FAIR Signposting Profile

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This page details concrete recipes that platforms that host research outputs (e.g. data repositories, institutional repositories, publisher platforms, etc.) can follow to implement Signposting, a lightweight yet powerful approach to increase the FAIRness of scholarly objects.

Landing pages support humans that interact with scholarly objects on the web, providing descriptive metadata and links to content. These pages are not optimized for use by machine agents that navigate the scholarly web. For example, how can a robot determine which links on the myriad of landing pages lead to content and which to metadata? Signposting caters to machine agents by providing this information, and more, in a standards-based way. It contributes to FAIR's Findable, Accessible, and Reusable by uniformly conveying to machines what the persistent identifier of a scholarly object is, where its landing page is, where and what its content is, where metadata that describes it is, and what the persistent identifier of its author is. It conveys this by means of meaningful links that have web locations (HTTP URIs) as their target. As such it does significantly more than merely providing the information. It invites machine agents to follow the links to their target location on the web, and hopefully find further information and links there. It essentially provides them with a map to guide their travels across the scholarly web. Signposting contributes to FAIR's Interoperable through its uniform approach and because it is entirely based on widely implemented web protocols specified in IETF RFCs. As such, the interoperability that results from adopting it is not restricted to the scholarly landscape but encompasses the web at large.

The recipes provided in this document take a gradual approach towards increasing FAIRness for scholarly resources by means of Signposting:

- **Level 1** requires providing a minimal set of typed links via HTTP `<link>` headers and/or HTML `<link>` elements. Despite its simplicity, it already significantly improves the ability of machine agents to navigate the scholarly web.
- **Level 2** requires providing a comprehensive set of typed links via a Link Set and making that Link Set discoverable. It increases the action radius of machine agents and provides them with a complete map of a scholarly object.

"Signposting has a ridiculously low cost of entry (if you serve scholarly content over HTTP, you're already almost there)"
- Luc Boruta in GitHub feedback on this document.

Make it so!

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1. Introduction

1.1. A Scholarly Object on the Web

It has become common to publish scholarly objects on the web as a set of web resources, each equipped with an HTTP URI. A **scholarly object** typically has:

- A **persistent identifier**, e.g. a DOI or handle expressed as an HTTP URI.
- A **landing page** that is reachable by dereferencing the persistent identifier and following HTTP redirects. The landing page typically describes the scholarly object and provides links to its content resources. Note that, in some cases, such as articles published in HTML, the landing page actually represents content of the resource. For the purpose of the recipes it still is referred to as the landing page.
- One or more **content resources** that provide the actual content of the scholarly object, such as a PDF article, a CSV dataset, a ZIPped software repository, a dynamically generated map.
- One or more **metadata resources** that describe the scholarly object in commonly used formats.
- Other **identifiers** that pertain to the scholarly object, including:
  - Identifiers for **authors**, e.g. ORCID or ISNI, expressed as HTTP URIs.
  - Identifiers of applicable **licenses**, e.g. Creative Commons licenses, expressed as HTTP URIs.
  - Identifiers for scholarly object **types** expressed as HTTP URIs from commonly used vocabularies, e.g. schema.org.

1.2. Typed Links
Typed links are more expressive than plain `href` links in HTML. They actually express the nature of the relationship between the origin and the target of the link. Note that, in this document, the term origin is used as an intuitive synonym for the term link context, which is used in the Web Linking RFC8288 that defines typed web links.

The IANA Link Relation Registry lists a wide range of relation types that are described in formal specifications such as IETF RFCs. Using relation types from that Registry yields web-scale interoperability and therefore the FAIR Signposting Profile builds on it.

There are 3 approaches to convey typed links:

1. For HTML pages: Using the HTML `<link>` element in the head section of the HTML.
2. For web resources of any media type: Using Link in the HTTP response header.
3. For web resources of any media type: Using a standalone document called a Link Set that is made discoverable by means of a typed link with the linkset relation type. More details on Link Set are provided in Section 1.4

Approach (2) has significant advantages:

- The approach can uniformly be used for any web resource, not only for the landing page but also for any type of content resource. Machine agents only need to look in one place to find guidance for the next destination in their travels.
- In addition to being available via HTTP GET requests, the HTTP header that contains Link is accessible via the HTTP HEAD request, which only returns transaction metadata not a resource representation. As such machine agents can obtain a map for their journey by issuing a HTTP HEAD even against resources that have access restrictions. All the while saving bandwidth and hence energy.
- Typed links conveyed via Link in the HTTP header allow one to explicitly indicate the origin of the link. This allows having any resource as link origin, not just the resource that the machine agent interacts with as is the case with `<link>` in HTML. As a result, links provided via Link in the HTTP header of the landing page can also contain links that have content resources as link origin.

