

Machine-Actionability and Interoperability





Collective Motion of Humans in Mosh and Circle Pits at Heavy Metal Concerts

Jesse L. Silverberg,^{*} Matthew Bierbaum, James P. Sethna, and Itai Cohen

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(Received 13 February 2013; published 29 May 2013)

Human collective behavior can vary from calm to panicked depending on social context. Using videos publicly available online, we study the highly energized collective motion of attendees at heavy metal concerts. We find these extreme social gatherings generate similarly extreme behaviors: a disordered gaslike state called a *mosh pit* and an ordered vortexlike state called a *circle pit*. Both phenomena are reproduced in flocking simulations demonstrating that human collective behavior is consistent with the predictions of simplified models.

DOI: [10.1103/PhysRevLett.110.228701](https://doi.org/10.1103/PhysRevLett.110.228701)

PACS numbers: 89.65.Ef, 47.32.-y, 87.15.Zg, 87.23.Cc

Human collective behaviors vary considerably with social context. For example, lane formation in pedestrian traffic [1], jamming during escape panic [2], and Mexican waves at sporting events [3] are emergent phenomena that have been observed in specific social settings. Here, we study large crowds (10^2 – 10^5 attendees) of people under the extreme conditions typically found at heavy metal concerts [4]. Often resulting in injuries [5], the collective mood is influenced by the combination of loud (130 dB [6]), fast

Fig. 2, the decay length was 0.39 ± 0.03 m, which is approximately human shoulder width. Taken together, these findings offer strong support for the analogy between mosh pits and gases. As a further check, we examined the 2D speed distribution. Previous observations of human pedestrian traffic and escape panic led us to expect a broad distribution not well described by simple analytic expressions [2,13]. However, the measured speed distribution in mosh pits was well fit by the 2D Maxwell-Boltzmann



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Fig. 2, the decay length was $0.39 \pm$ (approximately human shoulder width). These findings offer strong support for the mosh pits and gases. As a further check, 2D speed distribution. Previous observations in pedestrian traffic and escape panic led us to a distribution not well described by simple analyses [2,13]. However, the measured speed distribution in mosh pits was well fit by the 2D Maxwell





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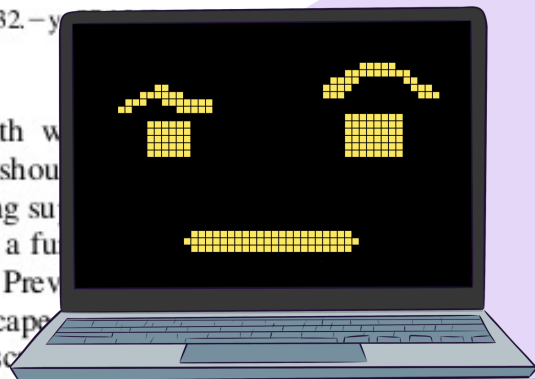
Human collective behavior can vary from calm to panicked depending on social context. Using videos publicly available online, we study the highly energized collective motion of attendees at heavy metal concerts. We find these extreme social gatherings generate similarly extreme behaviors: a disordered gaslike state called a *mosh pit* and an ordered vortexlike state called a *circle pit*. Both phenomena are reproduced in flocking simulations demonstrating that human collective behavior is consistent with the predictions of simplified models.

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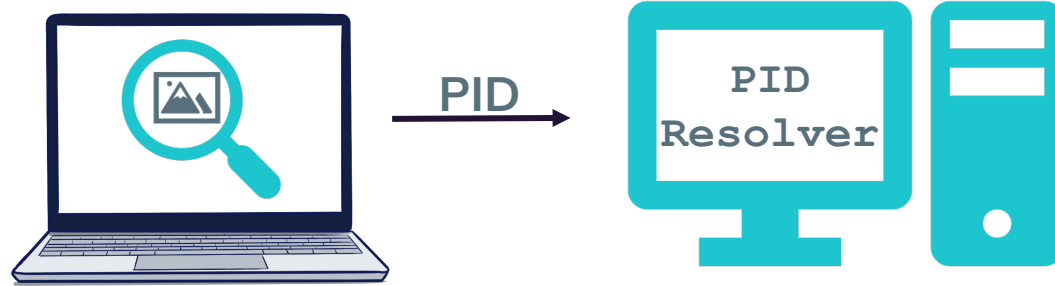
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Fig. 2, the decay length was approximately human shoulder width. These findings offer strong support for the models of mosh pits and gases. As a function of crowd density, we show the 2D speed distribution. Previous studies of pedestrian traffic and escape panic showed a distribution not well described by these models [2,13]. However, the measured speed distribution in mosh pits was well fit by the 2D Maxwell-Boltzmann





