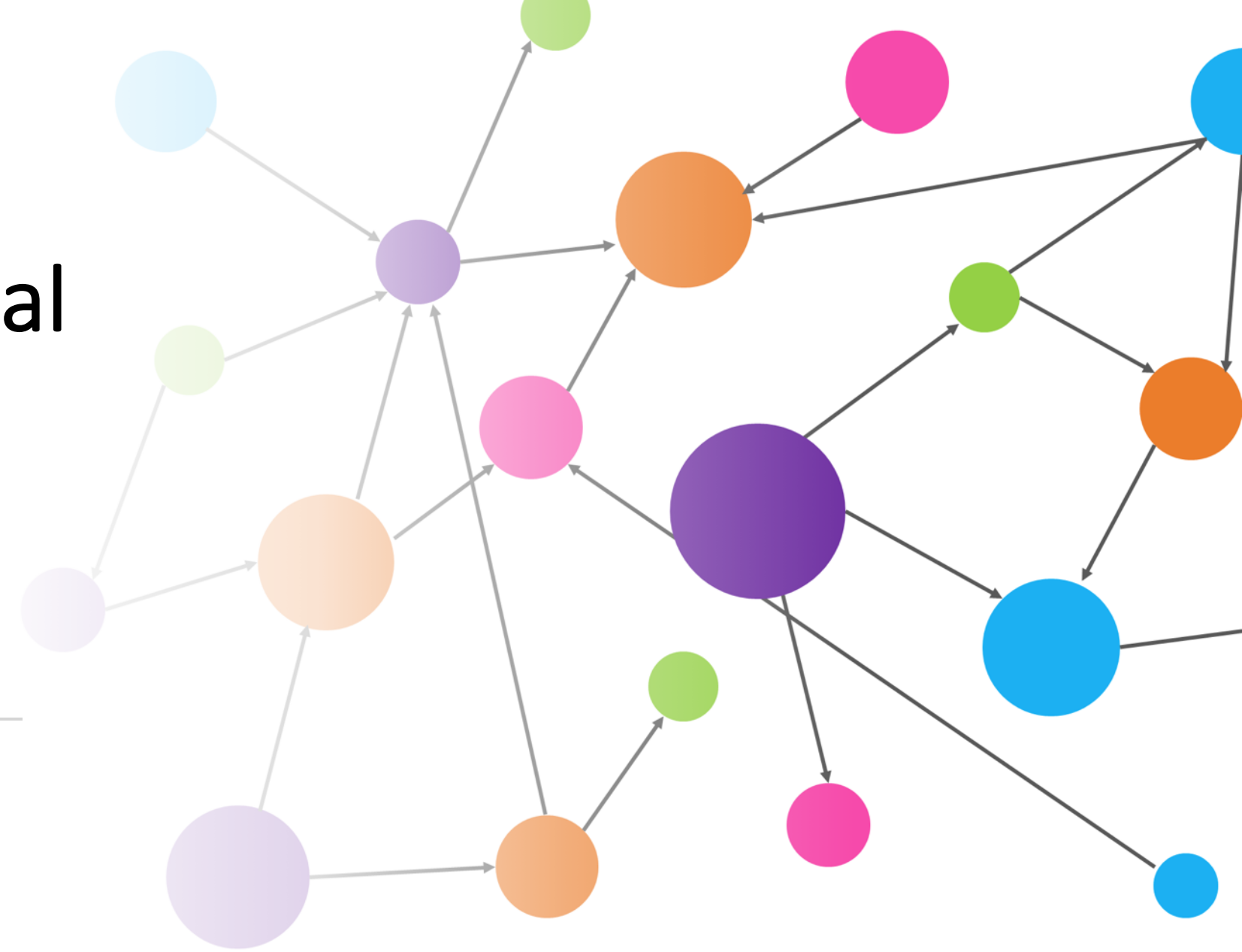
Knowledge graphs for global and regional geologic time scales



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Outline

- 1. Introduction
- 2. Deep time knowledge base
- 3. R package
- 4. Summary

Knowledge graph?

A knowledge graph acquires and integrates information into an ontology and applies a reasoner to derive new knowledge.

Ehrlinger and Wöß, 2016

university of idaho

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About 254,000,000 results (1.10 seconds)

www.uidaho.edu

University of Idaho - Offering top-ranked programs in the ...

The **University of Idaho**, based in the Northwest, is a leading research school, providing majors and degrees for graduate and undergraduate students.

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As Idaho's flagship research library, the University of Idaho Library ...

