

The iPlant Collaborative Semantic Web Platform:

Using OWL and SSWAP (Simple Semantic Web Architecture and Protocol)
for On-Demand Semantic Pipelines



Ontology Summit
March 2012

DAMIAN GESSLER, Ph.D.
SEMANTIC WEB ARCHITECT
IPLANT COLLABORATIVE
UNIVERSITY OF ARIZONA

dgessler (at) iplantcollaborative (dot) org

BLAZEJ BULKA, Ph.D.
SEMANTIC WEB ENGINEER
CLARK AND PARSIA, LLC

blazej (at) clarkparsia (dot) com

The Field



Science is not a spectator sport

<http://www.agriculture.com/ag/slideshow/slideShow.jhtml?slideid=/templatedata/ag/slideshow/data/1144946148737.xml&page=2>

From Simple Actions Emerge Complex Systems



Sugar cane

Rain Forest

http://img.timeinc.net/time/daily/2008/0803/a_wbiofuels_0407.jpg

<http://www.agriculture.com/ag/slideshow/slideShow.jhtml?slideid=/templatedata/ag/slideshow/data/1144946148737.xml&page=2>

Evidence-based Decision-making



http://blog.lib.umn.edu/ellis271/arch1701/bigstockphoto_Global_Warming_217540%203.jpg



http://www.smartpower.org/blog/wp-content/photos/field_turbines.jpg

Decisions have downstream and unintended consequences;
analyses and decisions that utilize a scientific approach bias
our odds towards attaining viable solutions.

Evidence-based Decision-making Requires ... Evidence

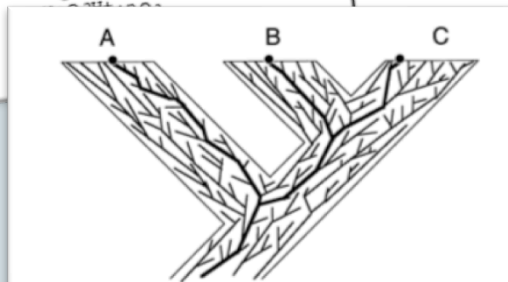
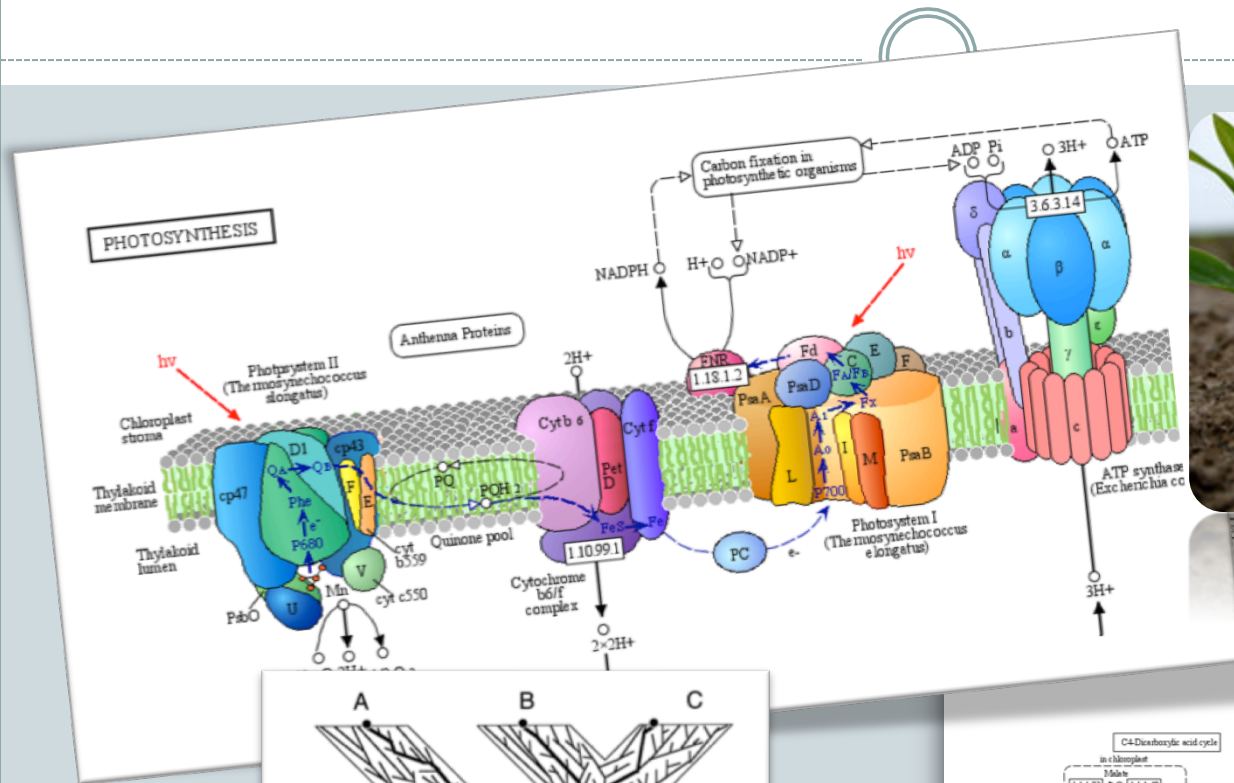
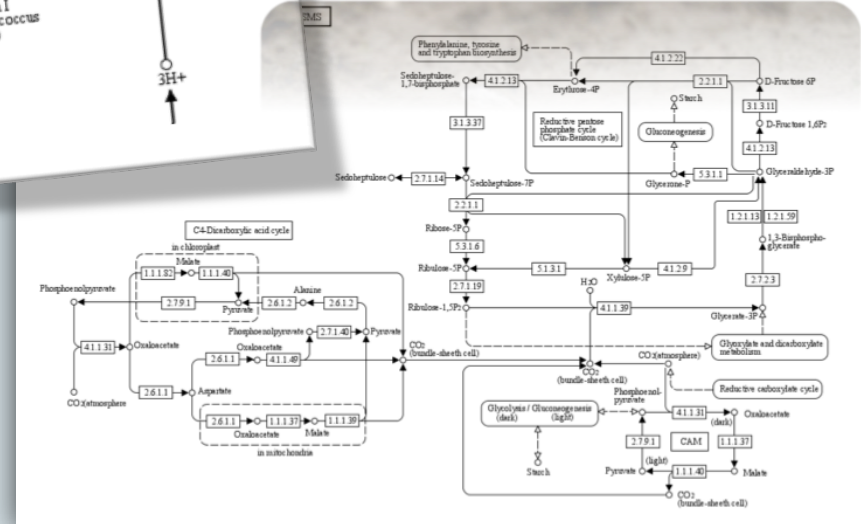


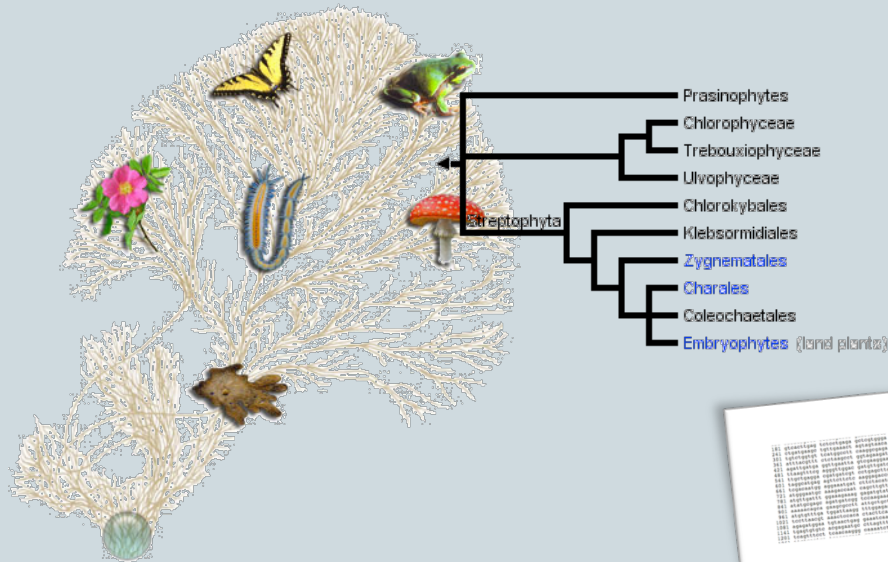
FIGURE 1. A gene tree contained within a species tree leading to three extant species: A, B, and C. Bold branches of gene tree show relationships among the sampled copies of the gene (●). Sampled copies from sister species B and C are sister copies.