Approach (3) has the same advantages as approach (2) but additionally allows to convey large numbers of links without running the risk that the HTTP header becomes too large to be handled by the web server.

1.3. Typed Links in the FAIR Signposting Profile

The Relation Types that are used for the FAIR Signposting Profile as a means to meaningfully interlink resources that represent a scholarly artifact on the web are shown in the below table. The general description of their meaning is based on the more formal language used in the specification that define them. Their specific use for the FAIR Signposting Profile is provided in the descriptions of Level 1 and Level 2, below.

<table>
<thead>
<tr>
<th>Relation Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>author</td>
<td>The target of the link is a URI for an author of the resource that is the origin of the link.</td>
</tr>
<tr>
<td>cite-as</td>
<td>The target of the link is a persistent URI for the resource that is the origin of the link.</td>
</tr>
<tr>
<td>describedby</td>
<td>The target of the link provides metadata that describes the resource that is the origin of the link.</td>
</tr>
<tr>
<td>describes</td>
<td>The origin of the link is a resource that provides metadata that describes the resource that is the target of the link. It is the inverse of the describedby relation type.</td>
</tr>
<tr>
<td>type</td>
<td>The target of the link is the URI for a class of resources to which the resource that is the origin of the link belongs.</td>
</tr>
<tr>
<td>license</td>
<td>The target of the link is the URI of a license that applies to the resource that is the origin of the link.</td>
</tr>
</tbody>
</table>
1.4. Typed Links Provided in Link Sets

Link Sets are specified in RFC9264, Linkset: Media Types and a Link Relation Type for Link Sets:

- A Link Set is a collection of typed links, including links pertaining to the resource that makes the set of links discoverable.
- A Link Set is made discoverable by means of a typed link with the linkset relation type registered in the IANA Link Relation Registry. A type attribute on that link conveys the media type that is used to serialize the Link Set.
- Two approaches exist to serialize a Link Set: one is JSON-based (media type application/json+linkset) and the other uses the same format as the payload of the HTTP Link header (media type application/linkset).
- For all typed links in a Link Set, both link origin and link target must be explicitly provided and expressed as absolute URIs. This allows to unambiguously interpret a Link Set without the need to save contextual information such as the URI where it is published.

2. Recipes for Implementing the FAIR Signposting Profile

This section describes two complementary approaches to convey typed links: the Level 1 and Level 2 recipes. They differ regarding the way in which typed links are conveyed and regarding the extent of the set of typed links that is conveyed:

- How typed links are conveyed:
  - Level 1: Typed links are conveyed by value in the HTTP Link header and/or the HTML <link> element.
  - Level 2: Typed links are conveyed by reference in a link set, which is made discoverable by means of a link with the linkset relation type in the HTTP Link header and/or the HTML <link> element.
- How comprehensive the set of typed links is:
  - Level 1: A minimal set of typed links with the landing page (mandatory), the content resources (recommended), and the metadata resources (recommended) as link origin.
  - Level 2: A comprehensive set of typed links with the landing page (mandatory), the content resources (mandatory), and the metadata resources (mandatory) as link origin.

Implementing the Level 1 recipe entails:

2.1. Level 1 - A Minimal Set of Typed Links via the HTTP Link header and/or HTML <link>

Implementing the Level 1 recipe entails:

- Mandatory - Providing a minimal set of typed links that have the landing page as link origin. These links are conveyed in the landing page's HTTP Link header and/or using <link> elements in the <head> of the HTML of the landing page. See Section 2.1.1.
- Recommended - For each content resource, providing a minimal set of typed links with that resource as link origin. These links are conveyed in the content resources' HTTP Link header. See Section 2.1.2. This is recommended rather than mandatory because cases exist whereby content resources are hosted on a different platform than the landing page; modifying HTTP headers on these platforms may not be possible.
- Recommended - For each metadata resource, providing a minimal set of typed links with that resource as link origin. These links are conveyed in the metadata resources' HTTP Link header. See Section 2.1.2. This is recommended
rather than mandatory because cases exist whereby metadata resources are hosted on a different platform than the landing page; modifying HTTP headers on these platforms may not be possible.

