Layered, Adaptive Results: Interaction Concepts for Large, Heterogeneous Data Sets

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ABSTRACT

Some data environments are not well served by current styles of search results presentation. One example of this is large-scale archival, library or museum collections. The range of user goals and interaction needs can be quite broad, and the information itself is highly structured yet very heterogeneous – it spans many subject areas, information types, and presentation/media. Based on the use of semantic web formats for metadata, we believe it is possible to leverage the semantic relationships to drive aspects of results presentation – to change elements of the UI itself in response to the results data. We present these concepts as a catalyst for discussion with the HCIR research community, exploring how semantic structures can support arrangement and components available for refining search results sets, and thus make the interface more responsive to user's goals and needs.

1. INTRODUCTION

Current commercial search tools are primarily instance-driven – they focus the user on specific content items (results lists) and rely on the quality of relevance algorithms to increase the likelihood that information related to a user's goals will be near the top of the results set. While this has successfully addressed some needs in targeted, open world seeking scenarios, limitations have been identified both for exploratory search [1] and in more closed-world situations (e.g. intranets and specific domain searching).

Beyond instance-level lists, facets provide a simple, interactive abstraction of the underlying results set, derived from the attributes of the result instances. However, while they are successful in helping users filter large results sets, they become problematic when the data is very heterogeneous or changes frequently, and thus the available categories for facets are not easily representative of the potential results set. Facet categories can be difficult to establish, and what can be reliably categorized may not map to users' needs.

There are increasing examples of visualization of search results in order to get a meta-level profile of the types of results returned [2, ch.10]. There are also good examples of model-driven interactions with results sets, based on semantic data relationships, where the interaction with the model extends beyond filtering to broader exploration. mSpace[1] and Parallax[2] are two of the best known examples. However, in these cases, the models remain primarily subject-centered, and the UI itself does not adapt to aspects of the model that are mapped to, or present in, the results metadata and content. Fortunately, it's encouraging to see the concept of responsive UIs increasingly discussed in semantic UI and HCIR papers [e.g. 3, 4, 5].

The work described here represents design thinking and data modeling, not yet implementation. Future prototypes and user studies will assess the value of the concepts, identify what metadata refinement is needed, and find performance issues for technical design. In the meantime, this position paper aims to open discussion of the concepts with HCIR researchers.

2. DOMAIN & INFORMATION CONTEXT

The domains where this approach is being considered are not "open world" search domains. Within the archival, library and museum environments, records and artifacts have particular attributes that provide opportunities and challenges [6]:

- Metadata is highly structured, as are hierarchical relationships within sets of information. However, much of this structure is catalog, not subject, related.
- Some subject and entity categorization exists, although often at a higher aggregate level, and it may be inconsistently applied.
- A wide range of subjects can be present in collections, as they come from a wide range of sources.
- Vocabulary changes quite dramatically over time, yet the vocabulary used to describe items must remain appropriate to its period for historical integrity. Classification schemes that aim to capture this vocabulary can become huge themselves, with millions of terms in the most used schemes.
- Not all materials are equally indexable for search – collections include handwritten text, scanned photographs, drawings, encoding-rich databases, statistical data, legalese, and lots of redundant content.
- User needs (and familiarity with archival/research techniques) vary quite widely, from researching all aspects of detailed subjects that span dozens (or hundreds) of years, to finding single specific documents relating to individual personal ancestors.

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[1] http://mspace.fm
[2] http://www.freebase.com/labs/parallax/

While such collections are not open-world, they can't be considered entirely closed world, either. Useful collections from one institution are often cross-referenced and incorporated with specific materials from other sources. Increasing use of shared ontologies and standard classification schemes (such as the Library of Congress Subject Headings[3]) aim to support cross-collection research and search federation. One might consider this a "porous world" scenario for IR purposes.