<http://www.kegg.jp/kegg/atlas>

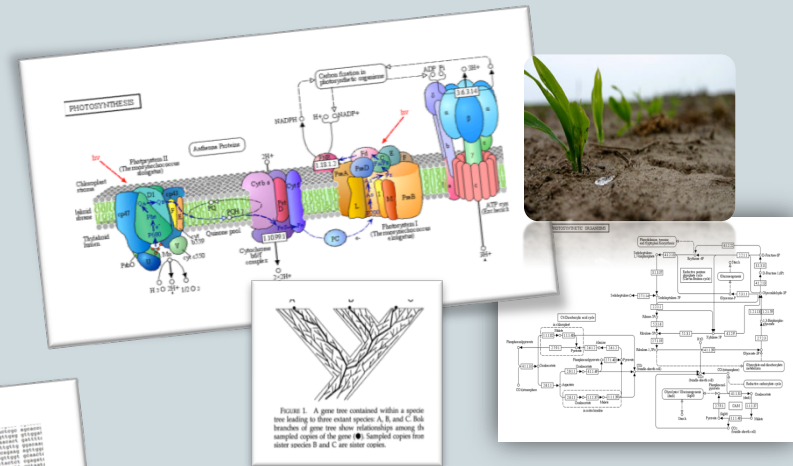
Maddison WP 1997 Syst. Biol. 46(3): 523-536

iPlant Integrative, Collaborative, Science



iPToL

Evolution
(cognitive model)



Ultra High-Throughput Sequencing
(200+ Gbp/run)

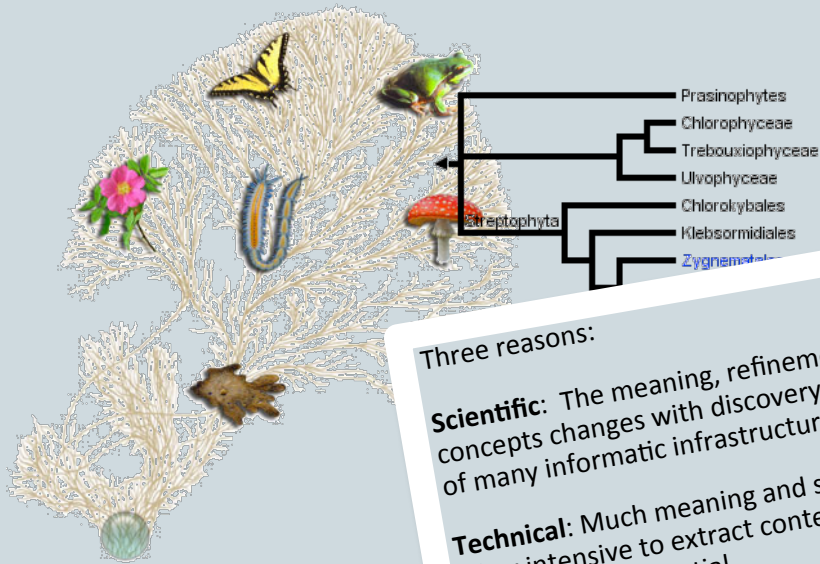
iPG2P

Association Genetics / QTL Mapping

Technology
(drivers)

Advances
(scientific and social return)

Data Integration is Hard



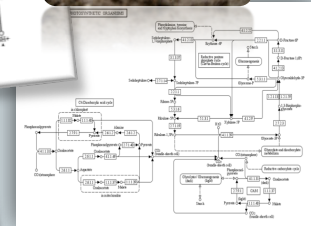
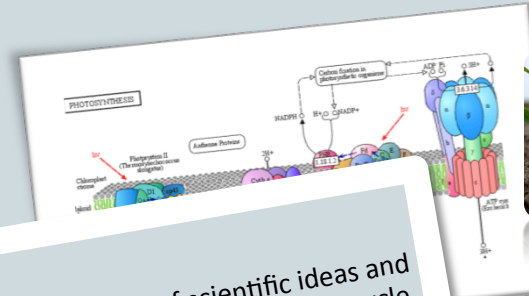
iPToL

Three reasons:

Scientific: The meaning, refinement, context, and value of scientific ideas and concepts changes with discovery; it changes at a rate faster than the life cycle of many informatic infrastructures

Technical: Much meaning and semantics is implicit, not explicit. Thus it is labor intensive to extract context and merge data and services; scaling is linear, not exponential.

Social: Value and discoveries are generated across disciplines, under different funding models, in different institutions, in different cultures, with different reward structures



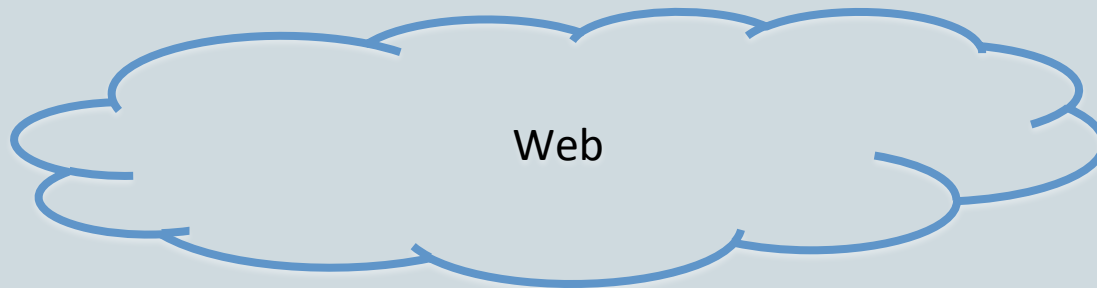
Association Genetics / QTL Mapping

Evolution
(cognitive model)

Technology
(drivers)

Advances
(scientific and social return)