This Level aims for uniformity for machine agents that navigate scholarly resources. The limitation for the number of links that must be provided avoids that HTTP headers become too large.

2.1.1. Level 1 - Typed Links Pertaining to the Landing Page

The below image and table show the links with the landing page as link origin that are to be provided when implementing Level 1 of this recipe. In the image:

- Solid green lines indicate links that must be provided.
- Dashed green lines indicate links that must be provided, whenever possible; see the table for more information.

Examples are provided in Section 3.1.

<table>
<thead>
<tr>
<th>Link Relation Type</th>
<th>Link Cardinality</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>author</td>
<td>0 or more</td>
<td>For each author of the scholarly object that has a persistent identifier (e.g. ORCID expressed as HTTP URI), provide a link that has the landing page as link origin and the persistent identifier of the author as target. Be aware that the number of authors for a scholarly object can be large. As such, in order to avoid the risk of the HTTP header becoming too large, it may be safer to provide links for a limited number of authors in the HTTP header and to provide them for all when using Link Sets in Level 2.</td>
</tr>
<tr>
<td>cite-as</td>
<td>1</td>
<td>Provide a link that has the persistent identifier of the scholarly object (e.g. DOI expressed as an HTTP URI) as target.</td>
</tr>
<tr>
<td>describedby</td>
<td>1 or more</td>
<td>Provide one or more links that have the URI of metadata that describes the scholarly object in a commonly used format as target. On each link, provide the media type of the metadata in the type attribute. Common media types include application/x-bibtex (BibTeX), application/vnd.citationstyles.csl+json (CiteProc JSON), application/x-research-info-systems (RIS), application/vnd.datacite.datacite+xml (DataCite XML), application/vnd.datacite.datacite+json (DataCite JSON), application/vnd.jats+xml (JATS), application/vnd.codemeta.ld+json (Codemeta), text/x-bibliography (Formatted text citation). Many other bibliographic formats are in use that have text/plain, application/xml, application/json, or application/ld+json as media type. When providing metadata that describes the scholarly object using these media types, use profile as an extension target attribute on the link to convey, by means of an HTTP URI, the specific format of the metadata. For example, for metadata expressed as application/xml, provide the XML Namespace URI in the profile extension attribute.</td>
</tr>
<tr>
<td>type</td>
<td>2 (in most cases) or 1</td>
<td>Provide a first link that has as target the schema.org term (HTTP URI) for a Creative Work that best characterizes the scholarly object as a whole. For example, provide <a href="https://schema.org/ScholarlyArticle">https://schema.org/ScholarlyArticle</a> in case the object is a scholarly paper; provide <a href="https://schema.org/Dataset">https://schema.org/Dataset</a> if it is a dataset. If no appropriate term is available in <a href="https://schema.org/">https://schema.org/</a>, select one (HTTP URI) from a commonly used ontology. Provide a second link that has as target <a href="https://schema.org/AboutPage">https://schema.org/AboutPage</a> in the common case where an actual landing page is concerned. Do not provide this second link in case a content resource is concerned, i.e. do not provide this second link when the persistent identifier of the scholarly object directly resolves to a content resource, such as an HTML article, without presenting an intermediate landing page.</td>
</tr>
<tr>
<td>license</td>
<td>0 or 1</td>
<td>If the license under which the scholarly object is made available is known, provide a link that has as target the URI of that license. Common licenses used are those provided by the Creative Commons.</td>
</tr>
</tbody>
</table>
The landing page is modeled as a collection of content resources. As such, provide links that have content resources (e.g. the PDF article, the CSV dataset, the ZIPped software repository) as target. Use the `type` attribute on each link to convey the media type of the content resource. If specificity beyond the media type is required to indicate the nature of a content resource, use `profile` as an extension target attribute on the link to convey, by means of an HTTP URI, the more specific format of the content resource. Be aware that the number of content resources for a scholarly object can be unpredictably large. As such, in order to avoid the risk of the HTTP header becoming too large, it may be safer to only provide links for a limited number of content resources in the HTTP header and provide links for all when using Link Sets in Level 2.

