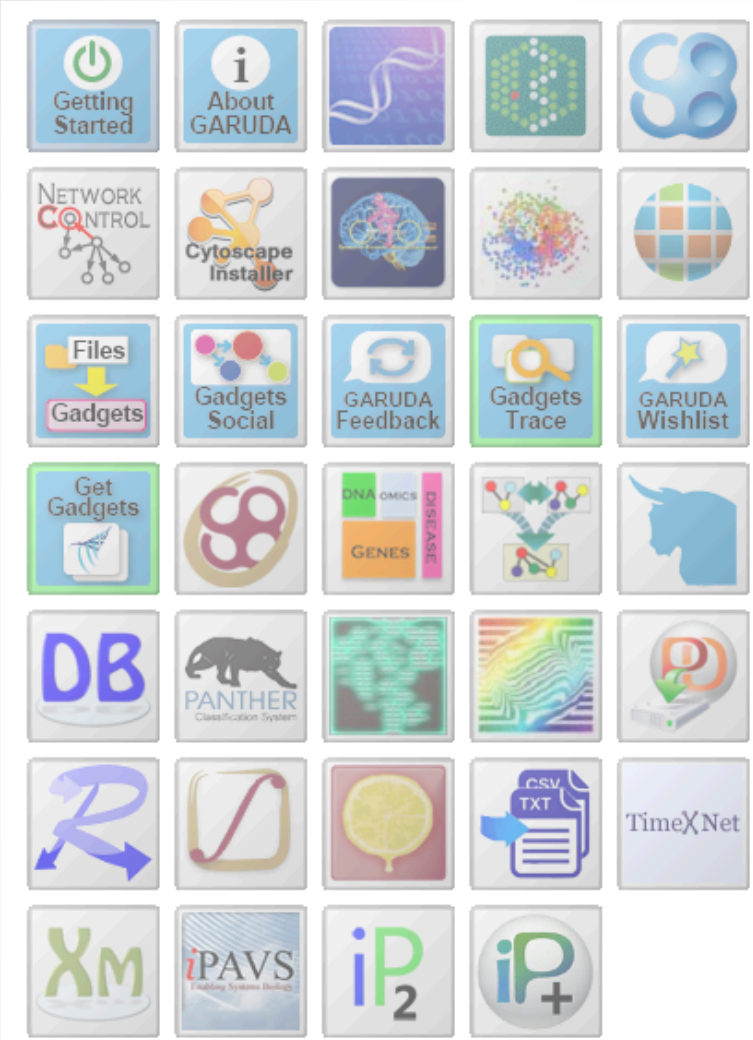


Garuda

The way biology connects

Samik Ghosh,
The Systems Biology Institute, Tokyo
The Garuda Alliance
www.garuda-alliance.org

ECCB, September 2014

SBI The Systems Biology Institute

GARUDA
THE WAY BIOLOGY CONNECTS

Computational Tools and Platforms

Landscape

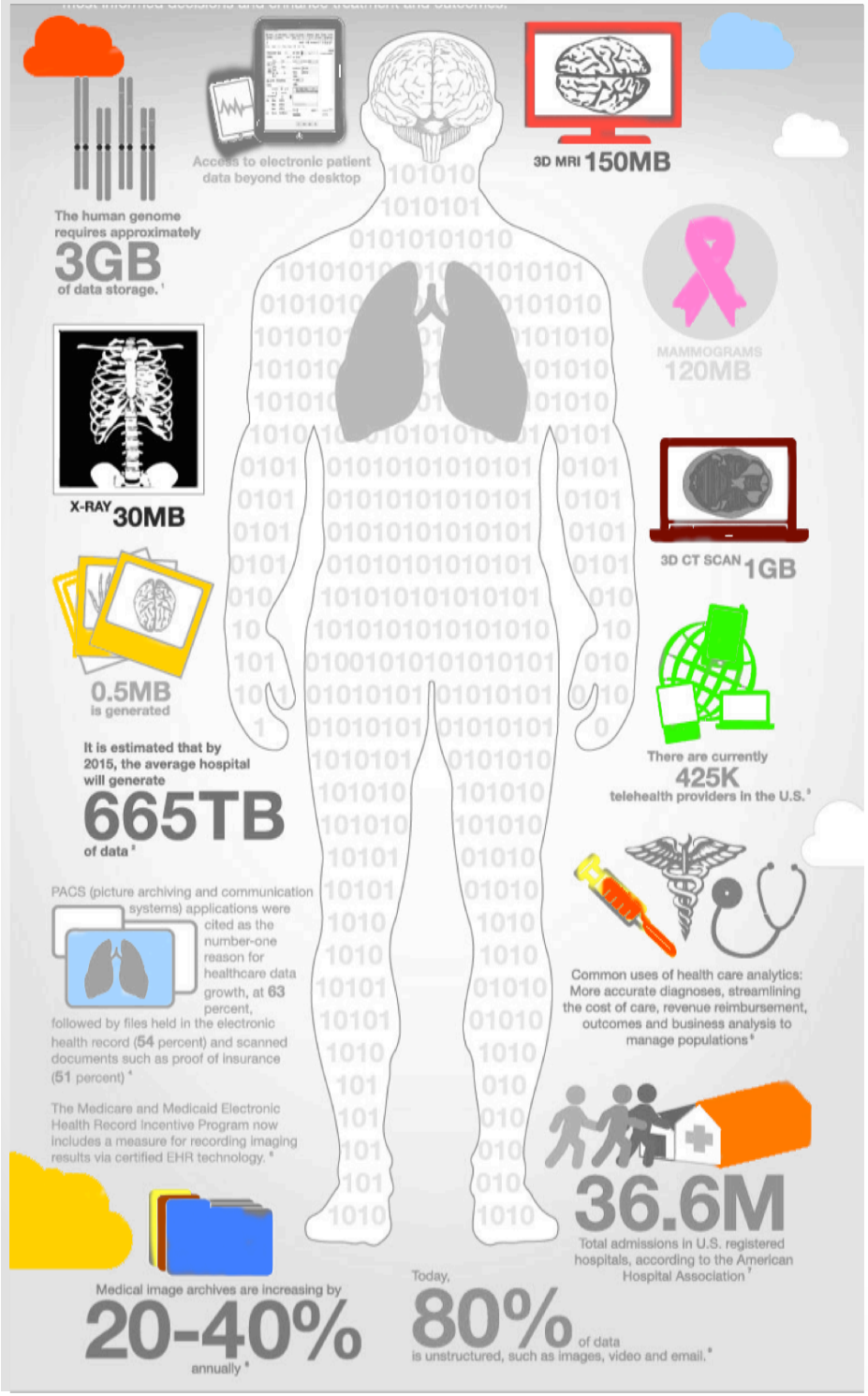
Computational tools and platforms drive analysis of experimental data