Bridging HPC, Enterprise, and Web assets



Enterprise Class

Discovery Environment, Atmosphere

Semantic Integration

Semantic Pipelining

Foundational Infrastructure

Texas Advanced Computing Center

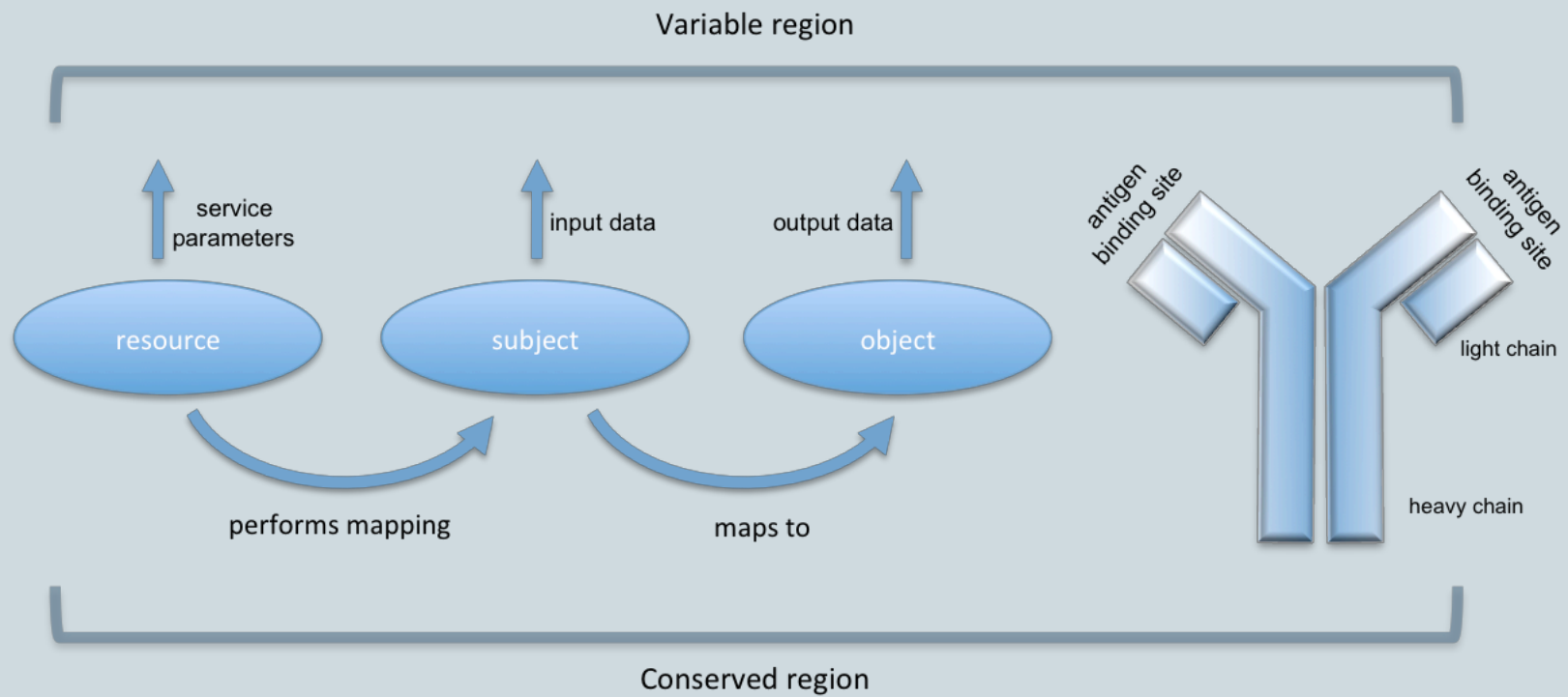
Distributed
Semantic Web Services
Logic-driven semantics

Enterprise Class
Virtual Workdesk
Cloud, Virtual machines

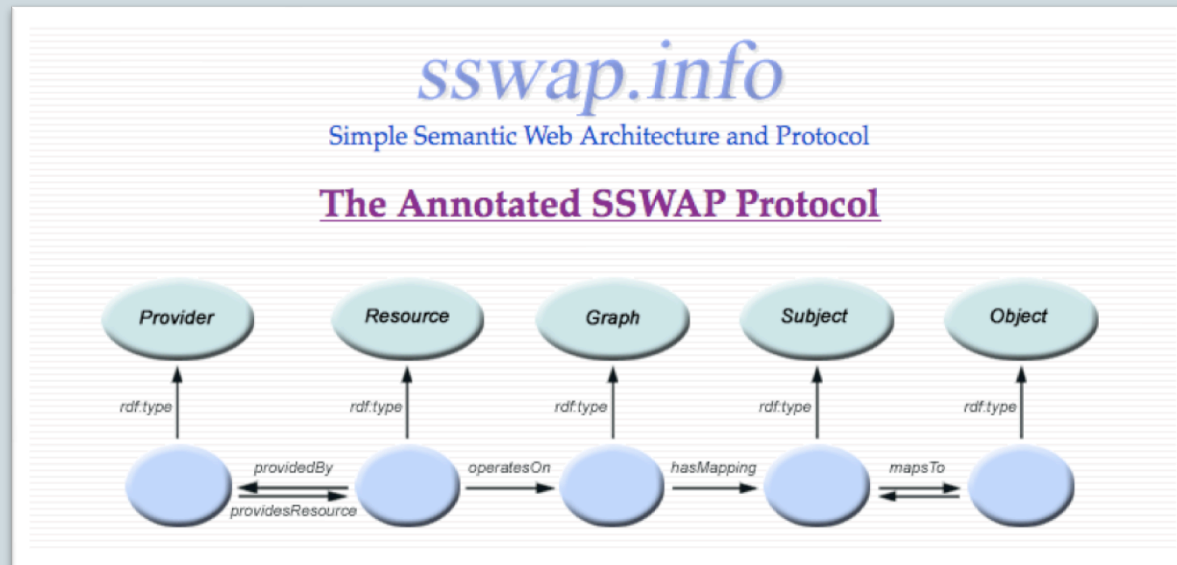
High Performance Computing
64K cores, 580 Tflops*
Petabyte scale storage

*10 Pflops in 2013

The Antibody Analogy as the Mediation Layer



Simple Semantic Web Architecture and Protocol



<http://sswap.info>

- Establish the framework to allow web resources to describe themselves and their offerings
- Establish the framework to allow ontological support
- Provide a semantically enabled Discovery Server

Architecture



Web service provider
(data and/or services)