### 2.1.2. Level 1 - Typed Links Pertaining to Content Resources and Metadata Resources

The below image and table show the links with **content resources** and **metadata resources** as link origin that need to be provided when implementing Level 1 of this recipe. In the image:

- Dashed green lines indicate links that must be provided, whenever possible, i.e. when it is possible to modify the HTTP headers for content/metadata resources.
- Dot-dashed black lines indicate links that must only be provided in case they convey information that is different from what is conveyed for the scholarly object as a whole by means of the link with the same link relation type ("type" in this case) on the landing page; see the table for further information with this regard.

Examples are provided in Section 3.1.
For each metadata resource, provide a link that has the metadata resource as origin and the landing page as target.

Provide a link only if the type of the content resource differs from the type that best characterizes the scholarly object as a whole. In this case, provide a link that has as target the schema.org term (HTTP URI) for a Creative Work that best characterizes the content resource. If no appropriate term is available in https://schema.org/, select one (HTTP URI) from a commonly used ontology. For example, if the scholarly object as a whole is best characterized as a scholarly paper (https://schema.org/ScholarlyArticle type is provided at the landing page), and the content resource is a dataset, provide a link that has https://schema.org/Dataset as target.

For each content resource, provide a link that has the content resource as origin and the landing page as target.

### 2.2. Level 2 - A Comprehensive Set of Typed Links via a Link Set

Implementing the Level 2 recipe entails:

- **Mandatory** - Providing a Link Set with a comprehensive collection of typed links, consisting of:
• Links with the landing page as link origin. See Section 2.2.1.
• Links with the content resources and metadata resources as link origin. See Section 2.2.2. and Section 2.2.3., respectively.

- Mandatory - Making this Link Set discoverable by providing a linkset link in the landing page's HTTP Link header and/or in <link> in the HTML page's <head> (solid green line in the below image). The media type used to represent the Link Set must be conveyed in the type attribute on the link. Examples are provided in Section 3.2.
- Recommended - Making this Link Set discoverable by providing a linkset link in the HTTP Link header of the content resources and metadata resources. The media type used to represent the Link Set must be conveyed in the type attribute on the link. This link is recommended (dashed green line in the below image) rather than mandatory because cases exist whereby content/metadata resources are hosted on a different platform than the landing page; modifying HTTP headers on these platforms may not be possible. Examples are provided in Section 3.2.

The Link Set that is made available at Level 2 combines links that have the landing page as link origin (Section 2.2.1.), links that have each of the content resources as link origin (Section 2.2.2.), and links that have each of the metadata resources as link origin (Section 2.2.3.). Such a Link Set provides machine agents with a complete map of the scholarly object and is easily cacheable. The below image illustrates the approach.

2.2.1. Level 2 - Typed Links Pertaining to the Landing Page

The below image and table show the links with the landing page as link origin that must be conveyed in a Link Set when implementing the Level 2 recipe. In the image:

- Solid green lines indicate links that must be provided.
- Dashed green lines indicate links that must be provided, whenever possible; see the table for further information with this regard.