Client – PID Resolver Interaction





PID Record Request



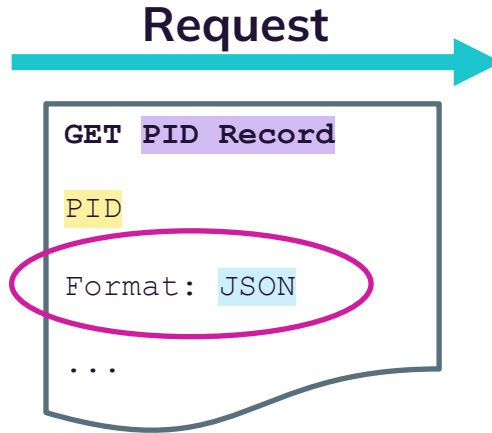
Request

```
GET PID Record  
  
PID  
  
Format: JSON  
  
...
```





PID Record Request





PID Record Schemas

```
▼<xsd:schema xmlns="http://www.crossref.org/schema/5.3.1" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:fr="http://www.crossref.org/fundref.xsd" xmlns:ct="http://www.crossref.org/clinicaltrials.xsd" xmlns:rel="http://www.crossref.org/relations.xsd" xmlns:mml="http://www.w3.org/1998/Math/MathML" xmlns:jats="http://www.ncbi.nlm.nih.gov/JATS1" targetNamespace="http://www.crossref.org/schema/5.3.1" >
  <!-- *****
  Crossref Metadata Input Schema v. 5.3.1
  ***** -->
```

This is the latest iteration of the Crossref Metadata Input Schema, used to register metadata records with Crossref. This schema was originally developed for Crossref by Inera (<http://www.inera.com>)

As of version 4.5.0 all changes are noted in the release notes for the schema repository in GitLab: <https://gitlab.com/crossref/schema/-/releases>

Prior updates are noted as comments within previous schema versions. -->

```
<!-- include common schema -->
<xsd:include schemaLocation="common5.3.1.xsd"/>
<!-- imported schema -->
<xsd:import namespace="http://www.ncbi.nlm.nih.gov/JATS1" schemaLocation="JATS-journalpublishing1-3d2-mathml3.xsd"/>
<xsd:import namespace="http://www.w3.org/1998/Math/MathML" schemaLocation="http://www.w3.org/Math/XMLSchema/mathml3/mathml3.xsd"/>
<xsd:import namespace="http://www.crossref.org/fundref.xsd" schemaLocation="fundref.xsd"/>
<xsd:import namespace="http://www.crossref.org/clinicaltrials.xsd" schemaLocation="clinicaltrials.xsd"/>
<xsd:import namespace="http://www.crossref.org/AccessIndicators.xsd" schemaLocation="AccessIndicators.xsd"/>
<xsd:import namespace="http://www.crossref.org/relations.xsd" schemaLocation="relations.xsd"/>
<!-- *** Head elements (used when processing submission XML) -->
```

```
▼<xsd:element name="doi_batch">
```

```
  ▼<xsd:annotation>
```

```
    <xsd:documentation>Top level element for a metadata record submission. This element indicates the start and end of the XML file. The version number is fixed to the version of the schema.
```

```
  </xsd:annotation>
```

```
  ▼<xsd:complexType>
```

```
    ▼<xsd:sequence>
```

```
      <xsd:element ref="head"/>
```

```
      <xsd:element ref="body"/>
```

```
    </xsd:sequence>
```

```
    <xsd:attribute name="version" type="xsd:string" fixed="5.3.1"/>
```

```
  </xsd:complexType>
```

```
</xsd:element>
```

```
▼<xsd:element name="head">
```

```
  ▼<xsd:annotation>
```

```
    <xsd:documentation>Container for information related to the DOI batch submission. This element uniquely identifies the batch deposit to Crossref and contains information that will be used for DOI
```

```
    processing. </xsd:documentation>
```

```
  </xsd:annotation>
```

```
  ▼<xsd:complexType>
```

```
    ▼<xsd:sequence>
```

```
      <xsd:element ref="doi_batch_id"/>
```

```
      <xsd:element ref="timestamp"/>
```

```
      <xsd:element ref="depositor"/>
```

```
      <xsd:element ref="registrant"/>
```

```
    </xsd:sequence>
```

```
  </xsd:complexType>
```

```
</xsd:element name="body">
```

```
  ▼<xsd:annotation>
```