- A wide variety of tools and techniques are available
  - Genomic analysis
  - Proteomic analysis
  - Pathways and network analysis
  - Simulation and modeling at multiple scales

Landscape

- Complexity and multiple dimensions of analysis characterize biomedical research
- It is extremely challenging to develop a single tools which covers these dimensions
- The focus is shifting to “platforms”

Why Garuda?



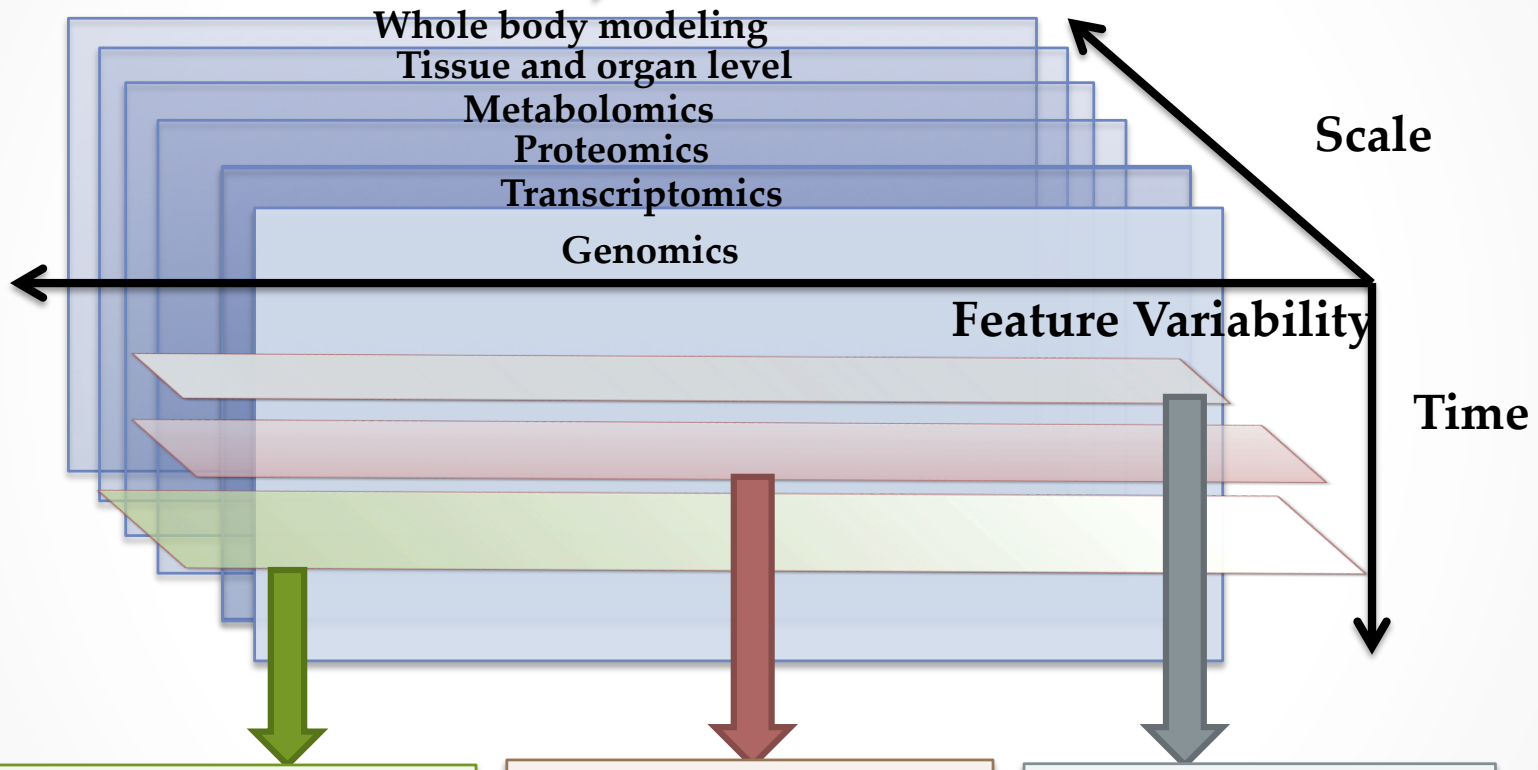
Data Diversity

Biological data has:

- High Variety
- High Variability
- High Volume
- Need Veracity
- Need Visualization