3. DESIGN DRIVERS IN THE DATA

It is important to identify metadata and classification elements that will provide sufficient leverage to support relevance and usability, and still be consistently available (and reliable) across a wide and rapidly-growing data environment. While the specific leverage elements will be different in various domains and collections, there are a few key "drivers" that appear to be most useful when identifying interaction approaches in the archival environment. The design concepts presented in this paper have focused on:

- **Quantity:** The number of results returned (overall and by type), and balance of attributes in results.
- **User context:** Their search "perspective" (focus on particular content object types), and motivation (depth, breadth, duration of research).
- **Structure:** The relationships between objects (hierarchy of objects and their aggregate descriptions), and object types that can be mapped to interaction components.
- **Subject alignment:** The degree of consistency or variance in returned results.

4. APPROACH

Layering deals with arranging UI components based on the quantity of results, particularly for result sets with strong structure or where large volumes of data are associated with particular terms (searching for things related to "John Kennedy" and "Nuclear" returns large numbers of records for the US President, the aircraft carrier, the space center, along with other non-related records).

Layering aggregates related items so users can survey the results set overall, in order to assess alignment with their expectations/goals. They then progressively explore details from within related sets, as well as remove less relevant sets. It also exploits the blending of search and browse actions over time.

Adaptive aspects of the UI provide users with appropriate controls for the attributes of the results they are exploring at any one time, as well as aligning the UI to their personal situation.

The mix of layering and adaptive approaches may also make the application more scalable over time, because collections could be searchable with less of curators' item-level preparation time.

5. LAYERING

There are two aspects being explored for UI layering: *result item layering* (responding to the structure in results, such as parent-child instances, by collapsing sets of related results), and *containership layering* (responding to quantity of results by organizing information into object type sets).

[3] http://id.loc.gov/

5.1 Result Item Layering

Imagine that a search result set includes 5,000 photographs based on the work of three photographers, as well as individual record-level results from ten databases that return over 1,000 items each. Because of the structure of the metadata, those 15,000 "results" will flood the list, and typical facet categorization will not adequately narrow such similarly-described items. Rather than flat lists of individual instances, a hierarchical representation could look like this:

Figure 1: Layered result with relevant item sets presented together

As the user explores the hierarchal data set, increasingly specific refinement can be available, since the data set is increasingly homogeneous and smaller.

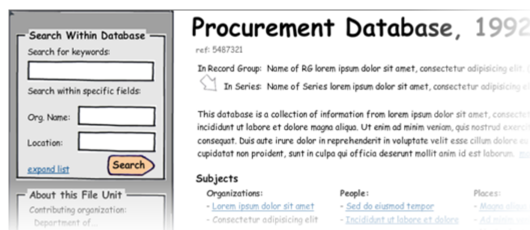

Figure 2: Content display includes "search within" relevance

The underlying semantic model that would be leveraged by the search application would need to look something like this:

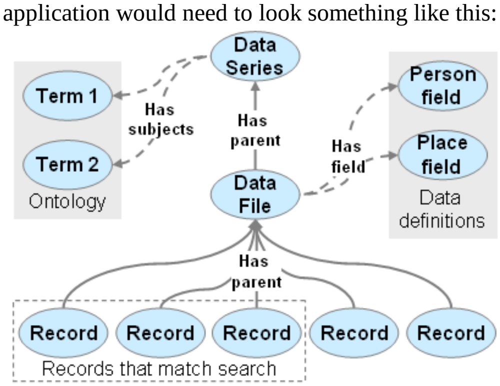

Figure 3: Hierarchy relationship models, with field maps

5.2 Containership Layering

As noted earlier, a search for "John Kennedy" will produce results for a large number of individuals, including the President and his son. It will also include many things named after the President, such as the aircraft carrier, library, performing arts center, space center, and many schools.

The concept of containership layering is to take strong type attributes and use them as a primary grouping mechanism. In small result sets, this can be presented as a primary facet, but as the result set grows the containers can be used differently.