Architecture: Protocol



*Mapping from local schema to OWL via
our HTTP API at <http://sswap.info/api>*

http:GET

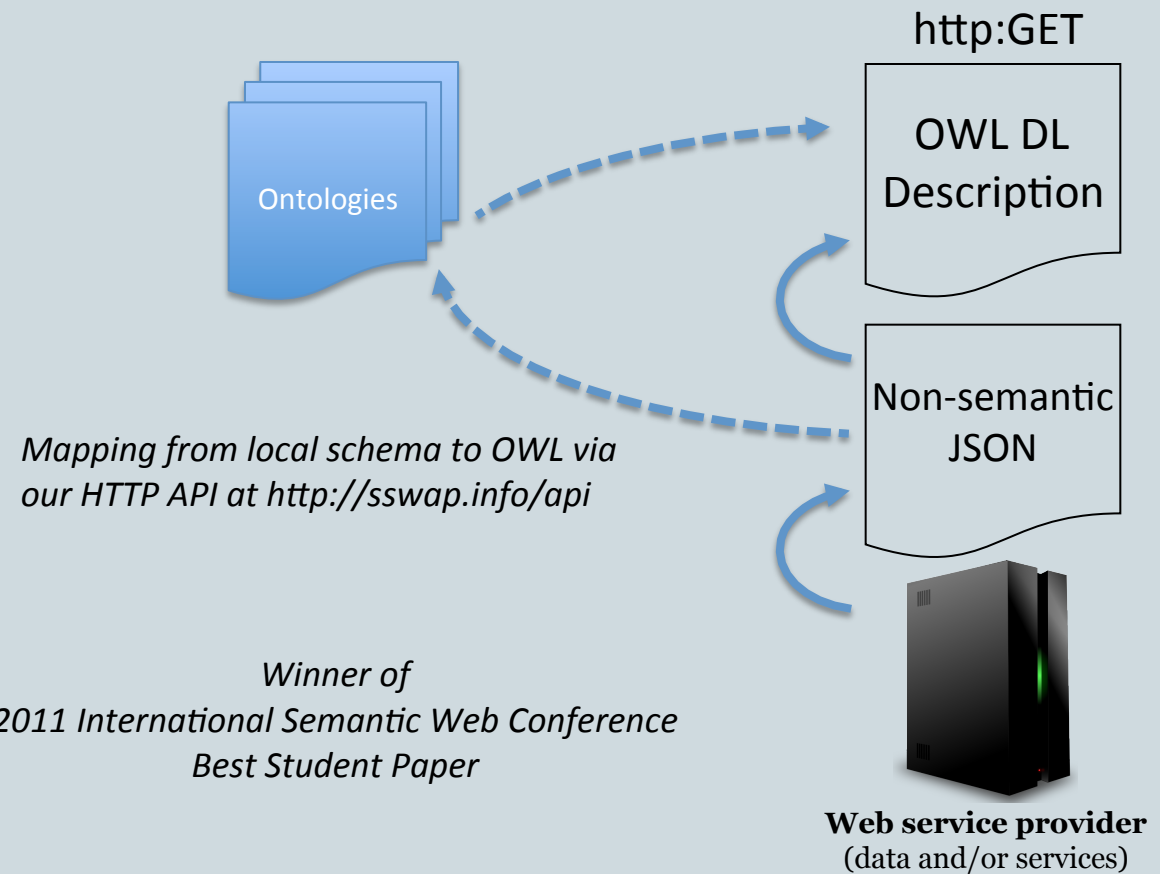
OWL DL
Description

Non-semantic
JSON



Web service provider
(data and/or services)

Architecture: Protocol



HTTP API: sswap.info/api



Home /makePDG /makeRDG
 /makeRIG /makeType
 /makeRRG /makeProperty
 /makeRQG JSON Syntax
 Protocol
 More

SSWAP HTTP API

/makeRDG

NAME
`/makeRDG` — make an RDG (Resource Description Graph)

SYNOPSIS
e.g., `curl -d @<jsonFile> http://sswap.info/api/makeRDG`

DESCRIPTION
`/makeRDG` is the basename of a URL for a RESTful web service that converts JSON (Javascript Object Notation) into a SSWAP OWL RDF/XML Resource Description Graph (RDG). Input is sent to the URL via a HTTP POST, for example by a program such as curl or wget. A HTTP GET on `/makeRDG` (for example, as initiated by visiting the URL with a browser) returns this manual page. Content negotiation may be used to return a machine parsable JSON schema if the requested response MIME type is `application/json`.

A Resource Description Graph (RDG) is a human-readable, machine-parsable description of a semantic web service using the SSWAP Protocol. The use of OWL allows an RDG to describe a service in terms that are amenable to a computable logic. The RDG is hosted at the URL of the service such that a HTTP GET on the service URL (with no query string parameters) returns the RDG, while an HTTP POST (with an RIG [Resource Invocation Graph] as the body of the POST; see `/makeRIG`) or an HTTP GET with a query string invokes the service. RDGs are OWL DL RDF/XML documents that follow the SSWAP Protocol and are used to describe a service.

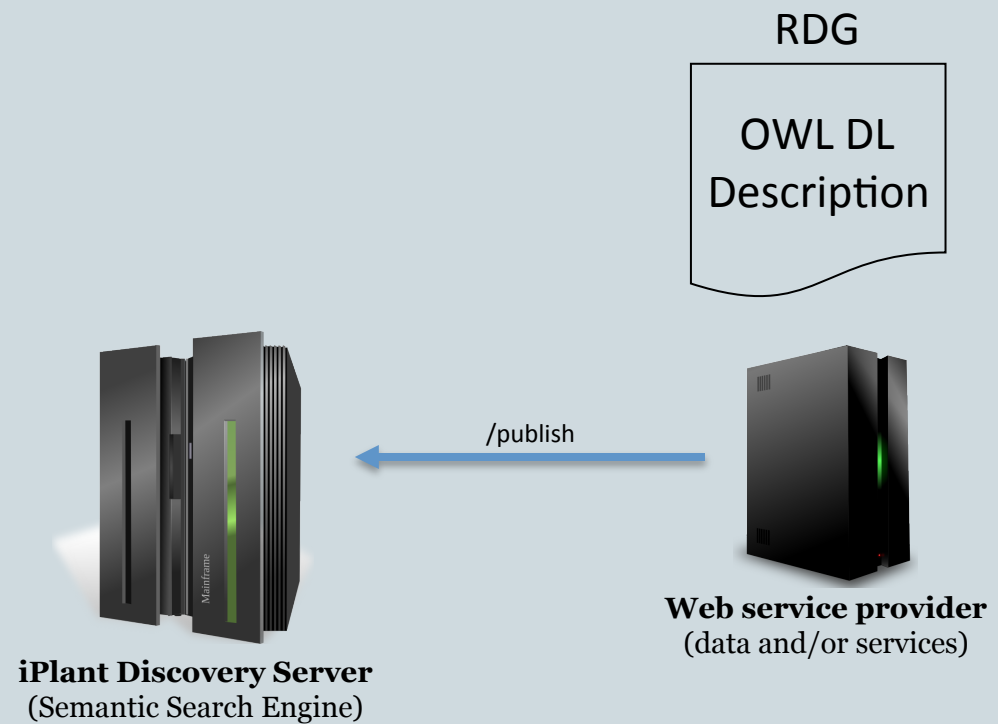
RDGs allow automated semantic matching, as possible, between service invocation vocabularies and semantics (as used by a client) and service description vocabularies and semantics as used by the service. They set the template for the service's invocation (via a Resource Invocation Graph; see `/makeRIG`), its return data (as a Resource Response Graph; see `/makeRRG`) and semantic discovery via query graphs (a Resource Query Graph; see `/makeRQG`).

Third-party web servers may host their own `/makeRDG` (see **AVAILABILITY**). `/makeRDG` is hosted as a public service at `http://sswap.info/api/makeRDG`.

Examples of RDGs are numerous: search on anything at `http://sswap.info`, then click on the RDF icon next to any service on the results' page to view its RDF/XML RDG; or view the canonical graph at `sswap.info/examples/resources/canonical/canonicalResource`.