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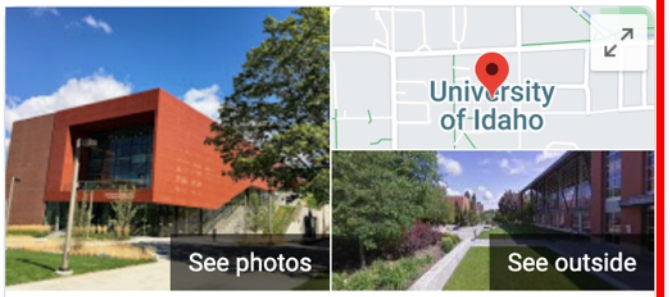
https://www.google.com/search?q=university+of+idaho&ne...

Google knowledge graph supported



University of Idaho

Website Directions Save Call

Public land grant university in Moscow, Idaho

The University of Idaho is a public land-grant research university in Moscow, Idaho. It is the state's land-grant and primary research university, and the lead university in the Idaho Space Grant Consortium. Wikipedia

Avg cost after aid	Graduation rate	Acceptance rate
$15K	56%	77%

Graduation rate is for first-time, full-time undergraduate more
Source: US Dept of Education · Learn more

Address: 875 Perimeter Dr, Moscow, ID 83844

Phone: (208) 885-6111

Undergraduate enrollment: 7,528 (2018–19)