PID Record Schemas

```

<xsd:schema xmlns="http://www.crossref.org/schema/5.3.1" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:fr="http://www.crossref.org/fundref.xsd" xmlns:ct="http://www.crossref.org/clinicaltrials.xsd" xmlns:rel="http://www.crossref.org/references.xsd" xmlns:mml="http://www.w3.org/1998/Math/MathML" xmlns:jats="http://www.ncbi.nlm.nih.gov/JATS1" targetNamespace="http://www.crossref.org/schema/5.3.1">
  <!-- *****
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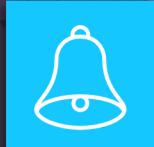
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<!-- include common schema -->
<xsd:include schemaLocation="common5.3.1.xsd"/>
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<xsd:import namespace="http://www.ncbi.nlm.nih.gov/JATS1" schemaLocation="JATS-journalpublishing1-3d2-mathml3.xsd"/>
<xsd:import namespace="http://www.w3.org/1998/Math/MathML" schemaLocation="http://www.w3.org/Math/XMLSchema/mathml3/mathml3.xsd"/>
<xsd:import namespace="http://www.crossref.org/fundref.xsd" schemaLocation="fundref.xsd"/>
<xsd:import namespace="http://www.crossref.org/clinicaltrials.xsd" schemaLocation="clinicaltrials.xsd"/>
<xsd:import namespace="http://www.crossref.org/AccessIndicators.xsd" schemaLocation="AccessIndicators.xsd"/>
<xsd:import namespace="http://www.crossref.org/references.xsd" schemaLocation="references.xsd"/>
<!-- *** Head elements (used when processing submission XML) -->
<xsd:element name="doi_batch">
  <xsd:annotation>
    <xsd:documentation>Top level element for a metadata record submission. This element indicates the start and end of the XML file. The version number is fixed to the version of the schema.

```



PID Record Schemas

are also called

Kernel Information Profiles

identifies the batch deposit to Crossref and contains information that will be used

```

<xsd:element name="doi_batch">
  <xsd:annotation>
    <xsd:documentation>Top level element for a metadata record submission. This element indicates the start and end of the XML file. The version number is fixed to the version of the schema.
  </xsd:annotation>
  <xsd:complexType base="xsd:string" use="required"/>
</xsd:element>
<xsd:element name="body">
  <xsd:annotation>
    <xsd:documentation>

```


One Last Thing about PIDs...

PIDs in Schemas, Vocabularies and Ontologies



allosteric molecule

 http://purl.obolibrary.org/obo/MI_1159 

A molecule whose binding or catalytic properties at one site are altered by allosteric post-translational modification or binding of an allosteric effector at a distinct site. An allosteric molecule is identified by referring to its participant id. 

Search

Exact match Include obsolete terms Include imported terms

 Tree

 Graph

- ↳ molecular interaction (1,454)
 - ↳ attribute name (139)
 - ↳ interaction attribute name (38)
 - 3d-r-factors
 - 3d-resolution
 - 3d-structure
 - affected interaction
 - agonist
 - allosteric change in dynamics
 - allosteric change in structure
 - allosteric effector
 - allosteric k-type response
 - allosteric molecule**
 - allosteric post-translational modification
 - allosteric v-type response
 - allostery
 - altered physicochemical compatibility
 - antagonist
 - author-confidence
 - binding site hiding
 - caution
 - comment
 - complex-properties
 - composite binding site formation
 - configurational pre-organization
 - cooperative effect: plus

- Show counts
- Show obsolete terms
- Show all siblings

▼ Class Information

created_by

orchard

creation_date

2012-06-07T12:55:09Z

has_obo_namespace

PSI-MI

in_subset

[PSI-MI_slim](#)


▼ Class Relations

Subclass of


- [biological role](#)
- [interaction attribute name](#)
- [cooperative interaction](#)

Identifier

allosteric molecule

 http://purl.obolibrary.org/obo/MI_1159 

Purl

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has_obo_namespace

PSI-MI

in_subset

[PSI-MI_slim](#)

▼ Class Relations

Subclass of

- [biological role](#)
- [interaction attribute name](#)
- [cooperative interaction](#)



Persistent URLs (PURLs) are a form of **PIDs**. A PURL Resolver redirects HTTP requests to the current URL of a resource.