Quick Start
Here, we use the program `curl` to POST the in-line JSON content to the public `/makeRDG` service:

Architecture: Publication



RDG: Resource Description Graph

Behind the Scenes

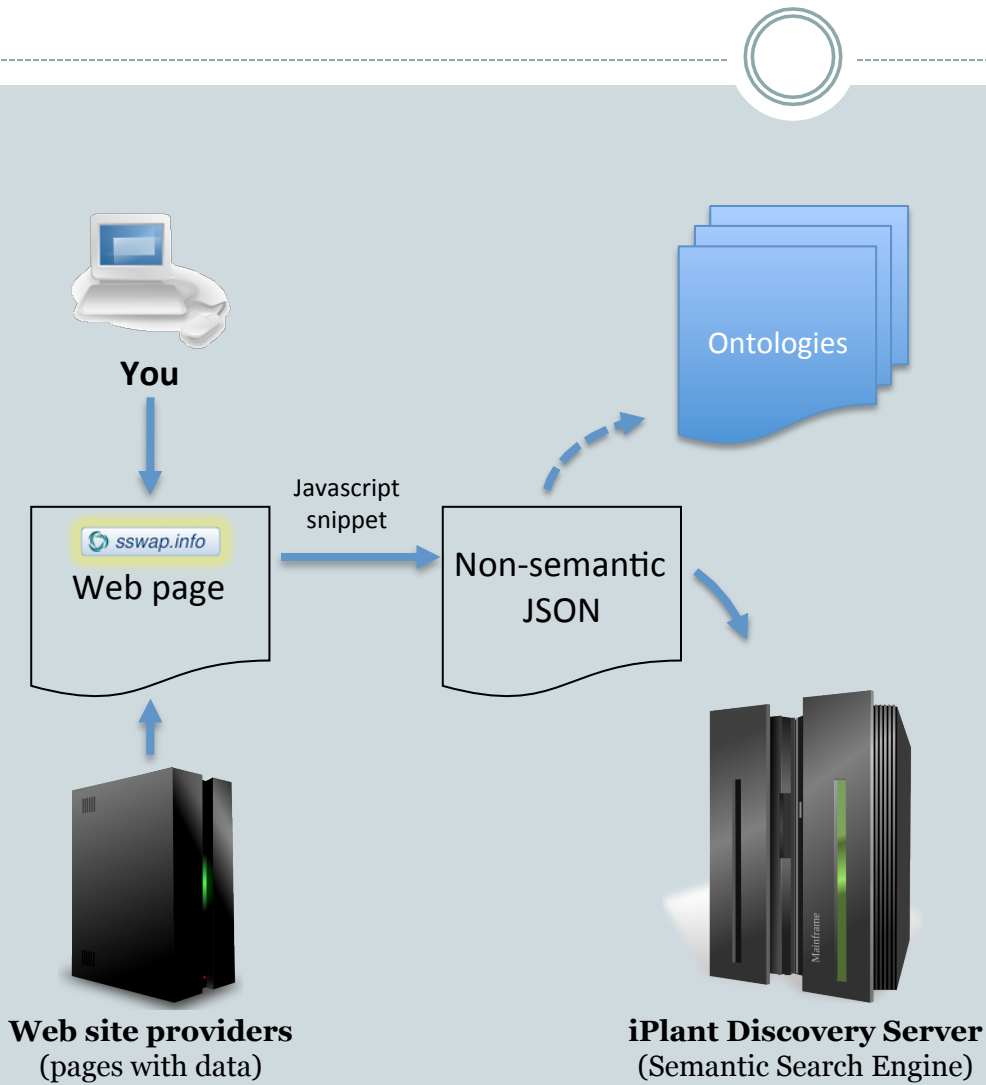


- Read the file as valid RDF/XML OWL SSWAP;
- Retrieve relevant terms;
- Disambiguate and validate the graph;
- Determine on OWL species for reasoning guarantees;
- Generate inferred truths (Pellet: <http://clarkparsia.com/pellet>)
- Evaluate consistency: do any statements imply a logical impossibility?
- Fully classify: make an explicit, complete subsumption hierarchy;
- Fully realize: assign each and every individual to its most direct class

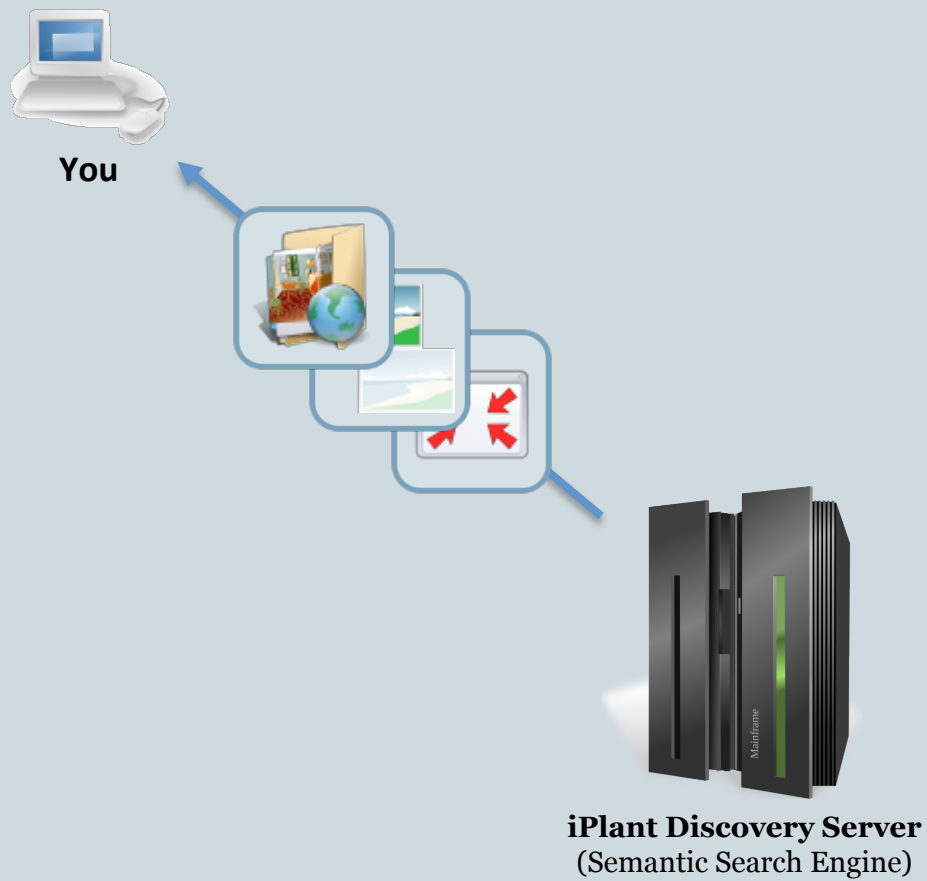
Architecture: Discovery from web sites



Architecture: Discovery from web sites



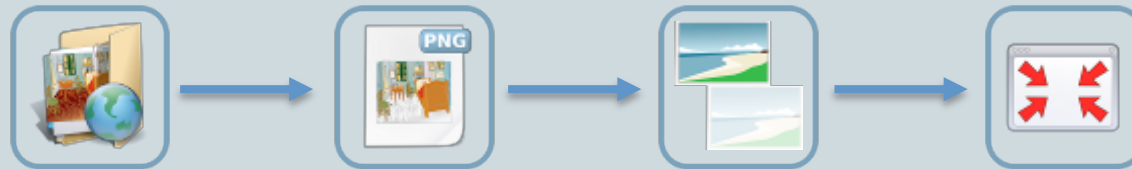
Architecture: Discovery from web sites



Architecture: Discovery from web sites



You



iPlant Discovery Server
(Semantic Search Engine)

iPlant Semantic Pipeline

Discovery from any web site



Taxonomic Name Resolution Service

NCEAS iPlant Collaborative BREN MISSOURI BOTANICAL GARDEN
 THE UNIVERSITY OF ARIZONA CSH Cold Spring Harbor Laboratory Yale

Home About Instructions API/Source Code Sources Contributors Future TNRS Application

Enter List Upload and Submit List Retrieve Results

Enter scientific names to check

zea mays
acacia

Clear Submit List

Welcome

TNRS allows you to validate and correct a list of plant names against an authoritative database of published scientific names and authorities. You may enter names on the fly by typing or pasting up to 5000 names in the Enter List tab to the left. Alternatively, you can upload a text file with an unlimited number of names in the Upload and Submit List tab. Your file MUST be plain text, with one name per line, and must have a .csv or .txt filename extension; word processor or spreadsheet files are NOT supported. You will receive an email notification when the list is done being processed. You can retrieve your results at that time in the Retrieve Results tab. Click the links above for more detailed instructions and other information. [Click here for support](#)