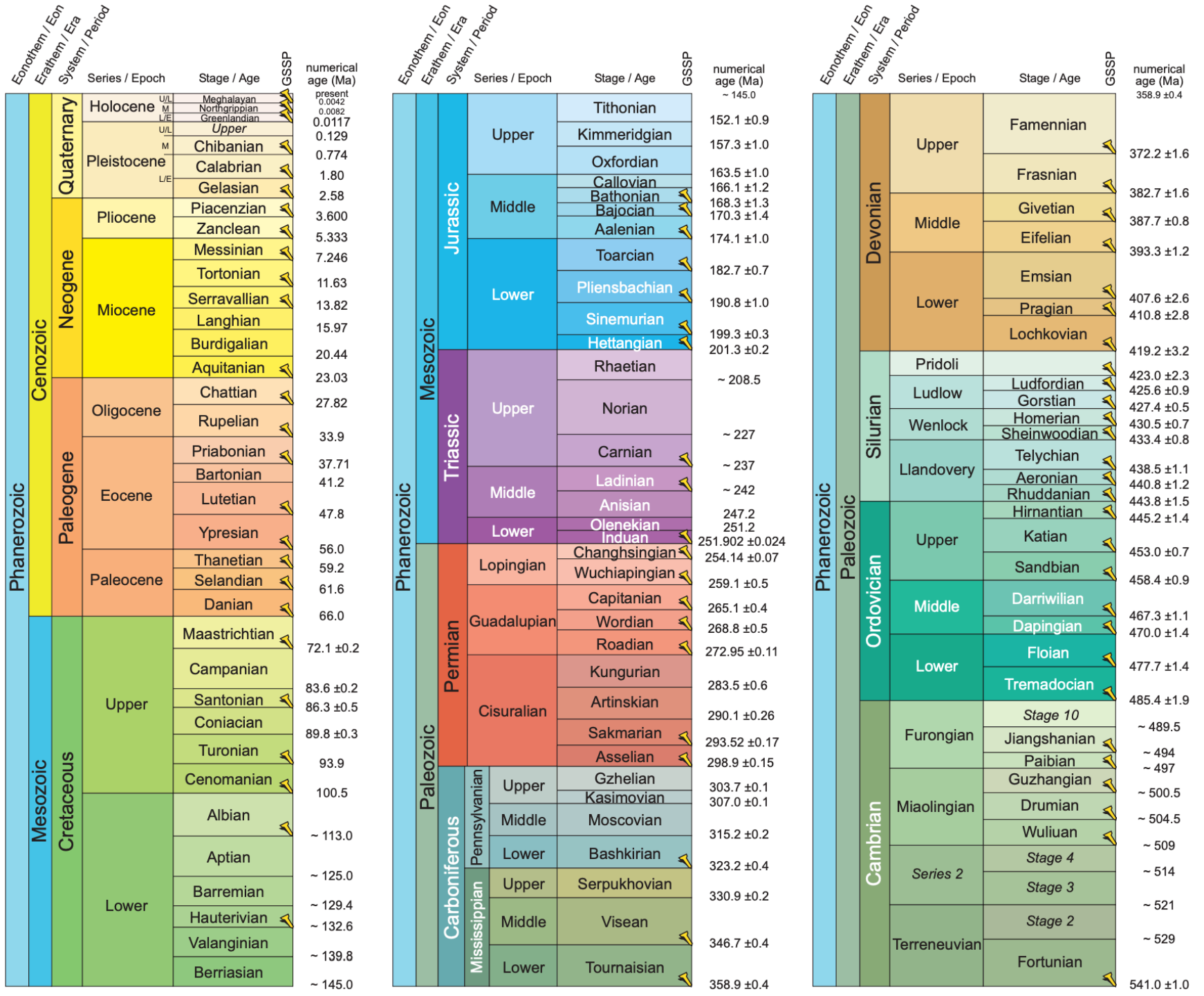
- Google Search

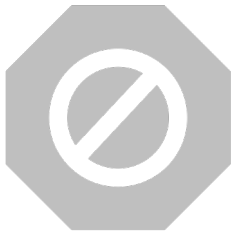
These infoboxes were added to Google's search engine in May 2012

Geologic time scale (GTS)?

a system of chronological dating that classifies geological strata (stratigraphy) in time.

Basic element in geoscientific problem.





Issue in data-driven discovery related to GTS:

1. Heterogeneity of geologic time scale concept
2. Machine readability and reasoning

Knowledge graphs for geologic time scales (international and regional)