Across many public collections, there is a strong attribute set that may be useful: Organization, Person, Place, Event, Subject. If we consider using these to distinguish particular classes of results, we gain significant leverage in the UI. For example, consider our example search for "John Kennedy," with increasing results:

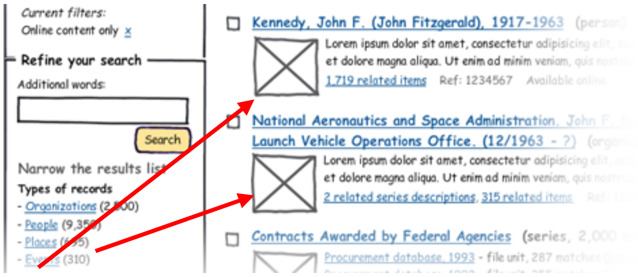

Figure 4: Simple results can use a common facet for a small number of items

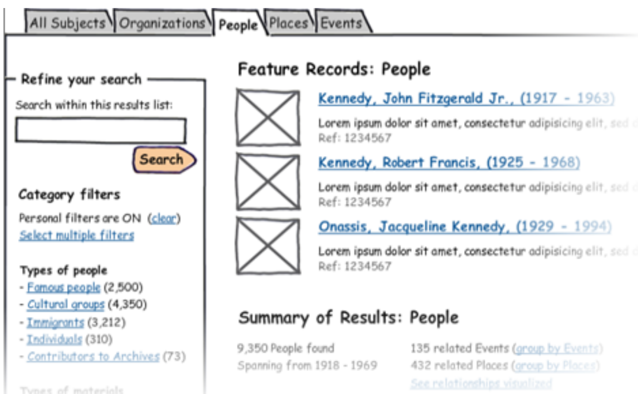

Figure 5: Layered search result, exploiting types as tabs to allow more refinement within focused subsets of results

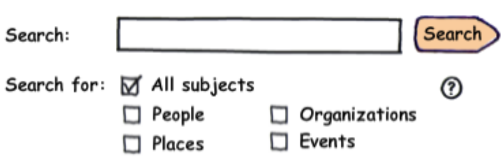

Figure 6: Simple user input as start of search can direct user to the most relevant tab by default

The same effect can help with searching databases, where a large number of results can be returned. For example, searching a large database for "James West" can produce numerous results that include "West Virginia." It is not practical for curators to map every field and value, then design a model that disambiguates every possible term in a user's search, but greater disambiguation could be possible from a layered UI – person-related results could flow into the Person tab, where location-related results could appear in the Places tab. An ontology that drives the metadata catalog for the database could help a curator map important specific fields when preparing the content:

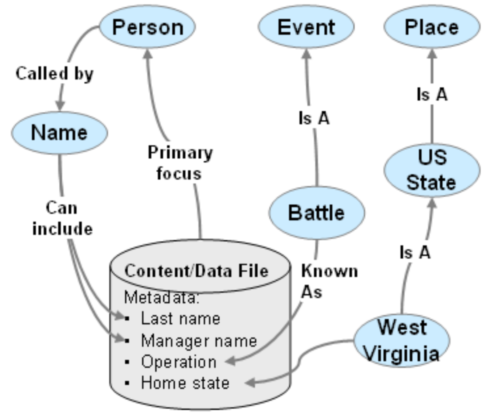

Figure 7: Basic semantic relationships can define containers

6. ADAPTIVE COMPONENTS

The main aspects of adaptive component selection currently being explored are *type-specific interactions* (providing widgets that work on particular data types, like maps and timelines), *quantity-driven interactions* (adding summarization and visualization as quantities of results increase), and *user data management* capabilities (controls for saving, annotating, relating, and organizing personal research activities – this type of adaptivity could also include user view customization).

6.1 Type-Specific Interactions

As part of the use of containership layering, the tab layers offer the benefit of more screen real estate that can be focused on any particular type of result. For example, the John Kennedy "Events" tab could show a timeline of major events to help users focus on particular events or time periods.

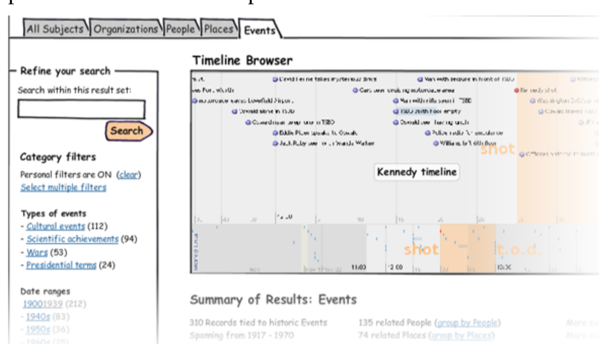

Figure 8: Timeline component mapped to "event" type data

The events on the timeline could be pulled from an ontology, rather than facet/instance data, allowing the events in the timeline to interact with other filters and data applied by users.