Analytics Diversity

HD Data → HD Analytics



Tissue & Organ Level
Physiological model, ADME/TOX and PK/PD Modeling

Proteomics & Metabolomics
Mass-spec analysis
Flux balance and pathway analysis

Genomics & Transcriptomics
Array Analysis, Gene enrichment, pathway analysis

Analytics Diversity

Plethora of databases, tools and services

Database

Modeling

Informatics

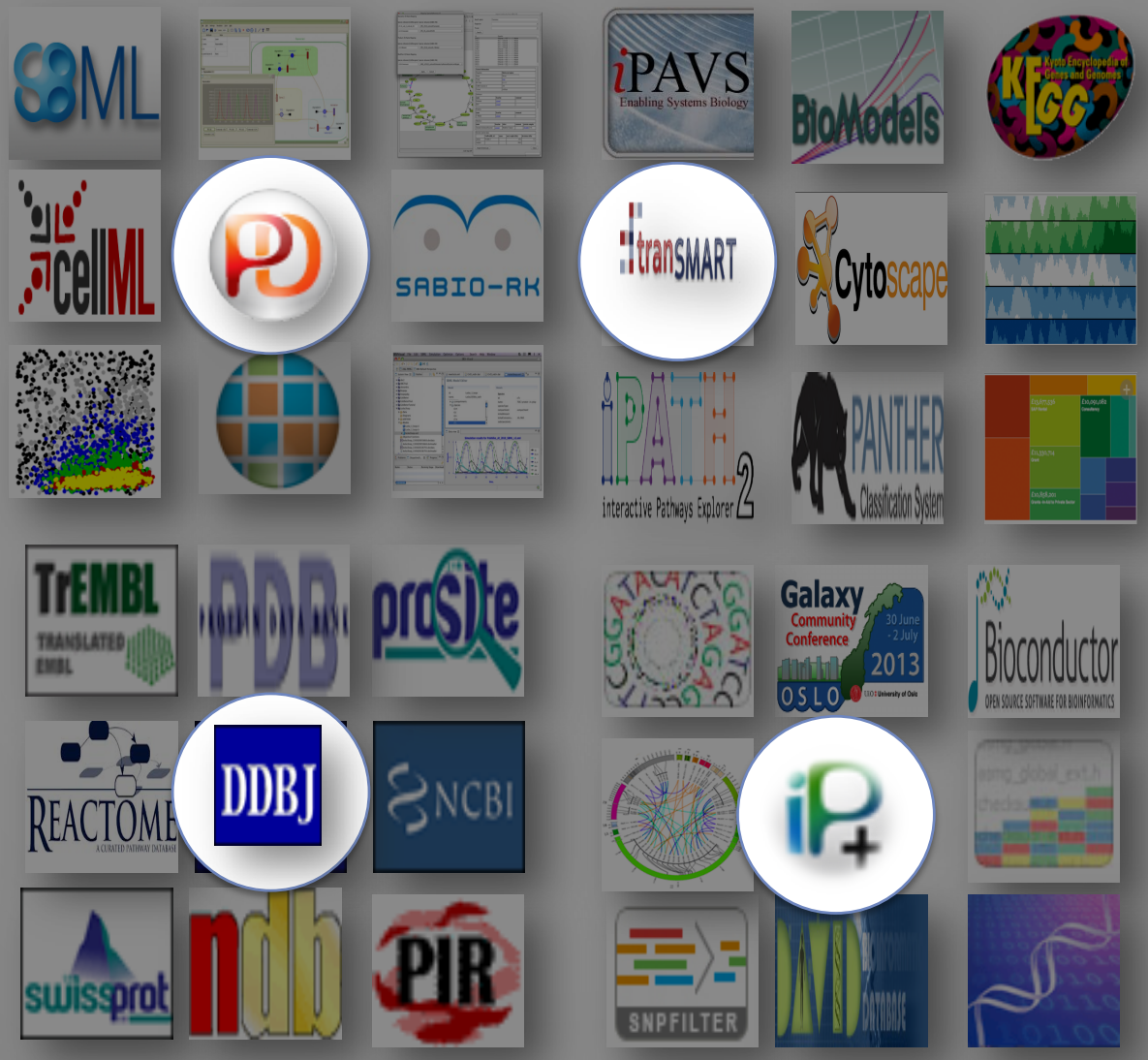
Networks

Analytics Challenges

Discoverability: which, how, what

Analytics Challenges

Where should I go….

