

# TEXTUAL INTRANETS: USING LINKED DATA TO COMPREHEND MANUSCRIPT TRADITIONS

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<http://nomoon.github.io>

# LINKED DATA

- ❖ A family of standards for the modelling, description, and interchange of data.
- ❖ Closely related to the idea of the “Semantic Web.”
- ❖ Major standards overseen by W3C.
- ❖ Tightly integrated with “web” technologies.

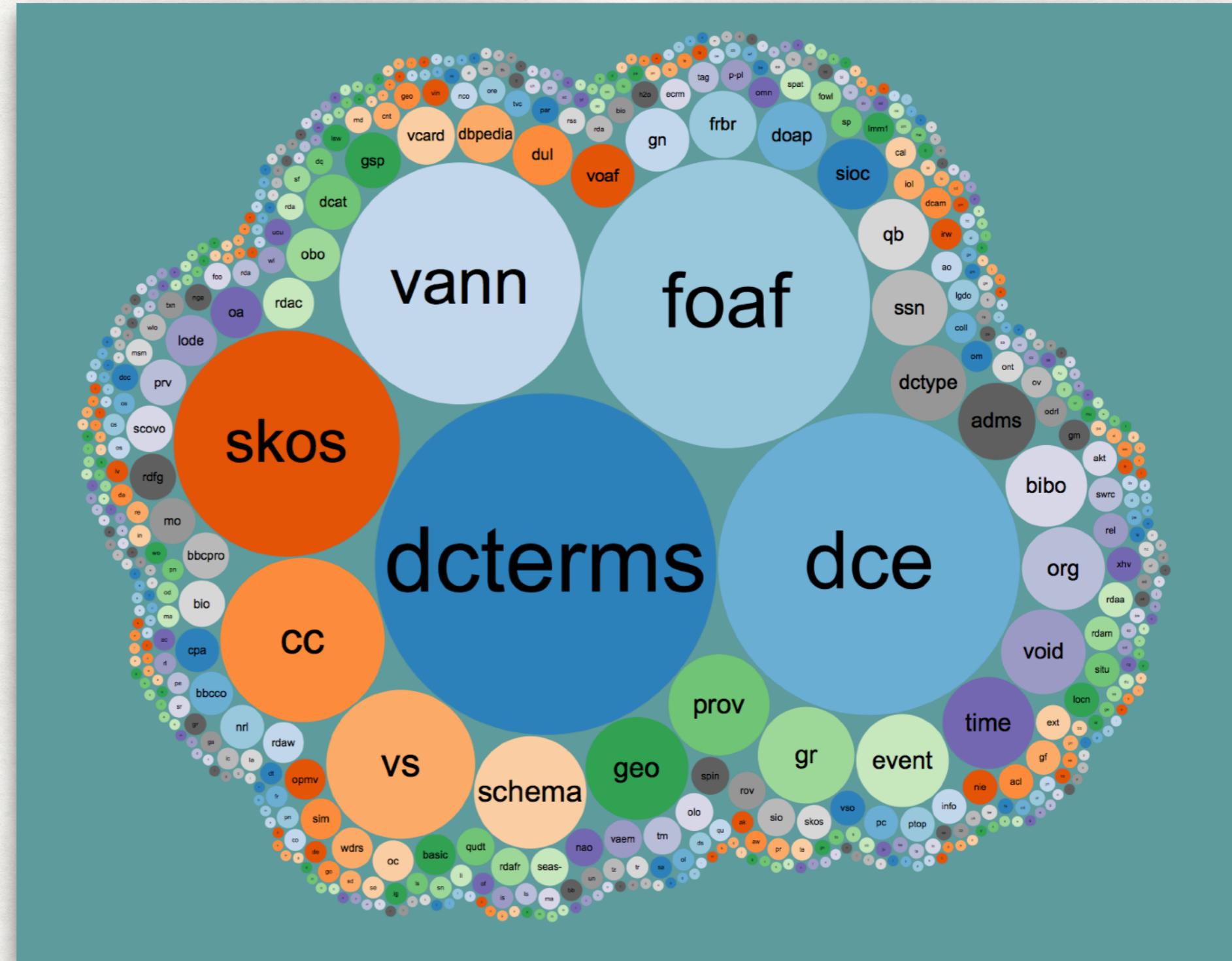
# LINKED DATA

## Principles

- ❖ Common, well-defined, machine-parseable formats.  
(RDF/XML, JSON-LD, RDFa, Turtle, N3)
- ❖ Resources represented as nodes/edges of a graph.  
(Berners-Lee: “The Giant Global Graph”)
- ❖ All resources identified with a unique URI  
(e.g. <http://ld.ubcsanskrit.ca/vp/mss/0IB-25804>)
- ❖ Information & metadata within resources standardized  
different ontologies/vocabularies of well-defined terms.  
(Dublin Core, Friend of a Friend, Linked Open Vocabularies, schema.org, etc.)
- ❖ Standards which model specific structures in a well-defined  
manner using Linked Data formats and ontologies.  
(Open Annotations, IIIF)

# LINKED DATA

## Vocabularies



Source:

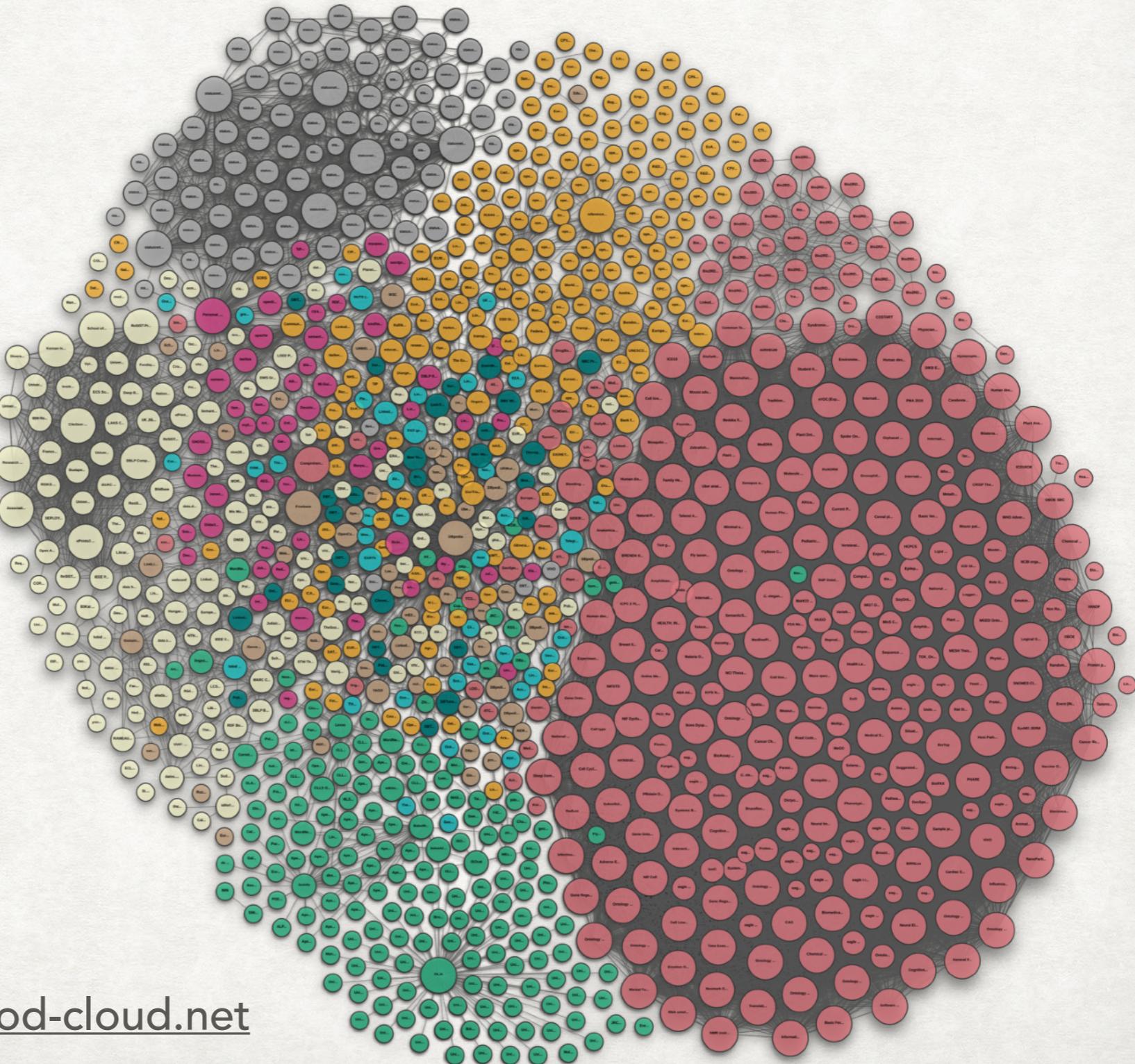
<http://lov.okfn.org/>

# LINKED DATA

## Datasets

Legend

Cross Domain
Geography
Government
Life Sciences
Linguistics
Media
Publications
Social Networking
User Generated
Incoming Links
Outgoing Links



Source: <http://lod-cloud.net>

# VETĀLAPAÑCAVIMŚATI

USE CASE EXAMPLES

# VETĀLAPAÑCAVIMŚATI

## PRIMARY SOURCE EXAMPLE (BORI-470)

संज्ञिरिष्यते॥१॥ इनिश्चुतावैतालोगतः॥ ॥२॥ इत्पृष्ठमकथानकं समाप्ते॥३॥ श्रीनर्मदावैत्रम्।  
प्राणम्पुरयन्त्रिका हंसयानं सरस्वती। नस्याऽप्रसादमास्ताद्यविदधामिक्षानकं॥४॥ अतिम  
दन्तुरं भासनगरं त्रमदनवीरेनामराजा। तत्रवणिकुरुरितः नस्मस्तुता महानसेनानाम। सा  
पिवसंतोस्तुतेवेत्त्रारामेकीउनायसखीभिः सरुगता। तत्रवणिकुरुसोमदनस्तुतः धर्मदित्योमित्रेण  
सहनत्रैवगतः। तां दृष्ट्याद्युनितोस्तो। यद्येषाममन्नायनितितोजीवितं सप्तलं प्रे। तेनविरुद्धे  
दनापादितेन कथमपिश्वरीनिभिताः। ब्रजानेतत्रैव आरामेगतः। तां एव द्विनीदृष्ट्या। तत्त्वे  
एव द्वरेण्युता। यद्दिममन्नायनितितस्तुतिष्यामि॥। बालेनित्यकलेखेयनाले  
मन्त्रवीवराजते। अन्तर्मताचापमात्रष्टविद्युः द्विनिष्पत्ति॥२॥ अन्तर्मत्येविद्युं धनुर्वेदोमन्तर्मत्यस्य  
महात्मनः। शरीरमक्षयं तत्त्वात्प्रित्यतं तगतिं प्रेतः॥३॥ तयोक्तं॥ वलिद्विनीमदनस्तुतो वीर  
दत्तः। पञ्चमेद्विवसेमोपरिणेष्यतितेनोक्तं। वलात्वारेण सेवयिष्यामि। तयोक्तं। तज्जिज्ञर्ये

```
<pb n="23r" facs="p45"/>