↳ molecular interaction (1,454)

↳ attribute name (139)

↳ interaction attribute name (38)

- 3d-r-factors
- 3d-resolution
- 3d-structure
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- allosteric change in dynamics
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- caution
- comment
- complex-properties
- composite binding site formation
- configurational pre-organization
- cooperative effect, class

Show counts

Show obsolete terms

Show all siblings

steric effector at a distinct site. An allosteric molecule is

Search

▼ Class Information

created_by

orchard

creation_date

2012-06-07T12:55:09Z

has_obo_namespace

PSI-MI

in_subset

PSI-MI_slim


▼ Class Relations

Subclass of


- biological role
- interaction attribute name
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Identifier

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Purl

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- Show counts
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▼ Class Information

created_by
orchard

creation_date
2012-06-07T12:55:09Z

has_obo_namespace
PSI-MI

in_subset
[PSI-MI_slim](#)

▼ Class Relations

- Subclass of**
- [biological role](#)
 - [interaction attribute name](#)
 - [cooperative interaction](#)

[Molecular Interactions Controlled Vocabulary](#)

Keywords:

Class: **allosteric molecule**

Term IRI: http://purl.obolibrary.org/obo/MI_1159

Definition: A molecule whose binding or catalytic properties at one site are altered by allosteric post-translational modification or binding of an allosteric effector at a distinct site. An allosteric molecule is identified by referring to its participant id. [database_cross_reference: PMID:18706817]

Annotations

- **has_obo_namespace:** [PSI-MI](#)
- **http://www.geneontology.org/formats/oboInOwl#created_by:** [orchard](#)
- **http://www.geneontology.org/formats/oboInOwl#creation_date:** [2012-06-07T12:55:09Z](#)
- **http://www.geneontology.org/formats/oboInOwl#id:** [MI:1159](#)
- **in_subset:** http://purl.obolibrary.org/obo/mi#PSI-MI_slim

Class Hierarchy

Thing

- + [molecular interaction](#)
- + [attribute name](#)
 - + [interaction attribute name](#)
 - [figure legend](#)
 - [comment](#)
 - [function](#)
 - [url](#)
 - [disease](#)
 - [caution](#)
 - [pathway](#)
 - [author-confidence](#)
 - [inhibition](#)
 - [stimulant](#)
 - [agonist](#)
 - [more...](#)
 - [allosteric molecule](#)

Superclasses & Asserted Axioms

- [interaction attribute name](#)
- [biological role](#)
- [cooperative interaction](#)

[Molecular Interactions Controlled Vocabulary](#)

Keywords:

Class: **allosteric molecule**

Term IRI: http://purl.obolibrary.org/obo/MI_1159

Definition: A molecule whose binding or catalytic properties at one site are altered by allosteric post-translational modification or binding of an allosteric effector at a distinct site. An allosteric molecule is identified by referring to its participant id. [database_cross_reference: PMID:18706817]

Annotations

- **has_obo_namespace:** [PSI-MI](#)
- http://www.geneontology.org/formats/oboInOwl#created_by: [orchard](#)
- http://www.geneontology.org/formats/oboInOwl#creation_date: [2012-06-07T12:55:09Z](#)
- <http://www.geneontology.org/formats/oboInOwl#id>: [MI:1159](#)
- **in_subset:** http://purl.obolibrary.org/obo/mi#PSI-MI_slim

Class Hierarchy

Thing

- + [molecular interaction](#)
- + [attribute name](#)
 - + [interaction attribute name](#)
 - [figure legend](#)
 - [comment](#)
 - [function](#)
 - [url](#)
 - [disease](#)
 - [caution](#)
 - [pathway](#)
 - [author-confidence](#)
 - [inhibition](#)
 - [stimulant](#)
 - [agonist](#)
 - [more...](#)
 - [allosteric molecule](#)

Superclasses & Asserted Axioms

- [interaction attribute name](#)
- [biological role](#)
- [cooperative interaction](#)

Molecular Interactions Controlled Vocabulary

Keywords:

Search terms

Class: **allosteric molecule**

Term IRI: http://purl.obolibrary.org/obo/MI_1159

Definition: A molecule whose binding or catalytic properties at one site are altered by allosteric post-translational modification or binding of an allosteric effector at a distinct site. An allosteric molecule is identified by referring to its participant id. [database_cross_reference: PMID:18706817]