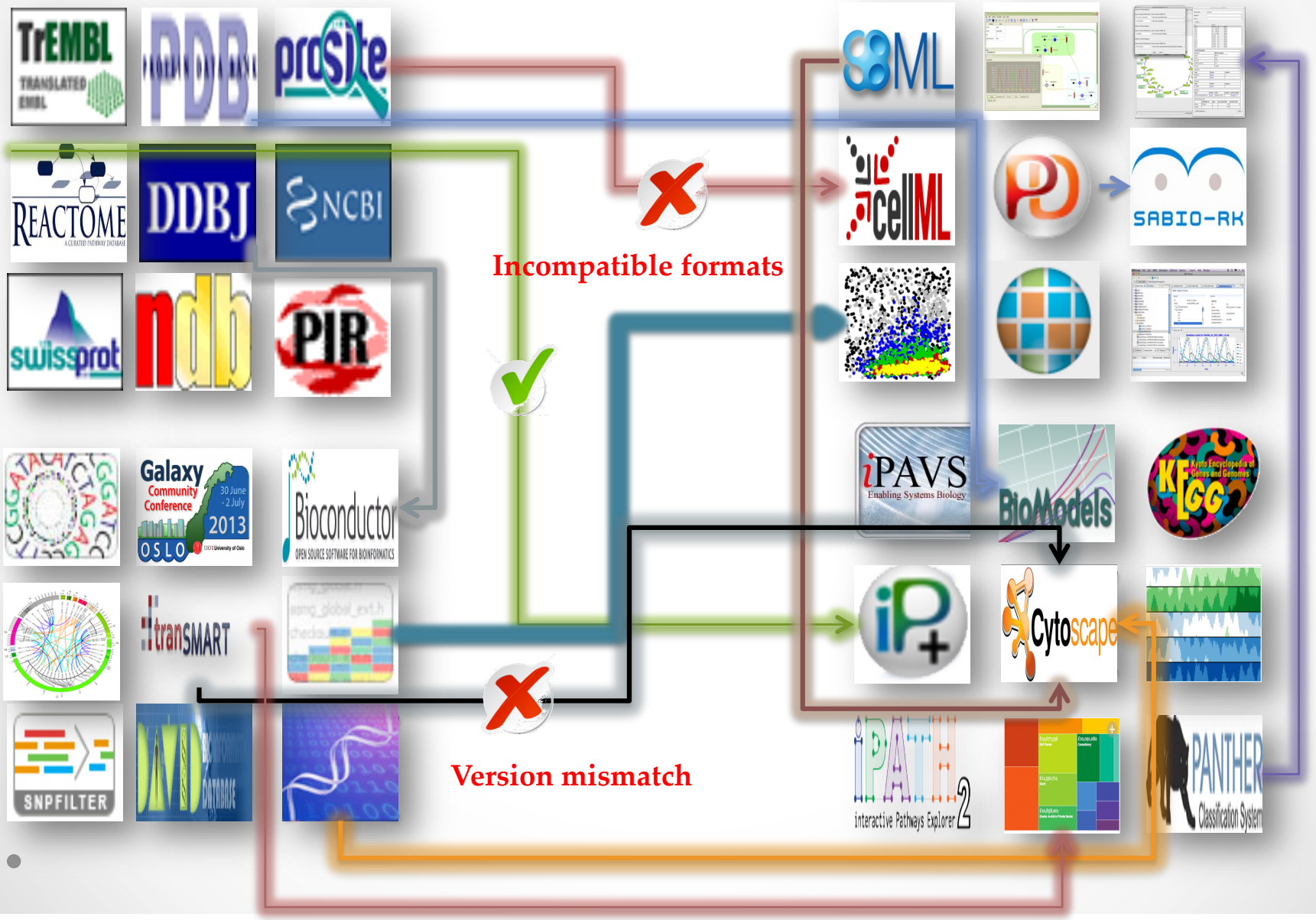


Analytics Challenges

Navigability: how to walk through multiple tools

Analytics Challenges

Navigability: road-blocks, dead-ends



Need for a Platform

Platform Needs

A platform for bio-medical research which is

- Open – Interface with multiple analytics tools
- Discoverable - One stop access
- Navigable – Reduce friction in using multiple tools

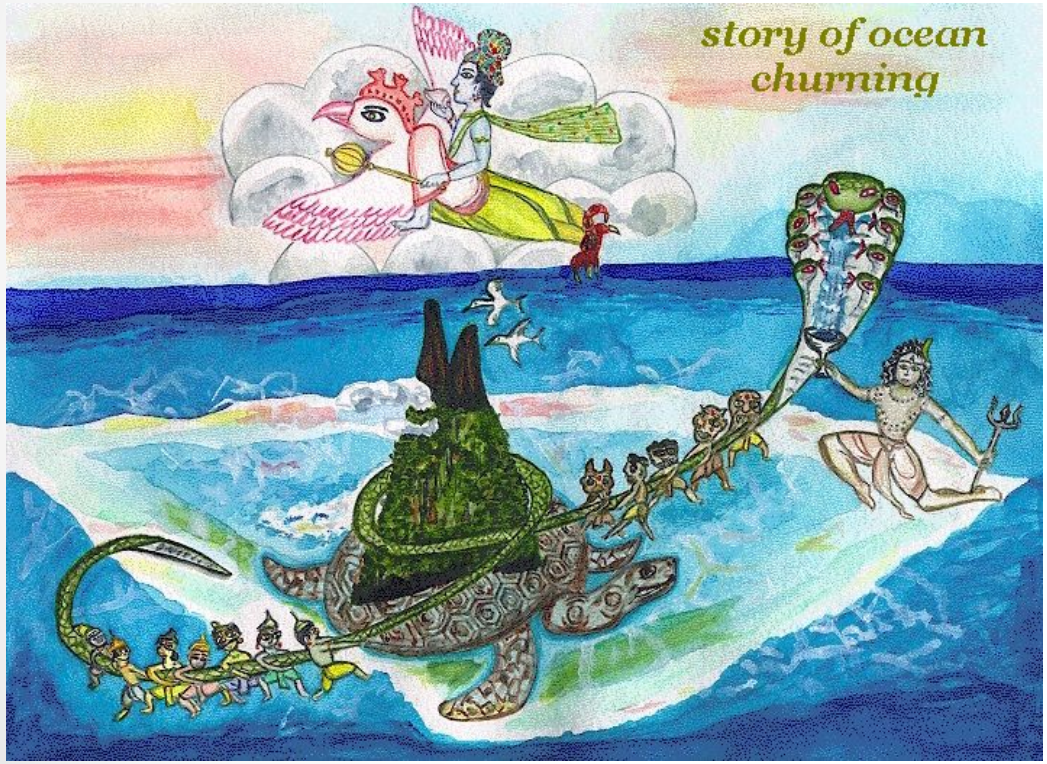
Software for systems biology: from tools to integrated platforms

Samik Ghosh[1], Yukiko Matsuoka[1,2], Yoshiyuki Asai[3], Kun-Yi Hsin[3] & Hiroaki Kitano[1,3,4] About the authors

What is Garuda?

What is Garuda?

The Myth....