In the example of "Person" data, a network diagram (drawn from the underlying RDF graph) could be used to illustrate family relationships between results of prominent/famous people (where such data maps exist in the ontology or name/subject thesaurus).

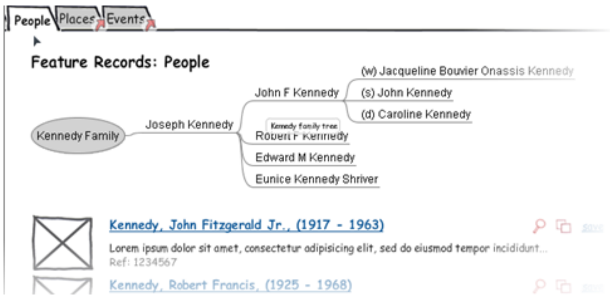

Figure 9: Relationship tree component for "person" type

6.2 Quantity-Driven Interactions

The more potentially relevant information the user needs to sort through and evaluate, the greater the need for different ways of controlling initial search results. Levels of abstraction can help a user identify characteristics (patterns) in the results, including:

- How homogeneous or heterogeneous the result set
- Whether there are clusters or dominant subject areas
- What filters could offer the greatest refinement value

Some of the representations we consider include thesauri maps to provide additional refinement (narrowing or broadening) and visualizations (to support actions like attenuating certain clusters of results, and making sure outliers do not get overlooked).

6.3 User Data Management Capabilities

In section 3, user motivation was mentioned as a driver. For example, a user's expectations are very different when taking 5-10 minutes to look up a photo for a junior high school book report than taking months to research photo composition techniques and subjects for a commercial historical reference book. In these examples, users have said they would value differences in the "directness" of the UI and the level of supporting capabilities available. One idea being explored allows the "motivation" preference to be stated by the user as part of the initial search entry. For multi-session searching, this could even be stored as a default preference in the user's profile.

Another approach is to provide users with options to add useful components and tools for more exploratory or research tasks. These choices could be saved as part of user preferences, and turned off (at least temporarily) when the user's situation is different. For example, the accordion display and editing/control buttons for account holders on the Footnote.com site, when viewing detailed records, is an example of useful additional tools for regular users when doing research.

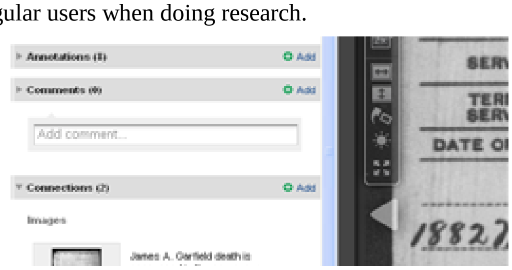

Figure 10: User data entry space and image manipulation controls available via show/hide; www.Footnote.com

The application should also respond differently when faced with different environment variables, such as when used on a mobile device or with an active screen reader employed by a blind user. The more complex the search results controls and representations become, the more they need to be responsive to the device or other environmental conditions brought by each user.

7. CONCLUSION

The layering and adaptive ideas described in this paper are the outcome of exploring user tasks, behaviors, and the particular data relationships found in archival, library or museum environments. Exploring these ideas with the HCIR community helps us consider effects and challenges with various approaches.

The increasing use of semantic web formats in the tools and data make it possible to provide a more dynamic, relevant user experience. Designing UIs based on models that support the user, rather than increase a user's cognitive load, is an important and challenging task. Using the relationship models inherent in the semantics to drive the way the interface itself is presented need to be explored and discussed, in order to overcome some issues with existing results interfaces when faced with large, heterogeneous, and changing data environments.

8. REFERENCES

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