Examples are provided in Section 3.2.
<table>
<thead>
<tr>
<th>Link Relation Type</th>
<th>Link Cardinality</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>author</td>
<td>0 or more</td>
<td>For each author of the scholarly object that has a persistent identifier (e.g. ORCID expressed as HTTP URI) provide a link that has the landing page as origin and the persistent identifier as target. Only if none of the authors have a persistent identifier should there be no links with this relation type.</td>
</tr>
<tr>
<td>cite-as</td>
<td>1</td>
<td>Provide a link that has the landing page as origin and the persistent identifier (e.g. DOI expressed as an HTTP URI) of the scholarly object as target.</td>
</tr>
<tr>
<td>describedby</td>
<td>1 or more</td>
<td>Provide one or more links that have the landing page as origin and the URI of metadata that describes the scholarly object in a commonly used format as target. On each link, provide the media type of the metadata in the type attribute. For common media types see the description of describedby in Level 1.</td>
</tr>
<tr>
<td>Term</td>
<td>Count</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>type</td>
<td>2 (in most cases) or 1</td>
<td>Provide a <strong>first</strong> link that has as target the schema.org term (HTTP URI) for a Creative Work that best characterizes the scholarly object as a whole. For example, provide <a href="https://schema.org/ScholarlyArticle">https://schema.org/ScholarlyArticle</a> in case the object is a scholarly paper; provide <a href="https://schema.org/Dataset">https://schema.org/Dataset</a> if it is a dataset. If no appropriate term is available in <a href="https://schema.org/">https://schema.org/</a>, select one (HTTP URI) from a commonly used ontology. Provide a <strong>second</strong> link that has as target <a href="https://schema.org/AboutPage">https://schema.org/AboutPage</a> in the common case where an actual landing page is concerned. Do not provide this second link in case a content resource is concerned, i.e. do not provide this second link when the persistent identifier of the scholarly object directly resolves to a content resource, such as an HTML article, without presenting an intermediate landing page.</td>
</tr>
<tr>
<td>license</td>
<td>0 or 1</td>
<td>If the license under which the scholarly object is made available is known, provide a link that has as target the URI of that license. Common licenses used are those provided by the Creative Commons.</td>
</tr>
<tr>
<td>item</td>
<td>1 or more</td>
<td>For each content resource, provide a link that has the landing page as origin and the content resource (e.g. the PDF article, the CSV dataset, the ZIPped software repository) as target. Use the <strong>type</strong> attribute on each link to convey the media type of the content resource. If specificity beyond the media type is required to indicate the nature of a content resource, use <strong>profile</strong> as an extension target attribute on the link to convey, by means of an HTTP URI, the more specific format of the content resource.</td>
</tr>
</tbody>
</table>

**2.2.2. Level 2 - Typed Links Pertaining to Content Resources**

The below image and table show the links that must be conveyed in a Link Set for each content resource when implementing Level 2 of this recipe.

- Solid green lines indicate links that must be provided.
- Dashed green lines indicate links that must be provided, whenever possible; see the table for further information with this regard.
- Dot-dashed black lines indicate links that must only be provided in case they convey information that is different from what is conveyed for the scholarly object as a whole by means of links with the same link relation type (respectively "author", "cite-as", "describedby", "license", and "type") on the landing page; see the table for further information with this regard.

Examples are provided in Section 3.2.
<table>
<thead>
<tr>
<th>Link Relation Type</th>
<th>Link Cardinality</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>author</td>
<td>0 or more</td>
<td>Provide links only if the content resource has authorship that is distinct from that of the scholarly object as a whole. In this case, for each author of the content resource that has a persistent identifier (e.g. ORCID expressed as HTTP URI), provide a link with the content resource as origin and that persistent identifier as target. Do not provide links that express the authorship of the scholarly object as a whole.</td>
</tr>
<tr>
<td>cite-as</td>
<td>0 or 1</td>
<td>Provide a link only if the content resource has a persistent identifier that is distinct from the persistent identifier of the scholarly object as a whole. In this case, provide a link that has the content resource as origin and the persistent identifier of the content resource (e.g. handle expressed as an HTTP URI) as target. Do not provide a link that expresses the persistent identifier of the scholarly object as a whole.</td>
</tr>
<tr>
<td>Description</td>
<td>Quantity/Attribute</td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------</td>
<td></td>
</tr>
<tr>
<td>describedby</td>
<td>0 or more</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provide links only if the content resource is described by metadata that is distinct from the metadata that describes the scholarly object as a whole. In this case, provide one or more links that has the content resource as origin and the URI of metadata that describes the content resource in a commonly used format as target. On each link, provide the media type of the metadata in the type attribute. For common media types see the description of describedby in Level 1.</td>
<td></td>
</tr>
<tr>
<td>type</td>
<td>0 or 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provide a link only if the type of the content resource differs from the type that best characterizes the scholarly object as a whole. In this case, provide a link that has as target the schema.org term (HTTP URI) for a Creative Work that best characterizes the content resource. If no appropriate term is available in <a href="https://schema.org/">https://schema.org/</a>, select one (HTTP URI) from a commonly used ontology. For example, if the scholarly object as a whole is best characterized as a scholarly paper (<a href="https://schema.org/ScholarlyArticle">https://schema.org/ScholarlyArticle</a> type is provided at the landing page) and the content resource is a dataset provide a link that has <a href="https://schema.org/Dataset">https://schema.org/Dataset</a> as target.</td>
<td></td>
</tr>
<tr>
<td>license</td>
<td>0 or 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provide a link only if the content resource is made available under a license that is distinct from the license that applies to the scholarly object as a whole. In this case, provide a link that has the content resource as origin and the URI of the license under which the content resource (e.g. a Creative Commons license URI) is made available as target. Do not provide a link that expresses the license of the scholarly object as a whole.</td>
<td></td>
</tr>
<tr>
<td>collection</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provide a link that has the content resource as origin and the landing page as target.</td>
<td></td>
</tr>
</tbody>
</table>