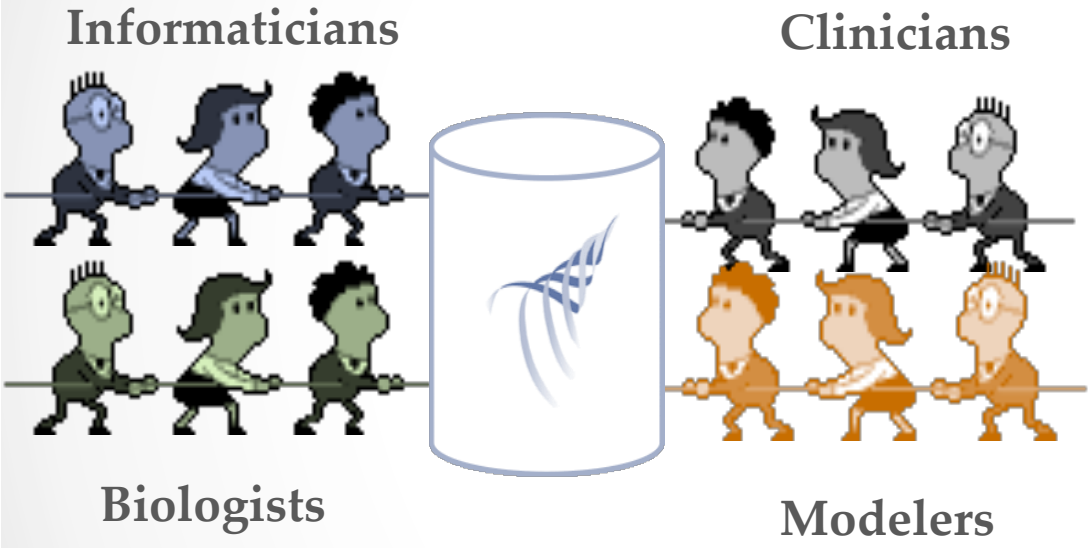


Garuda is a divine bird in Hindu mythology who is the mount (*vahana)* of Vishnu – the supreme God of the universe and commander of Churning of the Sea of Milk

A *Hindu* myth in which gods and demons cooperate to churn the primordial ocean, in order to produce amrita, the elixir of immortality

What is Garuda?

The Platform....

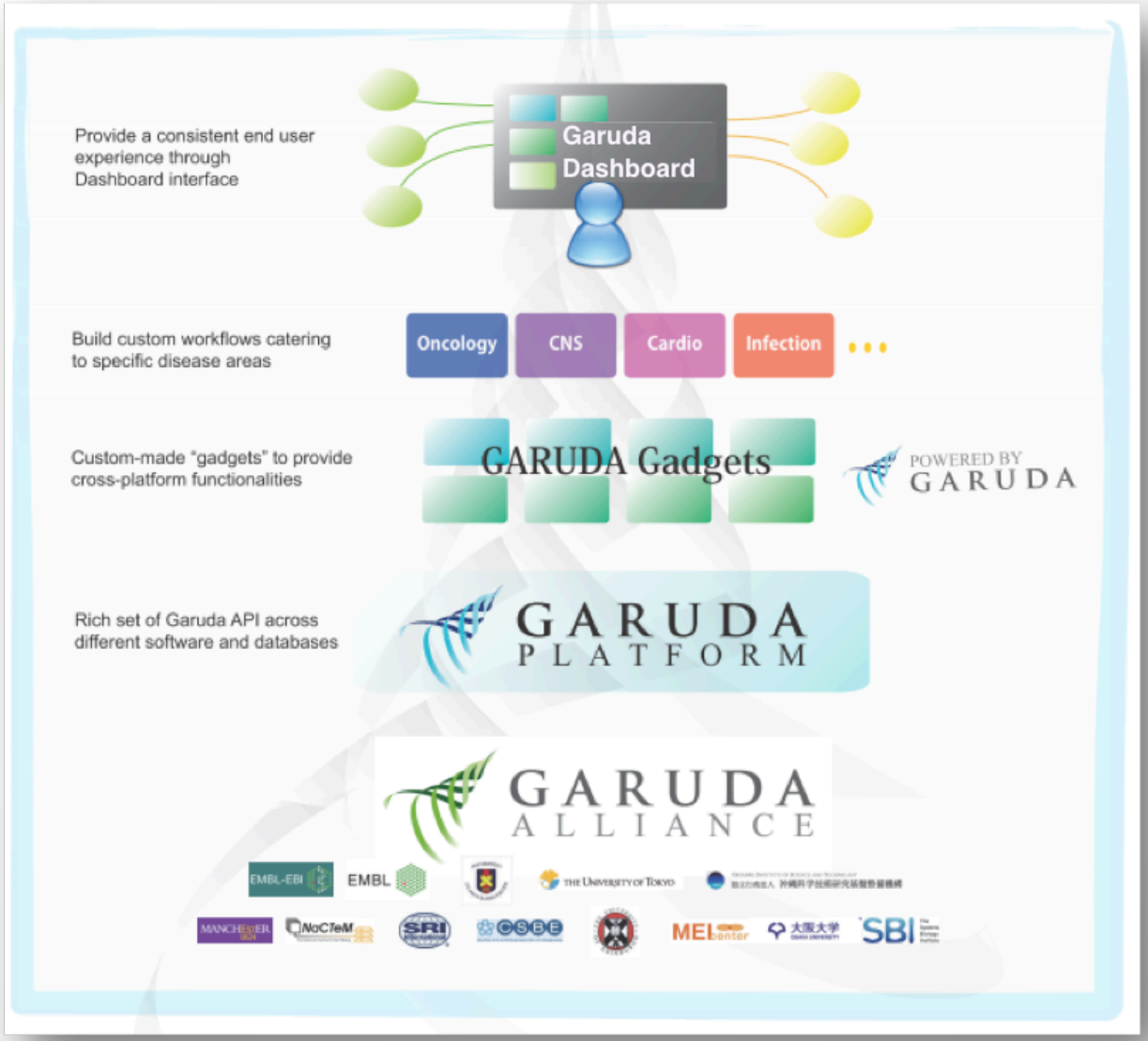


Garuda is an open, community-driven, common platform that provides a framework to –