+ services

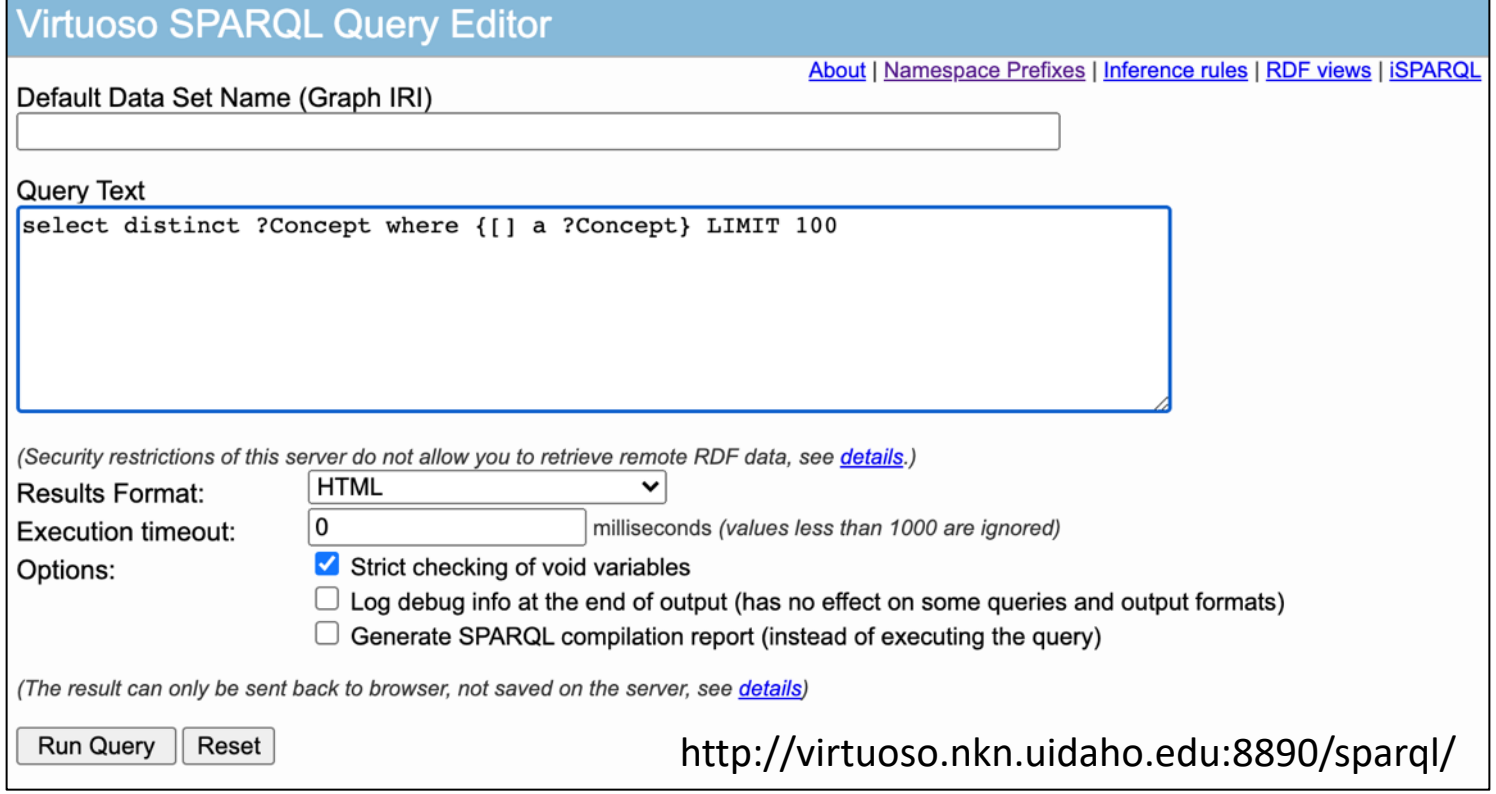
+ an R package

Knowledge graphs for geologic time scales

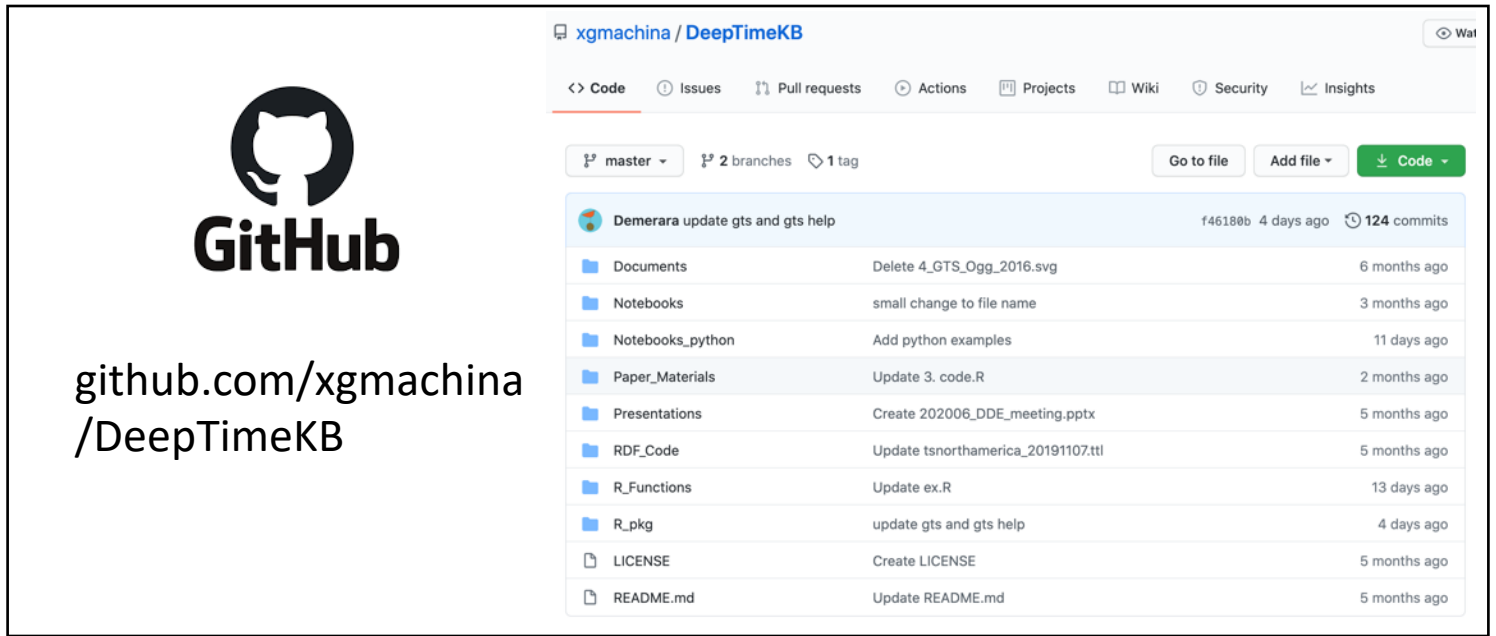
(15 international versions and 16 regions)

International versions	Regions
2020/01	East Avalonian
2019/05	West Europe
2018/08	California
2018/07	British
2017/02	Iberian-Morocco
2016/10	Baltoscania
2016/04	Boreal
2015/01	South China
2014/10	North China
2014/02	Russia Platform
2013/01	N-E Siberia
2012	Japan
2010	Kazakhstan
2009	Australia
2008	Tethyan
	New Zealand