### 2.2.3. Level 2 - Typed Links Pertaining to Metadata Resources

The below image and table show the links that must be conveyed in a Link Set for each metadata resource when implementing Level 2 of this recipe.

- Solid green lines indicate links that must be provided.

Examples are provided in Section 3.2.
For each metadata resource, provide a link that has the metadata resource as origin and the landing page as target.

3. Examples

This section shows examples for providing typed links and Link Sets for Level 1 and Level 2 of the FAIR Signposting Profile. Throughout the examples, the fictitious scholarly object as shown in the below table is used.

<table>
<thead>
<tr>
<th>Scholarly Object Resources</th>
<th>HTTP URI</th>
<th>Media Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistent Identifier</td>
<td><a href="https://doi.org/10.1234/56789">https://doi.org/10.1234/56789</a></td>
<td></td>
</tr>
<tr>
<td>Landing Page</td>
<td><a href="https://example.org/page/7507">https://example.org/page/7507</a></td>
<td>text/html</td>
</tr>
<tr>
<td>Content Resource 1 - Article</td>
<td><a href="https://example.org/file/7507/1">https://example.org/file/7507/1</a></td>
<td>application/pdf</td>
</tr>
<tr>
<td>Content Resource 2 - Dataset</td>
<td><a href="https://example.org/file/7507/2">https://example.org/file/7507/2</a></td>
<td>text/csv</td>
</tr>
</tbody>
</table>
3.1. Examples Level 1

At Level 1, a minimal set of typed links pertaining to the landing page must be provided. This can be done in the page's HTTP Link header and/or in <link> elements in the <head> section of that page's HTML. Remember that typed links in the HTTP Link header are accessible via both HTTP HEAD and GET, while links in the HTML are only accessible via HTTP GET. Each content resource should also provide a minimal set of links pertaining to itself. This should be done via the resource's HTTP Link header.

When using the Link header approach, the required typed links can be conveyed in a single the HTTP Link header or using multiple Link headers, one header per link. Line breaks must not be used in Link headers as they are not allowed per RFC7230; only whitespaces and tabs are supported as separators.

The below examples show responses to an HTTP GET request issued against the URI of the landing page of our fictitious scholarly object. In the first example, the HTTP header approach is used to convey the typed links, with all links provided in a single Link header. Note that the same links could simultaneously be provided via <link> elements in the HTML's <head>. In the second example, the typed links are provided in the HTML's <head> but not in the HTTP Link header.