- interface,
- discover, &
- navigate through

different applications, databases and services in bio-medical research

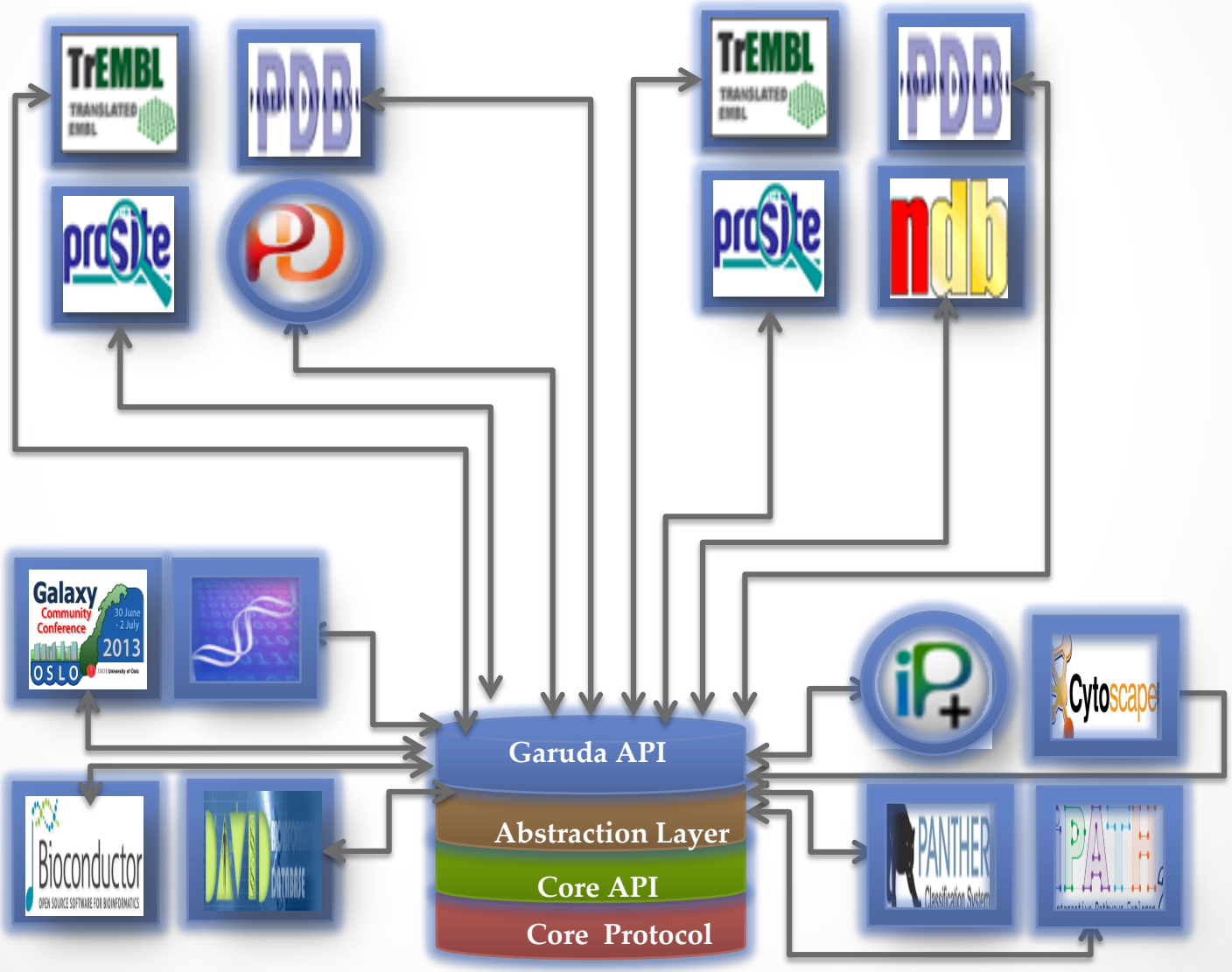
What is Garuda?



The Gadgets

Garuda Gadgets

Inter-operating universe of Garuda-enabled tools and services



The Dashboard

Garuda Dashboard

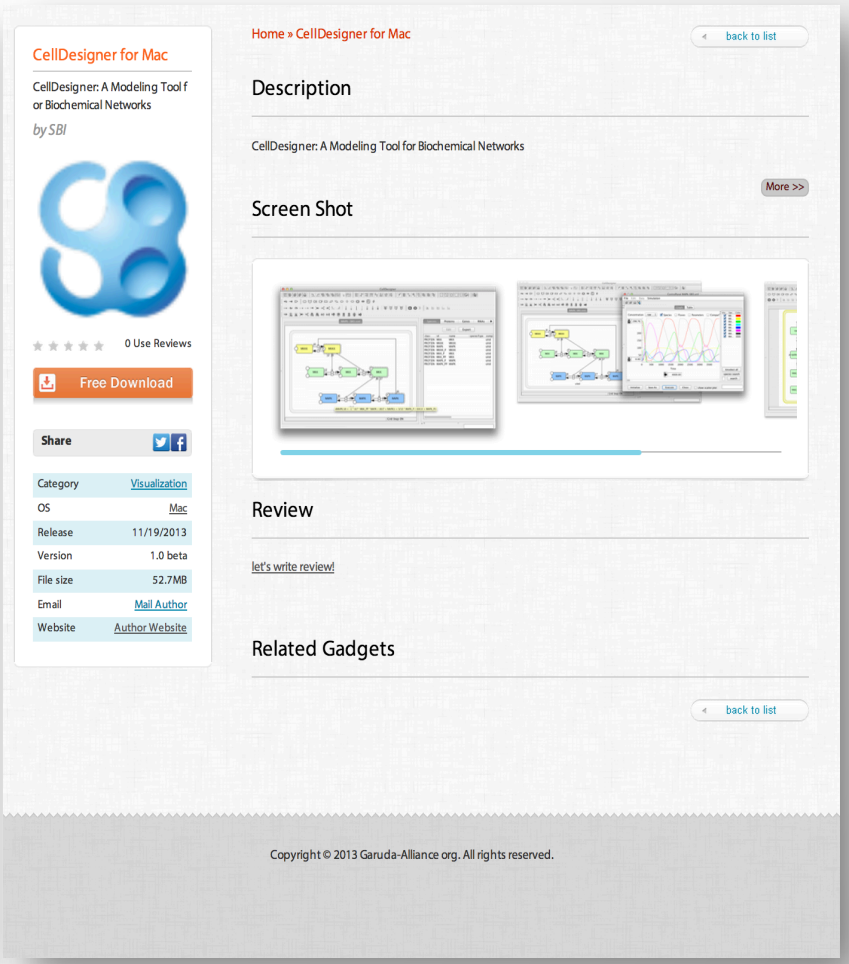
Provides the single window desktop interface to access and navigate gadgets