[sswap.info](#)

Download results Entered names result

Name Submitted	Name Matched	Overall Score	Status	Accepted Name	Details
zea mays	Zea mays L.	1.00	Accepted		Details
acacia	Acacia Mill. (+1 more)	1.00	Accepted		Details

Page 1 of 1

Displaying 1 - 2 of 2

Mock page for proof-of-principal only

iPlant Semantic Pipeline

Automatically presents semantic results



sswap.info
Simple Semantic Web Architecture and Protocol

New pipeline ▼ Login Register

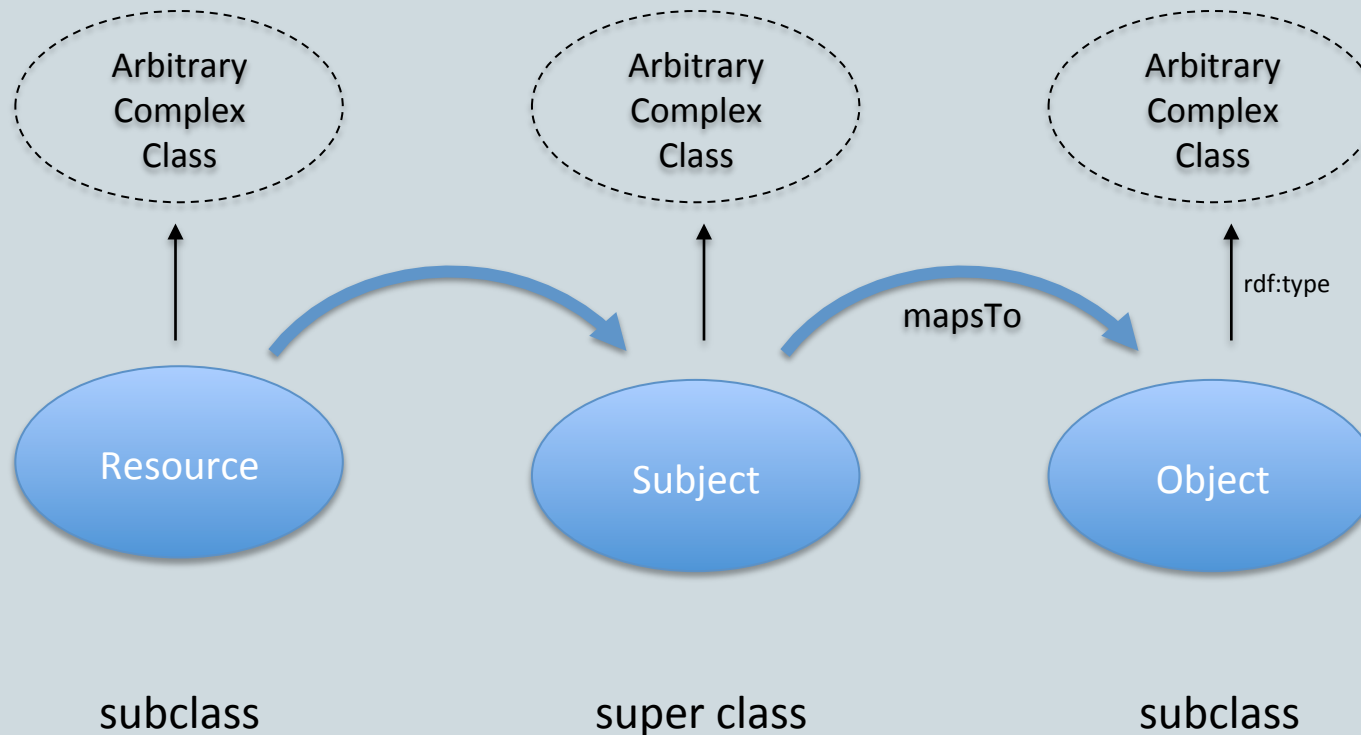
TNRS → Drag service icon here ▶▶

Clear filter Enter filter phrase Filter results

Showing 2 results

	Name: Extract images from page Description: Scans an HTML page and extracts all images from it Service URI: http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/extractImagesFromPage ▼ Provider: Test provider
	Name: SoyBase Locus Type Service Description: Returns a non-redundant list of all soybean genetic map loci contained in SoyBase. Service URI: http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/SoybaseLocusTypeService ▼ Provider: Test provider

On-demand Transaction-time Reasoning for Resolving Semantic Querying



Query: RQG (Resource Query Graph)

Data store: RDGs (Resource Description Graphs)

iPlant Semantic Pipeline

Automatic semantic match-making on DnD drop




sswap.info
Simple Semantic Web Architecture and Protocol

New pipeline ▼ Login
Register

TNRS → [Globe Icon] → [Drag service icon here] ▶▶▶


Service Details


 **Name:** Extract images from page
Description: Scans an HTML page and extracts all images from it
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/extractImagesFromPage> ▼
Provider: Test provider
Time started: N/A
Time finished: N/A

[Remove](#)

[Clear filter](#) Enter filter phrase [Filter results](#)

Showing 2 results

 **Name:** Converter to PNG
Description: Given an image in a format supported by Java ImageIO, it converts it into PNG
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/convertToPNG> ▼
Provider: Test provider

 **Name:** SoyBase Locus Type Service
Description: Returns a non-redundant list of all soybean genetic map loci contained in SoyBase.
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/SoybaseLocusTypeService> ▼
Provider: Test provider

iPlant Semantic Pipeline

Real-time reasoning on pipeline sanity



Mozilla Firefox

http://sswap.i...a-30bf5267556f

sswap.iplantcollaborative.org/IPC/5f9b7ebb-2172-464e-b0aa-30bf5267556f

sswap.info
Simple Semantic Web Architecture and Protocol

New pipeline ▼ Login
Register

Service Details

Name: Extract images from page
Description: Scans an HTML page and extracts all images from it
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/extractImagesFromPage>
Provider: Test provider
Time started: N/A
Time finished: N/A

[Remove](#)

[Clear filter](#) Enter filter phrase [Filter results](#)

Showing 5 results

	Name: Image conversion to grayscale Description: Given images in PNG format, converts them into a grayscale version Service URI: http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/grayscale Provider: Test provider
	Name: Dims image Description: Given images in PNG format, it dims them by the specified factor Service URI: http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/dim Provider: Test provider
	Name: Converter to PNG Description: Given an image in a format supported by Java ImageIO, it converts it into PNG Service URI: http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/convertToPNG Provider: Test provider
	Name: Scale image Description: Given images in PNG format, scales them to the desired size Service URI: http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/scale Provider: Test provider
	Name: SoyBase Locus Type Service Description: Returns a non-redundant list of all soybean genetic map loci contained in SoyBase.

iPlant Semantic Pipeline

DnD positioning for constrained service matching



sswap.info
Simple Semantic Web Architecture and Protocol

New pipeline ▼ Login
Register

TNRS → [Globe Icon] → [Drag service icon here] → [PNG Icon] ▶

Service Details

Extract images from page

Name: Extract images from page
Description: Scans an HTML page and extracts all images from it
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/extractImagesFromPage>
Provider: Test provider
Time started: N/A
Time finished: N/A

[Remove](#)

[Clear filter](#) Enter filter phrase [Filter results](#)

Showing 1 results

Converter to PNG

Description: Given an image in a format supported by Java ImageIO, it converts it into PNG
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/convertToPNG>
Provider: Test provider

iPlant Semantic Pipeline

DnD pipeline editing with ...