<lb n="1"/>... <div type="story" id="S9" num="9">śrīnarmadāyai namah |
<lb n="2"/><div type="verse" id="S9-1" num="1">pranamya parayā bhaktyā haṁsayānā<del>?</del><add>ऽ</add> sarasvatīm |
tasyāḥ prasādam āsādya vidadhāmi kathānakam ||1|| </div>asti ma-
<lb n="3"/>-danapuram nāma nagaram tatra madanavīro nāma rājā | tatra vanīka haridattah tasya sutā madanasenā nāma |
sā-
<lb n="4"/>-pi vasam̄totsave ārāme krīdanāya sakhībhīḥ saha gatā | tatra vanīksomadattasutah dharmadatto mitreṇa
<lb n="5"/>saha tatraiva gatah | tām dṛṣṭvā kṣubhito <add location="above">'</add>sau | yady eṣā mama bhāryā bhavati
tato jīvitam saphalam me | tena virahave-
<lb n="6"/>-danāpīditenā katham api śarvarī nirgamitā || prabhāte tatraiva ārāme gatah | tām ekākinī dṛṣṭvā | dakṣi-
<lb n="7"/>-ne kare gr̄hi<mod rend="overwrite">tvā</mod> | yadi mama bhāryā na bhaviṣyati tadāham mariṣyāmi || | <div
type="verse" id="S9-2"> bāle tilakalekheyam bhāle
<lb n="8"/>bhallīva rājate | bhrūlatācāpam ākṛṣya na vidmaḥ kiṁ hanisyasi |2| </div> <div type="verse"
id="S9-3">apūrvo yaṁ dhanurvedo manmathasya
<lb n="9"/>mahātmanah | śarīram akṣayam kṛtvā bhinnaty am̄targatam manah |3| </div>tayoktam || vanīka āmadattasuto
vīra-
<lb n="10"/>-dattah | paṁcame divase mām pariṇeṣyati tenoktam | balātkāreṇa sevayiṣyāmi | tayokyam <div type="verse"
id="S9-4"> lajjijjaīm ye-
```