The Gateway

Invited Access

Garuda Gateway

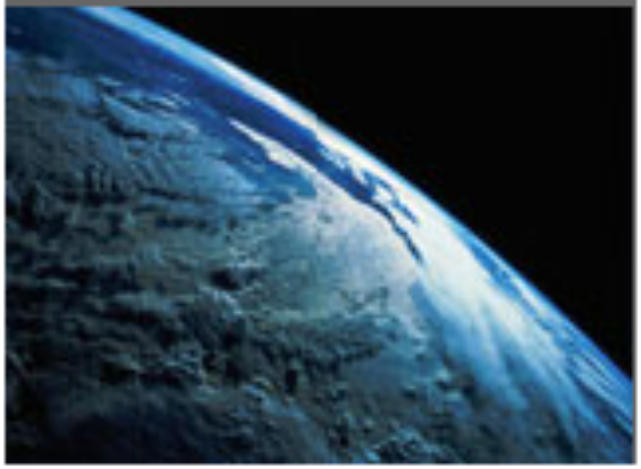
Web-based interface to access and discover gadgets



http://gateway.garuda-alliance.org

The Alliance

Round the World



Circle Asia

Circle North Asia

Circle Pacific


Star Alliance Book and Fly
STAR ALLIANCE
Welcome
Plan journey
Choose flights
Review itinerary
Enter personal details
Make payment
Confirm booking
Round the World. Add destinations to your itinerary.
ARCTIC OCEAN
Helsinki
Copenhagen
Warsaw
London
Brussels
Frankfurt
Vienna
Ljubljana
Zagreb
Istanbul
Lisbon
Madrid
Cairo
Addis Ababa
Johannesburg
INDIAN OCEAN
Beijing
Seoul
Shanghai
Tokyo
Bangkok
Singapore
Auckland
Honolulu
Denver
Chicago
Montreal
New York
Washington
Los Angeles
Houston
Your Round the World Itinerary
Add city to itinerary
1. Tokyo (JP)
2. Frankfurt (DE)
3. New York (US)
4. Honolulu (US)
5. Tokyo (JP)
Itinerary status: Complete, please choose flights
Direct flights
Single connections
Multiple connections
Not Selectable
Segments: 4 (max 16)
Stopovers: 3 (max 15)
Mileage: 18,576
39,000
Previous
Save
Email
Download PDF
Print
Help
Next

Garuda Alliance

A global consortium of key leaders in informatics and analytics

Garuda Alliance

Garuda One, Okinawa 2010

Garuda Three, Edinburgh 2010

Garuda Nine, Okinawa 2013

How does it work?

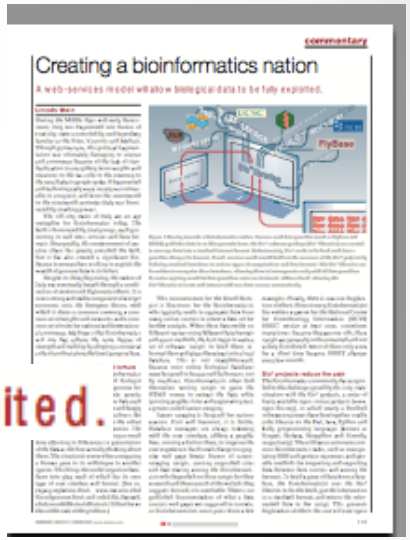
Bit of History….

commentary

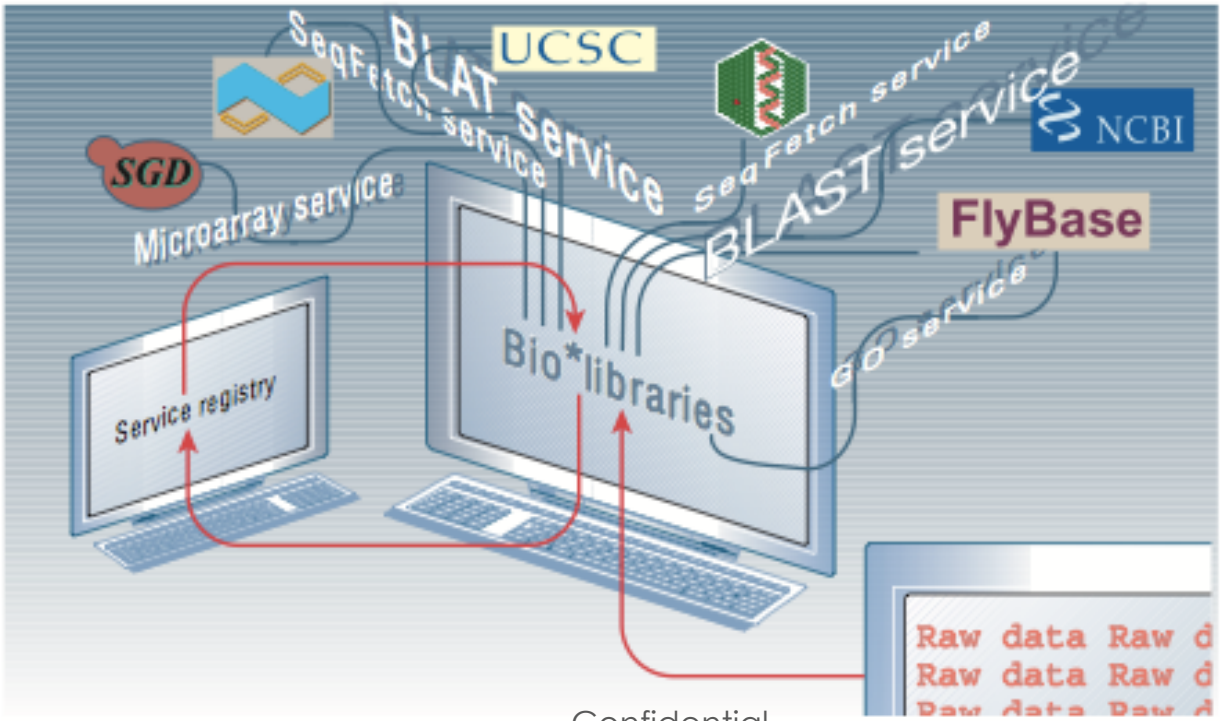
Creating a bioinformatics nation

A web-services model will allow biological data to be fully exploited.