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- **http://www.geneontology.org/formats/oboInOwl#creation_date:** 2012-06-07T12:55:09Z
- **http://www.geneontology.org/formats/oboInOwl#id:** MI:1159
- **in_subset:** http://purl.obolibrary.org/obo/mi#PSI-MI_slim

Class Hierarchy

Thing

- + [molecular interaction](#)
- + [attribute name](#)
- + [interaction attribute name](#)
- [figure legend](#)
- [comment](#)
- [function](#)
- [uri](#)
- [disease](#)
- [caution](#)
- [pathway](#)
- [author-confidence](#)
- [inhibition](#)
- [stimulant](#)
- [agonist](#)
- [more...](#)
- [allosteric molecule](#)

Superclasses & Asserted Axioms

- [interaction attribute name](#)
- [biological role](#)
- [cooperative interaction](#)

[Show RDF Source](#)



Internationalized Resource Identifier (IRI) is extending the URI, allowing for a greater set of characters.

allosteric molecule

http://purl.obolibrary.org/obo/MI_1159 Copy

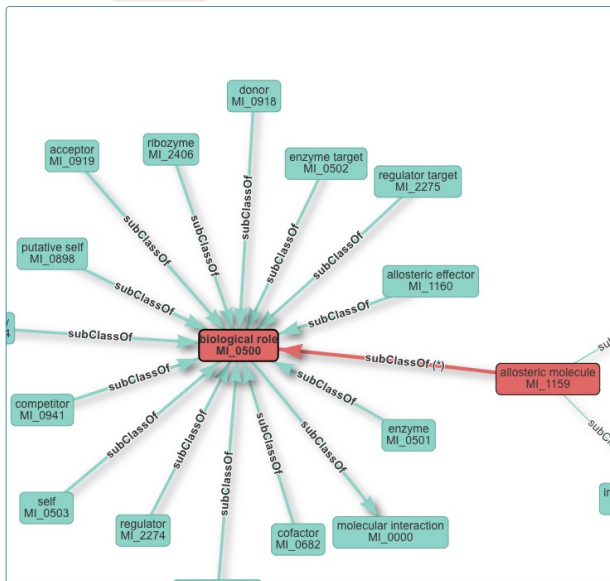
A molecule whose binding or catalytic properties at one site are altered by allosteric post-translational modification or binding of an allosteric effector at a distinct site. An allosteric molecule is identified by referring to its participant id.

Search

Exact match Include obsolete terms Include imported terms

Tree

Graph



Legend
Relationship
 Extended nodes (*) -
 subClassOf -
 Select/Deselect all

List of extended nodes (*):
 allosteric molecule (MI_1159)
 biological role (MI_0500)

Class Information

created_by
orchard

creation_date
2012-06-07T12:55:09Z

has_obo_namespace
PSI-MI

in_subset
PSI-MI_slim

Class Relations

- Subclass of**
- biological role
 - interaction attribute name
 - cooperative interaction

Create clusters Open all clusters Auto rearrange Hierarchical layout

Search node

Search Node

allosteric molecule

http://purl.obolibrary.org/obo/MI_1159 Copy

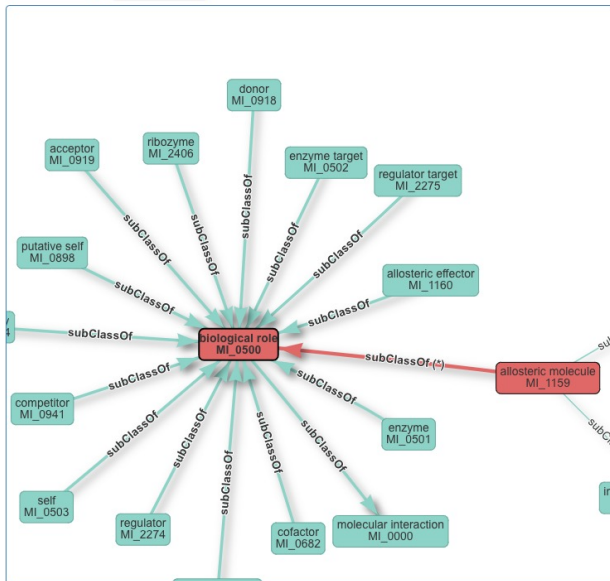
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Tree

Graph



Legend

Relationship Color Visibility
 Extended nodes (*) -
 subClassOf
 Select/Deselect all