Level 1 typed links pertaining to the landing page via the HTTP Link header

<table>
<thead>
<tr>
<th>Other Signposting Resources</th>
<th>HTTP URI</th>
<th>Media Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Landing Page</td>
<td><a href="https://schema.org/AboutPage">https://schema.org/AboutPage</a></td>
<td></td>
</tr>
<tr>
<td>Type of Content Resource 1 - Article</td>
<td><a href="https://schema.org/ScholarlyArticle">https://schema.org/ScholarlyArticle</a></td>
<td></td>
</tr>
<tr>
<td>Type of Content Resource 2 - Dataset</td>
<td><a href="https://schema.org/Dataset">https://schema.org/Dataset</a></td>
<td></td>
</tr>
<tr>
<td>Type of Content Resource 3 - ZIPped Software Repository</td>
<td><a href="https://schema.org/SoftwareSourceCode">https://schema.org/SoftwareSourceCode</a></td>
<td></td>
</tr>
<tr>
<td>License for scholarly object</td>
<td><a href="https://creativecommons.org/licenses/by/4.0/">https://creativecommons.org/licenses/by/4.0/</a></td>
<td></td>
</tr>
<tr>
<td>Link Set</td>
<td><a href="https://example.org/linkset/7507/json">https://example.org/linkset/7507/json</a> application/linkset+json</td>
<td></td>
</tr>
<tr>
<td>Link Set</td>
<td><a href="https://example.org/linkset/7507/lset">https://example.org/linkset/7507/lset</a> application/linkset</td>
<td></td>
</tr>
</tbody>
</table>
The below examples show responses to an HTTP HEAD request issued against the URI of a content resource (respectively, "Content Resource 1 - Article" and "Content Resource 2 - Dataset") of our fictitious scholarly object. Typed links are provided in the resource's HTTP header because that approach can uniformly be used for resources of any media type. Note that Content Resource 1 does not provide a type link because its type coincides with that of the scholarly object as a whole and that type is expressed at the level of the landing page. Content Resource 2, however, has a different type and expresses it by means of a type link.
The below example shows the response to an HTTP HEAD request issued against the URI of a metadata resource of our fictitious scholarly object. The typed link is provided in the resource’s HTTP header because that approach can uniformly be used for resources of any media type.

### Level 1 typed links pertaining to an HTTP Link header

```bash
$ curl -I "https://example.org/file/7507/1"
```

HTTP/1.1 200 OK
Date: Fri, 9 Oct 2020 19:21:29 GMT
Content-Type: application/pdf
Content-Length: 36588
Link: <https://example.org/page/7507> ; rel="collection" ; type="text/html"

```bash
$ curl -I "https://example.org/file/7507/2"
```

HTTP/1.1 200 OK
Date: Fri, 9 Oct 2020 20:03:49 GMT
Content-Type: text/csv
Content-Length: 4285
Link: <https://example.org/page/7507> ; rel="collection" ; type="text/html",
<https://schema.org/Dataset> ; rel="type"

3.2. Examples Level 2

At Level 2, a single Link Set contains a comprehensive set of links pertaining to the landing page, all content resources, and all metadata resources. This Link Set is made available through the provision of `linkset` links by both the landing page and each of the content/metadata resources.

For the landing page, this can be done using the HTTP Link header and/or via `<link>` element's in the HTML's `<head>`. The below examples illustrate both approaches. Each shows the inclusion of two `linkset` links pointing to different serializations of the Link Set. Note that the responses also contain the Level 1 links pertaining to the landing page.

### Link Sets made discoverable by the landing page using the HTTP Link header

```bash
$ curl -I "https://example.org/meta/7507/bibtex"
```

HTTP/1.1 200 OK
Date: Fri, 9 Oct 2020 19:24:33 GMT
Content-Type: application/x-bibtex
Content-Length: 120
Link: <https://example.org/page/7507> ; rel="describes" ; type="text/html"
Each content and metadata resource should also make the Link Set discoverable by means of a linkset link. The only way to do so uniformly for resources of any media type is by using the HTTP Link header approach. The below example illustrates this for Content Resource 1 (Article) of our fictitious scholarly object. It shows the response to an HTTP HEAD issued against that resource’s URI. Note that the response also contains the Level 1 links pertaining to the content resource.

Content resource provides linkset links
An actual Link Set is obtained by issuing an HTTP GET on a URI discovered as described above. The below examples show responses to requests issued against https://example.org/linkset/7507/json (application/linkset+json serialization) and https://example.org/linkset/7507/lset (application/linkset serialization), respectively. Note that it is possible to allow clients to interpret this JSON as JSON-LD by:

- Publishing a JSON-LD context document.
- Making the JSON-LD context document discoverable by providing a typed link with the http://www.w3.org/ns/json-ld#context relation type in the HTTP Link header of the Link Set.

This is shown in detail in Appendix B of the Linkset Internet Draft.

As indicated in Section 2.2.2., if a content resource has distinct a persistent identifier, type, authorship, or descriptive metadata it can be provided in the Link Set using cite-as, type, author, and describedby links, respectively, with the URI of the content resource as anchor. But such links must not be used if these properties are shared with the scholarly object as a whole. Note the way the anchor of each link is provided explicitly in the application/linkset serialization to avoid ambiguous interpretation.