Mozilla Firefox

http://sswap.j...a-30bf5267556f

sswap.iplantcollaborative.org/pc/5f9b7ebb-2172-464e-b0aa-30bf5267556f

Google

sswap.info

Simple Semantic Web Architecture and Protocol

[New pipeline](#) [Login](#)
[Register](#)

Service Details

Name: Extract images from page
Description: Scans an HTML page and extracts all images from it
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/extractImagesFromPage>
Provider: Test provider
Time started: N/A
Time finished: N/A

[Remove](#)

[Clear filter](#) Enter filter phrase [Filter results](#)

Showing 5 results

Name: Image conversion to grayscale
Description: Given images in PNG format, converts them into a grayscale version
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/grayscale>
Provider: Test provider

Name: Dims image
Description: Given images in PNG format, it dims them by the specified factor
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/dim>
Provider: Test provider

Name: Converter to PNG
Description: Given an image in a format supported by Java ImageIO, it converts it into PNG
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/convertToPNG>
Provider: Test provider

Name: Scale image
Description: Given images in PNG format, scales them to the desired size
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/scale>
Provider: Test provider

Name: SoyBase Locus Type Service
Description: Returns a non-redundant list of all soybean genetic map loci contained in SoyBase.

iPlant Semantic Pipeline

... automatic enforcement of semantic sanity



sswap.info
Simple Semantic Web Architecture and Protocol

New pipeline Login
Register

TNRS → [Globe] → [PNG] → [Drag service icon here] ▶

Service Details

Name: Extract images from page
Description: Scans an HTML page and extracts all images from it
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/extractImagesFromPage>
Provider: Test provider
Time started: N/A
Time finished: N/A

Remove

Showing results

Service cannot be removed The upstream and downstream services of the removed service are not compatible

	Name: Grayscale Description: Given images in PNG format, converts them into a grayscale version Service URI: http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/grayscale Provider: Test provider
	Name: Dims Image Description: Given images in PNG format, it dims them by the specified factor Service URI: http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/dim Provider: Test provider
	Name: Converter to PNG Description: Given an image in a format supported by Java ImageIO, it converts it into PNG Service URI: http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/convertToPNG Provider: Test provider
	Name: Scale Image Description: Given images in PNG format, scales them to the desired size Service URI: http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/scale Provider: Test provider
	Name: SoyBase Locus Type Service Description: Returns a non-redundant list of all soybean genetic map loci contained in SoyBase.

iPlant Semantic Pipeline

Generic, automatic semantic support for required and optional service parameters



The screenshot shows the sswap.info web interface in a Mozilla Firefox browser. The page title is "sswap.info" and the subtitle is "Simple Semantic Web Architecture and Protocol". The user is logged in as "dgressler". A pipeline titled "New pipeline - executed" is shown, consisting of several service icons: TNRS, a service with a globe icon, a service with a document icon, a service with a red arrows icon, a dashed box labeled "Drag service icon here", and "MyData". Below the pipeline, there is a "Service Details" section for the "Scale image" service. The details include: Name: Scale image, Description: Given images in PNG format, scales them to the desired size, Service URI: http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/scale, Provider: Test provider, Time started: N/A, and Time finished: N/A. A dialog box titled "Edit parameters for the service" is open, showing the URL: http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/scale. The dialog also has an "Output dimension" section with a "Less" dropdown, a "URL" field with a plus icon and the text "Leave blank for an anonymous node", and "Height" and "Width" fields both set to 400. There are "Cancel" and "OK" buttons at the bottom of the dialog.

iPlant Semantic Pipeline

'Play' enabled when data conditions are met



The screenshot shows the sswap.info web interface in a Mozilla Firefox browser. The page title is "sswap.info" with the subtitle "Simple Semantic Web Architecture and Protocol". A "New pipeline" button is visible in the top left. The user is logged in as "dgressler".

The main pipeline configuration is shown as a sequence of steps: TNRS (represented by a globe icon) → Extract images from page (represented by a globe and image icon) → Converter to PNG (represented by a PNG icon) → Drag service icon here (represented by a dashed box) → MyData (represented by a globe icon). A large blue play button is at the end of the pipeline.

Below the pipeline, the "Service Details" section for the "Extract images from page" service is displayed:

- Name: Extract images from page
- Description: Scans an HTML page and extracts all images from it
- Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/extractImagesFromPage>
- Provider: Test provider
- Time started: N/A
- Time finished: N/A

A "Remove" button is located below the service details.

Below the service details, there is a search filter section with a "Clear filter" button and a "Filter results" button. The text "Showing 5 results" is displayed.

The search results list five services:

- Image conversion to grayscale**
 - Description: Given images in PNG format, converts them into a grayscale version
 - Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/grayscale>
 - Provider: Test provider
- Dims image**
 - Description: Given images in PNG format, it dims them by the specified factor
 - Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/dim>
 - Provider: Test provider
- Converter to PNG**
 - Description: Given an image in a format supported by Java ImageIO, it converts it into PNG
 - Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/convertToPNG>
 - Provider: Test provider
- Scale image**
 - Description: Given images in PNG format, scales them to the desired size
 - Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/scale>
 - Provider: Test provider
- SoyBase Locus Type Service**
 - Description: Returns a non-redundant list of all soybean genetic map loci contained in SoyBase.

iPlant Semantic Pipeline

'Pause' between independent web services



The screenshot shows a Mozilla Firefox browser window displaying the sswap.info website. The page title is "sswap.info" with the subtitle "Simple Semantic Web Architecture and Protocol". The main content area shows a pipeline titled "New pipeline - running" with a status of "running". The pipeline consists of four steps: TNRS, a globe icon, a document icon, and MyData. Below the pipeline, there is a "Service Details" section for the "Extract images from page" service. The details include the name, description, service URI, provider, time started, and time finished. Below the details, there is a search bar with the text "Enter filter phrase" and a "Filter results" button. The search results show two items, both for the "Extract images from page" service.

sswap.info
Simple Semantic Web Architecture and Protocol

New pipeline - running Logout
Logged as dgressler

TNRS → [Globe] → [Document] → MyData

Service Details

Name: Extract images from page
Description: Scans an HTML page and extracts all images from it
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/extractImagesFromPage>
Provider: Test provider
Remove
Time started: January 16, 2012 2:10:32 PM MST
Time finished: January 16, 2012 2:10:43 PM MST

Showing 2 results

Name: Extract images from page
Description: Scans an HTML page and extracts all images from it
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/extractImagesFromPage>
Provider: Test provider

Name: SoyBase Locus Type Service
Description: Returns a non-redundant list of all soybean genetic map loci contained in SoyBase.
Service URI: <http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/SoybaseLocusTypeService>
Provider: Test provider

iPlant Semantic Pipeline

Generic data viewer



The screenshot shows a Mozilla Firefox browser window displaying the sswap.info website. The page title is "sswap.info" and the subtitle is "Simple Semantic Web Architecture and Protocol". The user is logged in as "dgressler".

The main content area shows a pipeline execution titled "New pipeline - executed". The pipeline consists of several steps: TNRS, a service icon, another service icon, a dashed box labeled "Drag service icon here", and MyData. A large blue play button is on the right.