- **Database hosted on the server of the Northwest Knowledge Network (NKN)**
- **Queryable through SPARQL end point**
- **Shared at Github**



http://virtuoso.nkn.uidaho.edu:8890/sparql/



github.com/xgmachina/DeepTimeKB

SPARQL query

```
prefix dc: <http://purl.org/dc/elements/1.1/>
prefix gts: <http://resource.geosciml.org/ontology/timescale/gts#>
prefix skos: <http://www.w3.org/2004/02/skos/core#>
prefix time: <http://www.w3.org/2006/time#>
prefix ts: <http://resource.geosciml.org/vocabulary/timescale/>


SELECT   DISTINCT ?schemeID str(?label) AS ?geoConcpet ?begTimeValue ?endTimeValue
WHERE
{
  GRAPH <http://deeptimekb.org/iscallnew>
    {
      {
        ?tconcept  a gts:GeochronologicEra ;
        rdfs:label ?label ;
        skos:inScheme ?schemeID.
        FILTER (lang(?label) = "en")
        FILTER strstarts(?label, "Jurassic")
        ?tconcept time:hasBeginning ?beg ;
        time:hasEnd ?end .
        ?beg time:inTemporalPosition ?begTime .
        ?end time:inTemporalPosition ?endTime .
        ?begTime time:numericPosition ?begTimeValue .
        ?endTime time:numericPosition ?endTimeValue .
      }
      UNION
      {
        ?tconcept a gts:GeochronologicEra ;
        rdfs:label ?label .
        FILTER (lang(?label) = "en")
        FILTER strstarts(?label, "Jurassic")
        ?tconcept dc:description
        [time:hasBeginning ?beg ;
          time:hasEnd ?end ;
          skos:inScheme  ?schemeID].
        ?beg time:inTemporalPosition ?begTime .
        ?end time:inTemporalPosition ?endTime .
        ?begTime dc:description
        [time:numericPosition ?begTimeValue ;
          skos:inScheme  ?schemeID].
        ?endTime dc:description
        [time:numericPosition ?endTimeValue ;
          skos:inScheme ?schemeID].
        FILTER regex(?schemeID, "2005").


      }
    }
}
ORDER BY DESC (?schemeID)
```

schemeID	geoConcpet	begTimeValue	endTimeValue
http://resource.geosciml.org/vocabulary/timescale/isc2005-12	Jurassic Period	199.6	145.5

```
> gts.range(geoConcept = "Jurassic", iscVersion = 2005)
     schemeID      geoConcpet begTimeValue endTimeValue duration
15 isc2005-12 Jurassic Period        199.6        145.5     54.1
```

An R package: *deeptimeKB*

12 functions

Functions	Description
gssp.map	Plot the locations of the Global Boundary Stratotype Section and Point (GSSP) on the world map
gts	Get all the properties of one geological time concept in the database
gts.gssp	Query the GSSP data
gts.hierarchy	Get the broader and narrower concept of one geological time concept in database
gts.iscSchemes	Function querying start time, end time and duration of a specific geological time concept
gts.level	Get the level of the geological time concept
gts.list	Function querying the geological time concept of a region or the international geological time concept
gts.listRegion	Function querying the geological time concept of a region or the international geological time concept
gts.point	Function querying all the geological time concepts that include the specified time point
gts.range	Function querying start time, end time, and duration of a specific geological time concept
gts.topo	Topology of two geological time concepts
gts.within	Function querying all geological time concepts within a time interval

installation from Github:

```
devtools::install_github("xgmachina/DeepTimeKB/R_pkg")
```

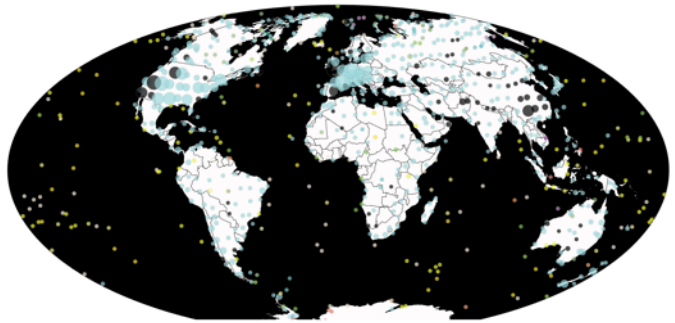
Deep time knowledge base interacts with other databases

Otaian Age
in New Zealand
(21.7-18.7 Ma)

The Paleobiology Database
revealing the history of life

deeptimeKB

The Paleobiology Database
revealing the history of life



Summary

- Created a knowledge database that covers multiple versions of international geologic time scale and regional ones.
- A SPARQL end point is created for online services.
- An R package is built to facilitate knowledge exploration.
- Prepare to publish the R package to CRAN.
- Our work improves the data interoperability and machine readability.