# VETĀLAPAÑCAVIMŚATI

## PRIMARY SOURCE EXAMPLE (OIB-25804)

मद्वचनं कलापितस्त स्थापत्यक स्यानाय जिवातया की चायिसा तुरामाकथम शुजायौ जवामिंग होकी चायदेन लिता।  
ठत्वमक्षयं करिष्यामि म सादासानाश्च नाय जिवातया की प्रतिपञ्जीज वदीयादशषमाणं ग्रंधवीदिवाङ्गम परिलीला  
सामो वाकनातो तांनी वाच्चन गर्गतो। इत कथानक कथयि यावेतालाना की रानेन्वत्यामीधुकः मन्वाधिकारा  
त्वा की पापवक अयाधिकः पावेतालाना ती कथरा जन भवकः अयाधिकः। ग्रंधव रोगना लज्जा। लवकथा द्विवाप्तक  
तप्त यस्तु शोकायः प्रथमे रुपाकार्तकातिन्नमयाधिके। इतवृक्षगावितालभूत्विवगतः। इतिकाय शुक्लवधु लविरचित्  
यावेनात एव विशतिकायी वीरमूलकथानक अष्टमे भैमाही। ग्राण्डीमहन मद्वनेन नामनगर अत्तवीरमद्  
नामामराजा। तत्र दण्डिक दिरण्ड लोनाम। तत्त्वात्तुताम दृनासना नामप्ता च वसीना अवसर्वीलि मानकीडनाय उद्घा  
नमता। तत्र वेण्णिकृता मद्वत्तुताम दृनाम दृनाम मम दृनाम दृनाम दृनाम दृनाम दृनाम दृनाम दृनाम  
दृनाम। वित्तयति येष्वामन्त्यायनिल दिष्टिति तत्त्वानीवित्तेनिकृत्वाना वालवत्तितत्त्वानीवित्तेनाम दृनाम। इतिवित्तिया  
तत्राव निकृत्वानीवित्तियत। तत्र विद्वामिनाट यानाननकथम यमिभव दीनिगमिता यम प्रजातन विवगतः। भास्त्रकालि  
नीटष्टुष्टुता दृहिण्णिकरा। जणति यहिमम ज्ञायनेन विष्णुस्तोतताऽऽप्राणयागं कृष्णामि ऋथपृथिवी  
वालविलकालवर्येत्तालभैविनाडन। दृनताचाप्मात्तुत्तुनज्ञानकः दृनिष्टुमि यत। वकर्त्तराम। उनकोल्प  
जात्तातरारीभिन्नकायि प्रातदीशो दृनिष्टुत्तुदथमिकं दृगशावलाचानरा। रामद्वौ येयदियातियात्रनः। रुद्रकृते  
खेजनमेजलाच्छिरामदीययदियात। दृशानननापि दृशानननानिनीताविनाराऊनकामज्ञाधीं। दृशुवर्किया  
धत्तावेसामन्मय दृशुमलत्यनः। सारीरमहर्यच्छान्तिन्नीतप्रतिमनः। इतत्याकी ओमदत्तमुत्तावीरदृशेनामार्पन  
प्रपृष्ठेनमाप्तरिणाष्टुतित्ताकी बलकारण्यं जजिष्टामि यतः। करकिशलयस्त्वं धत्तीनीमध्या। श्रव  
प्रपृथमनव्यायश्चाक्षीक्षनवरतपरिक्षेवालस्त्रीमंतिनीनामहृष्णेन नमामाष्टवमधुचनाथाऽपि॥