Below the pipeline, there is a "Service Details" section for the first service. It includes fields for Name, Description, Service URI, Provider, Time started, and Time finished. A "Remove" button is also present.

A modal window titled "View data from the service" is open in the foreground. It displays a list of data items, each with a "URL" field and a "Show optional properties" button. The URLs are: [http://sswap-a.iplantcollaborative.org/sswap-pipe\[...\]](http://sswap-a.iplantcollaborative.org/sswap-pipe[...]), [http://sswap-a.iplantcollaborative.org/sswap-pipe\[...\]](http://sswap-a.iplantcollaborative.org/sswap-pipe[...]), [http://sswap-a.iplantcollaborative.org/sswap-pipe\[...\]](http://sswap-a.iplantcollaborative.org/sswap-pipe[...]), and [http://sswap-a.iplantcollaborative.org/sswap-pipe\[...\]](http://sswap-a.iplantcollaborative.org/sswap-pipe[...]). An "OK" button is at the bottom right of the modal.

The background shows a list of services with their details, including "Image conversion", "Dims Image", "Converter to PNG", "Scale image", and "SoyBase Locus Type Service".

iPlant Semantic Pipeline

100% idempotent and RESTful via JSON API to a separate, underlying pipeline manager



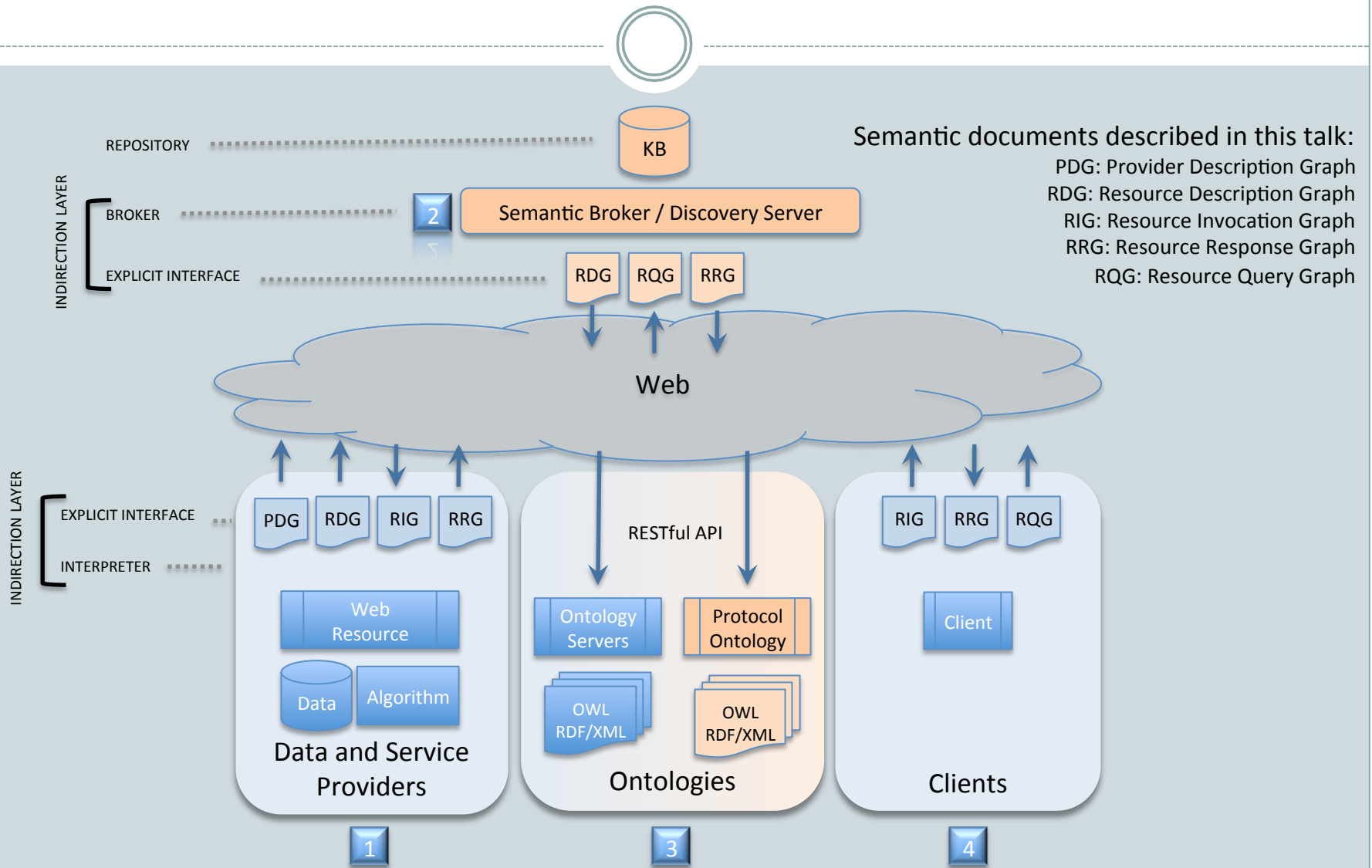
```
5f9b7ebb-2172-464e-b0aa-30bf5267556f.json
Last Saved: 1/16/12 2:13:55 PM
File Path: ~/Downloads/5f9b7ebb-2172-464e-b0aa-30bf5267556f.json
5f9b7ebb-2172-464e-b0aa-30bf5267556f.json (no symbol selected)
{
  "id": "5f9b7ebb-2172-464e-b0aa-30bf5237556f",
  "timeFinished": 1326748325988,
  "status": "EXECUTED",
  "timeStarted": 1326748232342,
  "name": "New pipeline",
  "owner": "owner",
  "elements": [
    {
      "timeFinished": 1326748243249,
      "input": {
        "label": "",
        "type": "http://www.w3.org/2002/07/owl#Thing"
      },
      "status": "EXECUTED",
      "timeStarted": 1326748232485,
      "serviceURI": "http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/extractImagesFromPage",
      "type": "service"
    },
    {
      "timeFinished": 1326748325988,
      "input": {
        "label": "",
        "type": "http://www.w3.org/2002/07/owl#Thing"
      },
      "status": "EXECUTED",
      "timeStarted": 1326748294830,
      "serviceURI": "http://sswap-a.iplantcollaborative.org/sswap-pipeline-test/test/data/pipeline/convertToPNG",
      "type": "service"
    }
  ],
  "outputData": "iplant:/username/outputdata",
  "inputData": "http://sswap.iplantcollaborative.org/ipc/rrg?token=4cdf020f-8e8f-4c2f-a722-4924cf884b9f",
  "timeout": 600000,
  "private": "false"
}
```

Ontological Attributes



- Ontologies are developed, maintained, and evolve distributively;
- Concepts and properties are related logically (across ontology domains) by first-order logic relations, rather than solely physically (all in the same file);
- Ontology alignment is operational and ephemeral (the service action of mapping input data of one type to output data of another type), rather than statically with axiomatic relations;
- Querying and discovery is based on subsumption matching, rather than exposed SPARQL queries;
- Reasoning is employed at transaction-time, both at the Discovery Server and individual third-party semantic web service points.

Semantic Architecture



Semantic documents described in this talk:
 PDG: Provider Description Graph
 RDG: Resource Description Graph
 RIG: Resource Invocation Graph
 RRG: Resource Response Graph
 RQG: Resource Query Graph

Acknowledgements



For more information please contact:

dgessler (at) iplantcollaborative (dot) org

Special thanks to:

- iPlant Collaborative
- Clark and Parsia, LLC
- NSF grants #0943879 and #EF-0735191