Level 2 typed links via a Link Set in application/linkset+json serialization
$ curl -i "https://example.org/linkset/7507/1/json"

HTTP/1.1 200 OK
Date: Fri, 9 Oct 2020 20:23:44 GMT
Server: Apache-Coyote/1.1
Content-Length: 2608
Content-Type: application/linkset+json
Connection: close

{
    "linkset": [
        {
            "anchor": "https://example.org/page/7507",
            "cite-as": [
                {
                    "href": "https://doi.org/10.5061/dryad.5d23f"
                }
            ],
            "type": [
                {
                    "href": "https://schema.org/ScholarlyArticle"
                },
                {
                    "href": "https://schema.org/AboutPage"
                }
            ],
            "author": [
                {
                    "href": "https://orcid.org/0000-0002-1825-0097"
                },
                {
                    "href": "https://isni.org/isni/0000002251201436"
                }
            ],
            "item": [
                {
                    "href": "https://example.org/file/7507/1",
                    "type": "application/pdf"
                },
                {
                    "href": "https://example.org/file/7507/2",
                    "type": "text/csv"
                },
                {
                    "type": "application/zip"
                }
            ],
            "describedby": [
                {
                    "href": "https://example.org/meta/7507/bibtex",
                    "type": "application/x-bibtex"
                },
                {
                    "href": "https://doi.org/10.5061/dryad.5d23f",
                    "type": "application/vnd.datacite.datacite+json"
                },
                {
                    "href": "https://example.org/meta/7507/citeproc",
                    "type": "application/vnd.citationstyles.csl+json"
                }
            ]
        }
    ]
}
Level 2 typed links via a Link Set in application/linkset serialization

```
$ curl -i "https://example.org/linkset/7507/lset"

HTTP/1.1 200 OK
Date: Fri, 9 Oct 2020 20:22:19 GMT
Server: Apache-Coyote/1.1
Content-Length: 2247
Content-Type: application/linkset
Connection: close

<https://doi.org/10.5061/dryad.5d23f> ; rel="cite-as" ; anchor="https://example.org/page/7507" ,
<https://schema.org/ScholarlyArticle> ; rel="type" ; anchor="https://example.org/page/7507" ,
<https://schema.org/AboutPage> ; rel="type" ; anchor="https://example.org/page/7507" ,
<https://orcid.org/0000-0002-1825-0097> ; rel="author" ; anchor="https://example.org/page/7507" ,
<https://example.org/file/7507/1> ; rel="item" ; type="application/pdf" ; anchor="https://example.org/page/7507" ,
<https://example.org/file/7507/2> ; rel="item" ; type="text/csv" ; anchor="https://example.org/page/7507" ,
<https://gitmodo.io/johnd/ct.zip> ; rel="item" ; type="application/zip" ; anchor="https://example.org/page/7507" ,
<https://example.org/meta/7507/bibtex> ; rel="describedby" ; type="application/x-bibtex" ;
anchor="https://example.org/page/7507" , <https://doi.org/10.5061/dryad.5d23f> ; rel="describedby" ;
type="application/vnd.datacite.datacite+json" ; anchor="https://example.org/page/7507" ,
<https://example.org/meta/7507/citeproc> ; rel="describedby" ; type="application/vnd.citationstyles.csl+json" ;
anchor="https://example.org/page/7507" , <https://creativecommons.org/licenses/by/4.0/> ; rel="license" ;
anchor="https://example.org/page/7507" , <https://example.org/page/7507> ; rel="collection" ; type="text/html" ;
anchor="https://example.org/file/7507/1" , <https://example.org/page/7507> ; rel="collection" ; type="text/html" ;
anchor="https://example.org/file/7507/2" , <https://example.org/page/7507> ; rel="collection" ; type="text/html" ;
anchor="https://example.org/page/7507" ; rel="describes" ; type="text/html" ;
anchor="https://doi.org/10.5061/dryad.5d23f" , <https://example.org/page/7507> ; rel="describes" ; type="text/html" ;
anchor="https://example.org/meta/7507/bibtex"
```

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