List of extended nodes (*):
 allosteric molecule (MI_1159)
 biological role (MI_0500)

Class Information

created_by
orchard

creation_date
2012-06-07T12:55:09Z

has_obo_namespace
PSI-MI

in_subset
PSI-MI_slim

Class Relations

Subclass of

- biological role
- interaction attribute name
- cooperative interaction

Create clusters Open all clusters Auto rearrange Hierarchical layout

Search node

Search Node

allosteric molecule

http://purl.obolibrary.org/obo/MI_1159 Copy

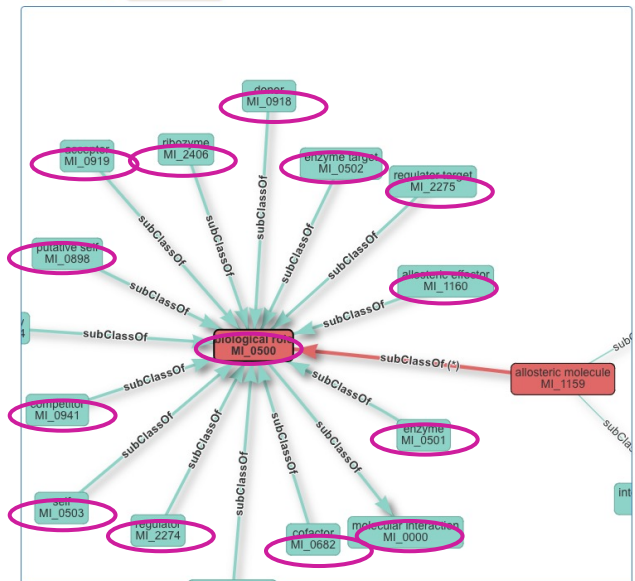
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Tree

Graph



Legend
Relationship
 Extended nodes (*) -
 subClassOf -
 Select/Deselect all

Color Visibility
 -
 -

List of extended nodes (*):
 allosteric molecule (MI_1159)
 biological role (MI_0500)

Class Information

created_by
orchard

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2012-06-07T12:55:09Z

has_obo_namespace
PSI-MI

in_subset
PSI-MI_slim

Class Relations

- Subclass of**
- biological role
 - interaction attribute name
 - cooperative interaction

Create clusters Open all clusters Auto rearrange Hierarchical layout

Search node

Search Node



The study of meaning, reference, or truth is called **Semantics**.



Formally describing **concepts**, **relationships** between (meta)data entities, and **categories**, encodes semantics with the data.

This technology is known as the **Semantic Web**.