<pb n="18v" facs="p50"/>  
<!-- Lines removed -->  
<lb n="6"/>-yām vaitālapañcavimśatikāyām vīramūlakathānakam aṣṭamam samāptam || cha <div type="story" id="Ś9"  
num="9">|| asti madanamarddanam nāma nagaram | tatra vīramardda-  
<lb n="7"/>-no nāma rājā | tatra <del rend="understrike">|</del> vaṇik hiraṇyadatto nāma | tasya sutā madanasenā nāma  
| sā ca vasam̄totsave sakhibhiḥ saha krīḍanāya udyā-  
<lb n="8"/>-ne matā | tatra vaṇiksomadattasuto dharmadatto nāma sa sukharamyadatto nāma mitreṇa saha tatraiva gataḥ |  
tasyāḥ rūpam̄ dr̄ṣṭvā kṣubhi-  
<lb n="9"/>-to <add place="above">'</add>sau | cīm̄tayati | yady eṣā mama bhāryā na bhaviṣyati | tato jīvitam̄  
niḥphalam̄ | no vā bhavati | tato jīvitam̄ saphalam̄ | iti vicīm̄tya |  
<lb n="10"/>tatrāt nijabhavane gataḥ | tena virahāgninā dāhyamānenā katham api sarvarī nirgamitā | sa prabhāte  
tatraiva gataḥ | sā ekāki-  
<lb n="11"/>-nī dr̄ṣṭā gṛhitā dakṣiṇe kare | bhanati | yadi tvam̄ mama bhāryā na bhaviṣyasi | tato 'ham̄ prāṇatyāgaṁ  
kariṣyāmi | atha paṭhati <unclear reason="rubbed">ca</unclear> ||  
<lb n="12"/><div type="verse" id="Ś9-2">bāle tilakalekheyam bhāle bhallī virājate | bhrūlatācāpam ākṛṣya na jāne kah  
haniṣyasi | 2 </div> yataḥ | <div type="verse" id="Ś9-3.3"> cekartta rāmo janakātmā-  
<lb n="13"/>-jākrte śarāmśi lāmkādhipater daśaiṣubhiḥ | tvadartham ekam̄ mrgaśāvalocane śaror madīyam̄ yadi yāti yātu  
nah | rabha<del>kṛte</del>  
<lb n="14"/>khamjanam amjalākṣi śiro madīyam̄ yadi yāti yātu | daśānanenāpi daśānanāni nītā vināśam̄ janākātmajārtham̄  
|| 3 </div><div type="verse" id="Ś9-3">apūrvo 'yam̄  
<lb n="15"/>dhanurvedo manmathasva mahātmanah śarīram aksavam bhutvā bhinnatvā mātarāgratam manah | 4 </div>tavoktam |

# VETĀLAPAÑCAVIMŚATI

PRIMARY SOURCE EXAMPLES AS URIs

[\*\*http://ld.ubcsanskrit.ca/vp/\*\*](http://ld.ubcsanskrit.ca/vp/)

- + mss/
  - BORI-470
  - OIB-25804
  - ...
- + stories/
  - Ś9
  - ...
- + verses/
  - Ś9-1
  - Ś9-2
  - Ś9-3
  - Ś9-3.3
  - Ś9-4
  - ...

