project. Part A: Hypermedia and knowledge representation for supporting an analysis of the text and narrative in Genesis 39 and of the respective exegesis and legendary homiletics. Part B: A representation syntax for intertextuality, that takes into account translation, editing, and the page layout of given editions. In: Poswick, F. (Ed.): Proc. Fourth International Conference on Bible and Computers (AIBI'94), Amsterdam, August 1994. Geneva & Paris: Champion-Slatkine (in press).

(44) Nissan, E., Weiss, H. (1995b: in preparation): HyperJoseph.

Hypertextual text- and knowledge-organization for an analyzed narrative passage from Genesis 39 (by Weiss & Nissan). By Nissan & Weiss: Part II: The text, narration as formulated, and action: a graphic formalism. Part III: Remarks on time as in the narrated story, in the context of the overall formalism. Part IV: Role reversal. Part V: For a formalization of intertextuality: the Biblical narrative and legendary homiletics. Part VI: Joseph as an exemplum in the traditional edification literature: a basis for considerations on desiderata in commonsense-based inter- and hypertextual retrieval. Part VII: Edulcorated accounts as based on expected background conceptualization. the case of Bibles for children. Part VIII: On the knowledge in iconography. Part IX: Towards a formal model of parody and subservient intertextual devices: Jacob, Joseph, pride and prejudice in a mock homily on Columbus. Part X: A comparative study of the foreign woman motif in homiletic narratology, and the mythopoiesis of narrative solutions as in a goal/plan perspective. Part XI: The man who did yield. An attempt at formalization of analogy and contrast in two parallel narratives: Joseph as an episodic and deontic model, and the legend of Emperor Rudolph's birth as an explicit calque. Book in preparation.

(45) Nowakowska, M. (1986): Cognitive Sciences: Basic Problems, New Perspectives, and Implications for Artificial Intelligence. New York: Academic Press.

(46) Pager, H. (1989-): The Rock Paintings of the Upper Brandberg.: Part I: Amis Gorge (1989). Part II: Hungorob Gorge (1993). Part III: Ga'aseb and Southwestern Gorges (in preparation). Köln: Heinrich-Barth-Institut.

(47) Persoft. (1988): Using Your IZE. Reference Manual. Madison, WI: Persoft, Inc.

(48) Rosowsky, S. (1957): The Cantillation of the Bible: The Five Books of Moses. New York: Reconstructionist Press.

(49) Ruozzi Sala, S.M. (1974): Lexicon nominum Semiticorum quae in papyris Graecis in Aegypto repertis: ab anno 323 a.Ch.n. usque ad annum 70 p.Ch.n. laudata reperiuntur (Italian). (Testi e Documenti per lo Studio dell'Antichità, XLVI.) Milan: Cisalpino-Goliardica (distrib. Hoepli).

(50) Weinberg, W. (1975-9): The history of Hebrew plene spelling. Hebrew Union College Annual. Vol. 46 (1975): 457-487; Vol. 47 (1976): 237-280; Vol. 48 (1977): 291-333; Vol. 49 (1978): 311-338; Vol. 50 (1979): 289-317.

(51) Weiss,H. (1985): The Voice of the Soul ("Kolha-Neshamah"): Studies in "Hadom ve-Kisseh" (Footstool and Throne), S.Y. Agnon's Book of Chronicles (Hebrew). Ramat-Gan: Bar-Ilan University Press.

(52) Weiss, H. (1989): Analytical index for the complete works of Agnon. A scholarly tool in preparation. Literary & Linguistic Computing 4(3).

(53) Weiss, H. (1990): Selections from the computerized literary index of the complete works of S.Y. Agnon (Hebrew). In: Fruchtman, M. & Kaddari, M.Z. (Eds.): Stylistics and the Literary Text. Special issue of Hebrew Linguistics, Nos. 28-29-30 (pp. 43-55). Ramat-Gan: Bar-Ilan University Press.

(54) Weiss, H. (1991): Dynamic indexing for the analysis of literary text. Int. Classif. 18(4): 200-204.

(55) Weiss, H. (1992): A prototype of a semi-automatic laboratory for indexing, classification and analysis for texts. Proc. 12th ALLC Conference: 226-229.

(56) Woods, D.D. (1986): Cognitive technologies: the design of joint human-machine cognitive systems.: The AI Magazine 6(4): 86-92.

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