in allosteric effector at a distinct site. An allosteric molecule is

Exact match Include obsolete terms Include imported terms

Search

▼ Class Information

created_by

orchard

creation_date

2012-06-07T12:55:09Z

has_obo_namespace

PST-MI

in_subset

PST-MI_slim

▼ Class Relations

Subclass of

- biological role
- interaction attribute name
- cooperative interaction



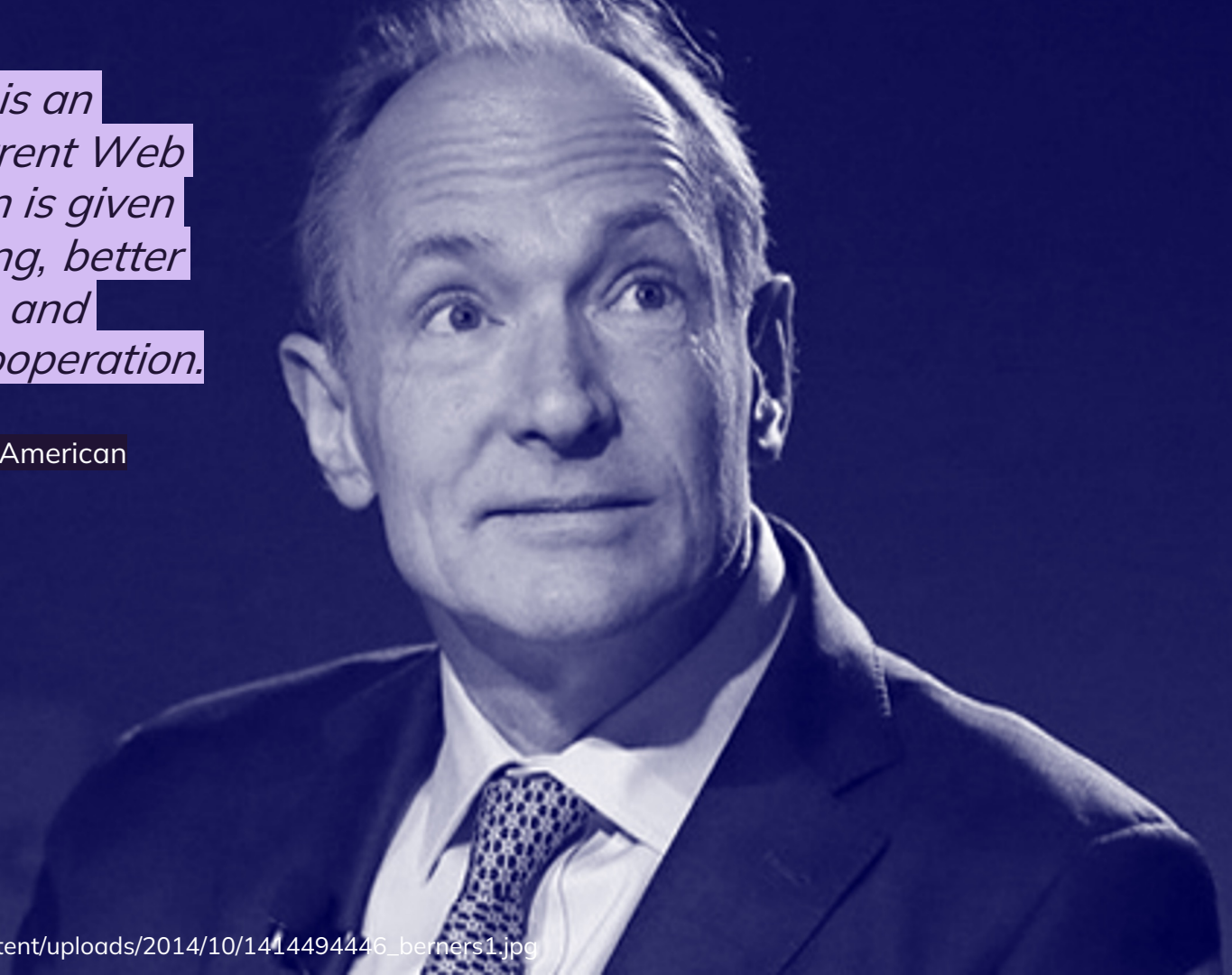
Create clusters Open all clusters Auto rearrange Hierarchical layout