# VETĀLAPAÑCAVIMŚATI

## SECONDARY SOURCE EXAMPLES

### Coding Verses [/stories/Ś9/verses]

```
<verse id="Ś9-1" sources="#MK Intr" remarks="Invocation to Sarasvatī">
    praṇamya parayā bhaktyā haṁsayānāṁ sarasvatīm
    tasyāḥ prasādām āśādya kariṣyāmi kathām imām </verse>
<verse id="Ś9-1.2"> lāmbodaram āmalīmām lāmboṣṭham gajakarṇakam layaghanaṁ pārvatīputram | namāmi gaṇanāyakam </verse>
<verse id="Ś9-1.3"> samtu vilokanabhāṣaṇavilāsaparihāsa keliparirāṁbhāḥ smaraṇam api kāmininām alām iha manaso
    vikāraye </verse>
<verse id="Ś9-1.4"> praṇamyaikaradām devam sāradām gurum eva ca namāmi prītipūrvam tu vakṣe haṁ nūtanām kathām
    </verse>
<verse id="Ś9-1.5"> balavān imdriya grāmo vidvāṁsam api karṣati nityam pramuditā mūrkhā ajāyūthapatir yathā paṇḍitān
    ity aduhkhārttā jñānāṁkuśavaśikṛtāḥ </verse>
<verse id="Ś9-2" sources="#ŚP 3293, #SR 258.41">
    bāle lalāma lekheyam bhāle bhallīva rājate bhrūlatācāpam ākṛṣya na jāne kam haniṣyasi </verse>
<verse id="Ś9-3" sources="#CnT III 58.6(?), #SH 1578, #SMS 2116">
    apūrvo yaṁ dhanurvedo manmathāsya mahātmanah śarīram akṣataṁ kṛtvā bhinatty antargatam manah </verse>
```

### Identifying a Verse within the collection [/verses/Ś9-2]

```
{
    "@context": "http://www.w3.org/ns/anno.jsonld",
    "@id": "http://ld.ubcsanskrit.ca/vp/verses/Ś9-2",
    "@type": "Annotation",

    "motivation": "identifying",

    "body": {
        "type": "TextualBody",
        "purpose": "describing",
        "value": "bāle lalāma lekheyam bhāle bhallīva rājate bhrūlatācāpam ākṛṣya na jāne kam haniṣyasi"
    },

    "target": [
        "mss/B0RI-470#Ś9-2",
        "mss/OIB-25804#Ś9-2",
        {
            "id": "sources/SR#258.41",
            "creator": "sources/sternbach_1971"
        },
        {
            "id": "sources/ŚP#3293",
            "creator": "sources/sternbach_1971"
        }
    ]
}
```

# VETĀLAPAÑCAVIMŚATI

## SECONDARY SOURCE EXAMPLES

### Identifying Sources within the collection [/sources/SR; /sources/ŚP]

```
{  
  "@context": "http://purl.org/dc/terms/",  
  "@id": "http://ld.ubcsanskrit.ca/vp/sources/SR",  
  
  "type": "Text",  
  "title": "Subhāśitaratna-bhāṣṭā-gāram, enlarged 8th ed., NSP, Bombay",  
  "date": "1952",  
  "isReferencedBy": "sources/sternbach_1971",  
  
  "hasPart": [ "258.41" ],  
  "relation": [ "verses/Ś9-2" ]  
}  
  
{  
  "@context": "http://purl.org/dc/terms/",  
  "@id": "http://ld.ubcsanskrit.ca/vp/sources/ŚP",  
  
  "type": "Text",  
  "title": "The Paddhati of Śāringadhara, a Sanskrit anthology, ed. by Peter Peterson, vol. I, BSS 37",  
  "date": "1888",  
  "isReferencedBy": "sources/sternbach_1971",  
  
  "hasPart": [ "3293" ],  
  "relation": [ "verses/Ś9-2" ]  
}
```

# VETĀLAPAÑCAVIMŚATI

SECONDARY SOURCE EXAMPLES AS URIs

[\*\*http://ld.ubcsanskrit.ca/vp/\*\*](http://ld.ubcsanskrit.ca/vp/)

- + **stories/**
  - + **Ś9/**
    - **verses**
- + **sources/**
  - ...
  - **sternbach\_1971**
  - **SR**
  - **ŚP**
  - ...
- + **verses/**
  - ...
  - **Ś9-2**
  - ...

# VETĀLAPAÑCAVIMŚATI

## STRUCTURAL EXAMPLES

### Identifying a folio's transcription with its images

(IIIF provides a related, more robust, but also more verbose structure for accomplishing this)

### Identifying a Story within the collection

```
{  
  "@context": "http://www.w3.org/ns/anno.jsonld",  
  "@id": "http://ld.ubcsanskrit.ca/vp/stories/S9",  
  "@type": "Annotation",  
  
  "motivation": "identifying",  
  
  "target": [  
    "mss/BORI-470#S9",  
    "mss/OIB-25804#S9"  
  ]  
}
```

```
{  
  "@context": "http://www.w3.org/ns/anno.jsonld",  
  "@id": "http://ld.ubcsanskrit.ca/vp/mss/OIB-25804/f018v",  
  
  "body": {  
    "id": "mss/OIB-25804/VP-OIB-25804.xml",  
    "format": "application/tei+xml",  
    "purpose": "transcribing",  
    "selector": {  
      "type": "RangeSelector",  
      "startSelector": {  
        "type": "FragmentSelector",  
        "value": "18v",  
      },  
      "endSelector": {  
        "type": "FragmentSelector",  
        "value": "19r",  
      }  
    },  
  },  
  
  "target": [  
    {  
      "id": "mss/OIB-25804/images/f018v.jpg",  
      "format": "image/jpeg"  
    },  
    {  
      "id": "mss/OIB-25804/VP-OIB-25804.pdf",  
      "format": "application/pdf",  
      "selector": {  
        "type": "FragmentSelector",  
        "value": "page=50"  
      }  
    }  
  ]  
}
```

# VETĀLAPAÑCAVIMŚATI

STRUCTURAL EXAMPLES AS URIs

[\*\*http://ld.ubcsanskrit.ca/vp/\*\*](http://ld.ubcsanskrit.ca/vp/)

- + **mss/**
  - ...
  - **OIB-25804/**
    - + **images/**
      - ...
      - **f018v.jpg**
      - ...
    - **VP-OIB-25804.pdf**
    - **VP-OIB-25804.xml**
    - ...
  - + **stories/**
    - ...
    - **Ś9**
    - ...

# GENERATING THE “INTRANET”

- ❖ The 3 resources we have:
  - ❖ Images / PDFs of manuscripts.
  - ❖ Transcriptions of manuscripts, which contain:
    - ❖ Bibliographic/provenance information.
    - ❖ Physical structure (folio numbers, lines)
    - ❖ Semantic structure (story divisions, verses)
    - ❖ Text
  - ❖ Secondary material:
    - ❖ Verse information:
      - ❖ Enumeration of verses coded with ID matching transcription.
      - ❖ Secondary source references via Sternbach

# GENERATING THE “INTRANET”

- ❖ What we can generate:
  - ❖ Unique URIs to all extant manuscripts and divisions within (semantic/structural).
  - ❖ Information about what files/objects those identifiers reference and where, in order to retrieve content (text, images, bibliographic information, etc.)
  - ❖ Secondary source references and their information.
  - ❖ Aggregate information:
    - ❖ i.e. which verses appear in which manuscripts or which secondary sources.
    - ❖ Verses used as an example here, but any novel entity can be implemented in this way.

# THANK YOU

## Some Links

- ❖ LD-JSON:  
<http://json-ld.org/>
- ❖ Web Annotation Data Model:  
<https://www.w3.org/TR/annotation-model>
- ❖ Dublin Core Metadata Initiative  
<http://dublincore.org>
- ❖ Text Encoding Initiative  
<http://www.tei-c.org/>
- ❖ International Image Interoperability Framework  
<https://iiif.io>
- ❖ Rerum @ Center for Digital Humanities, SLU  
<https://rerum.io>
- ❖ Textual Communities  
<http://www.textualcommunities.usask.ca>