Search node

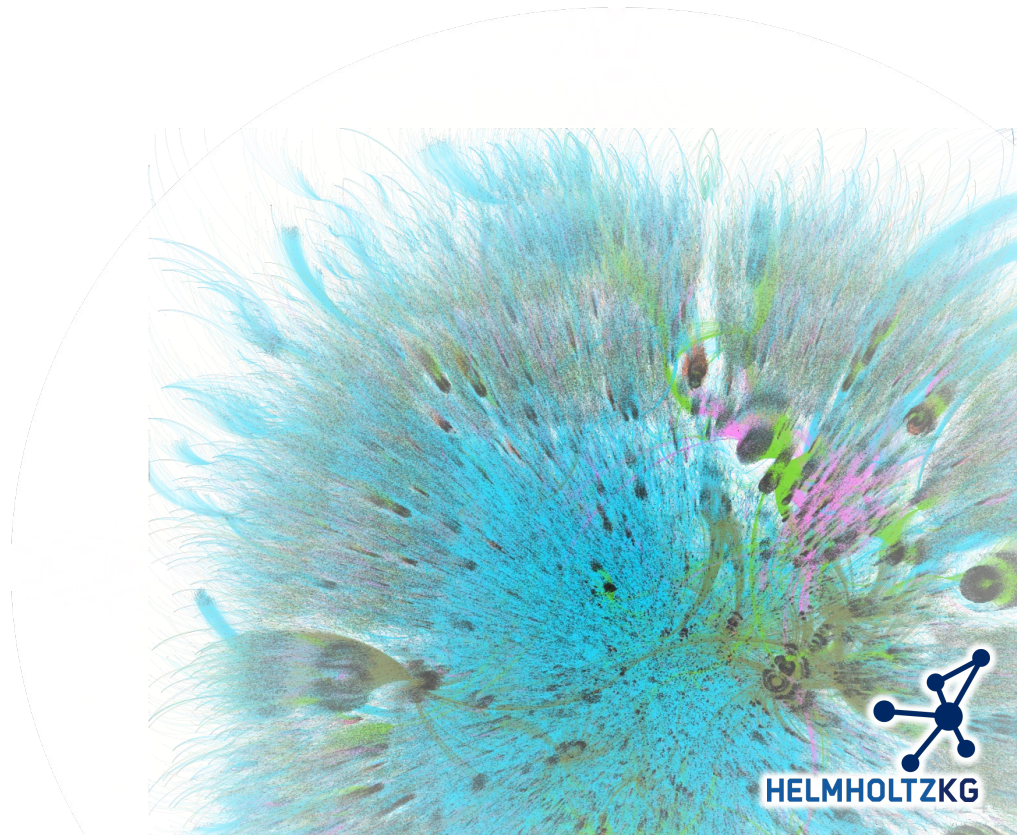
Search Node

The Semantic Web is an extension of the current Web in which information is given well-defined meaning, better enabling computers and people to work in cooperation.

Berners-Lee et al. (2001),
The Semantic Web, Scientific American



Semantic Web Technologies



<!-- http://purl.obolibrary.org/obo/IAO_0100001 -->

```
<owl:AnnotationProperty rdf:about="http://purl.obolibrary.org/obo/IAO_0100001">
  <obo:IAO_0000111 xml:lang="en">term replaced by</obo:IAO_0000111>
  <obo:IAO_0000114 rdf:resource="http://purl.obolibrary.org/obo/IAO_0000125"/>
  <obo:IAO_0000115 xml:lang="en">Use on obsolete terms, relating the term to another term that can be used as a substitute</obo:IAO_0000115>
  <obo:IAO_0000117 xml:lang="en">Person:Alan Ruttenberg</obo:IAO_0000117>
  <obo:IAO_0000119 xml:lang="en">Person:Alan Ruttenberg</obo:IAO_0000119>
  <rdfs:comment xml:lang="en">Add as annotation triples in the granting ontology</rdfs:comment>
  <rdfs:label>term replaced by</rdfs:label>
  <rdfs:label xml:lang="en">term replaced by</rdfs:label>
</owl:AnnotationProperty>
```

<!-- http://purl.obolibrary.org/obo/NCIT_C42618 -->

```
<owl:AnnotationProperty rdf:about="http://purl.obolibrary.org/obo/NCIT_C42618">
  <obo:IAO_0000115>A shortened form of a word or phrase. [Definition Source: NCI]</obo:IAO_0000115>
  <rdfs:label xml:lang="en">abbreviation</rdfs:label>
  <rdfs:subPropertyOf rdf:resource="http://www.w3.org/2004/02/skos/core#altLabel"/>
</owl:AnnotationProperty>
```

<!-- http://purl.obolibrary.org/obo/NCIT_C93495 -->

```
<owl:AnnotationProperty rdf:about="http://purl.obolibrary.org/obo/NCIT_C93495">
  <obo:IAO_0000115>The non-unique initials or abbreviated name used for identification. [Definition Source: NCI]</obo:IAO_0000115>
  <rdfs:label xml:lang="en">acronym</rdfs:label>
  <rdfs:subPropertyOf rdf:resource="http://www.w3.org/2004/02/skos/core#altLabel"/>
</owl:AnnotationProperty>
```

<!-- http://purl.obolibrary.org/obo/RO_0001906 -->

```
<owl:AnnotationProperty rdf:about="http://purl.obolibrary.org/obo/RO_0001906"/>
```

<!-- http://purl.obolibrary.org/obo/RO_0002259 -->

```
<owl:AnnotationProperty rdf:about="http://purl.obolibrary.org/obo/RO_0002259">
  <rdfs:subPropertyOf rdf:resource="http://www.geneontology.org/formats/oboInOwl#SubsetProperty"/>
</owl:AnnotationProperty>
```

„But this is another story and shall be told another time.“

Michael Ende, The Neverending Story (1979)

Questions?



DISCLAIMER

This slide deck is part of the Lesson

**Fundamentals of Scientific Metadata:
Why Context Matters**

published on **The Carpentries Incubator**.

Please cite this presentation as:

Gerlich, S., Strupp, A., Hofmann, V., Sandfeld, S. (2023).
Fundamentals of Scientific Metadata: Why Context Matters.
The Carpentries Incubator. DOI: [10.5281/zenodo.10091708](https://doi.org/10.5281/zenodo.10091708)

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