Lincoln Stein NATURE | VOL 417 | 9 MAY 2002 | www.nature.com


commentary
Creating a bioinformatics nation
A web-services model will allow biological data to be fully exploited.

A web-services model will allow biological data to be fully exploited.



Planet of APIs

Power of Open APIs!!!

NOISE TO SIGNAL
Rob Cottingham

Apparently our open API is giving our customers unprecedented control over their own lives and allowing them to seize control of their destinies. So please shut it down.

Planet of APIs

Build an eco-system of Garuda APIs

Courtesy: Google Images

Key Concepts

Dashboard

Provides the single window desktop interface to the end users for all things Garuda!

GCore

The engine driving the Garuda Platform. Provides the implementation of the Garuda Protocol and does all the heavy lifting!

Gadgets

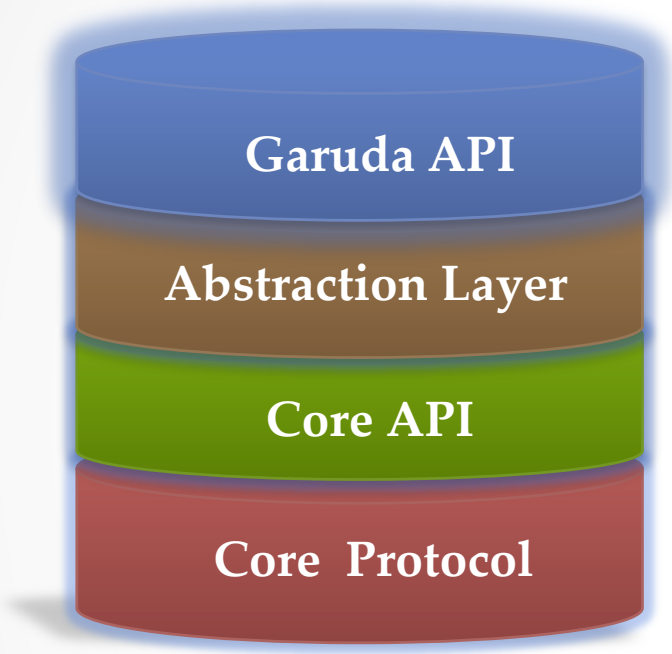
The "Garuda-enabled" software driving Garuda! Software which implement the Garuda Protocol APIs

Gateway

The web interface to Garuda Platform.
Provides gadget management and related functionalities

The Core Engine

Garuda Core



Core Protocol: A communication framework on existing networking protocols

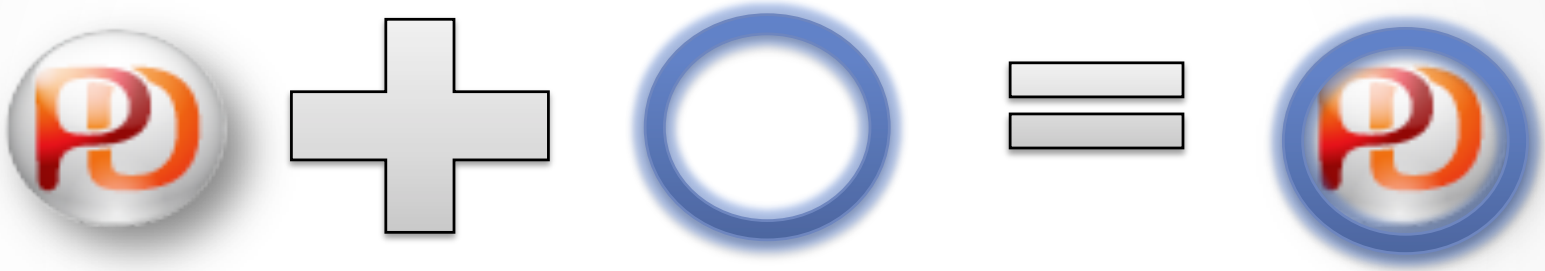
Core API: Core engine interface to the protocol

Abstraction Layer: A language and system agnostic interface to Core

Garuda API: Set of application programming interfaces to interact with Garuda Core over the Garuda Protocol (multi-language bindings)

Garuda Gadgets

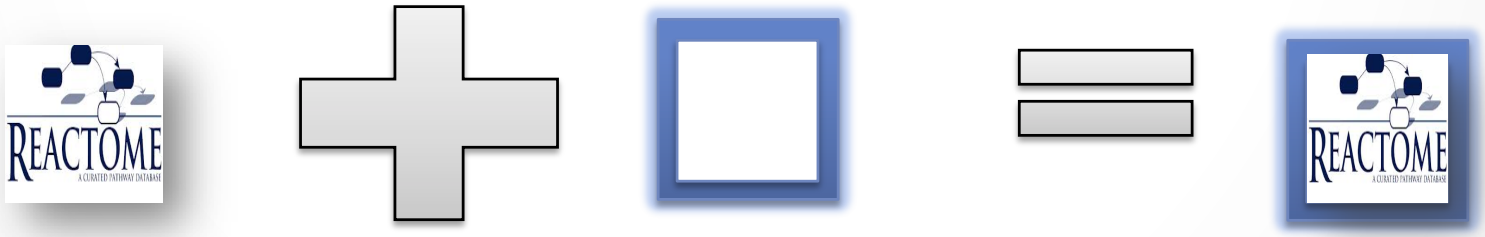
A software or service which implements the Garuda API to enable its functions on Garuda Platform



PhysioDesigner Application

Garuda API

PhysioDesigner Garuda Gadget



Reactome Web Service

Garuda API

Reactome Garuda Gadget

Core Principles

Single platform for end users

Plug and Play (PnP) for users

Dynamic inter-operability and discovery

Zero end-user configurations

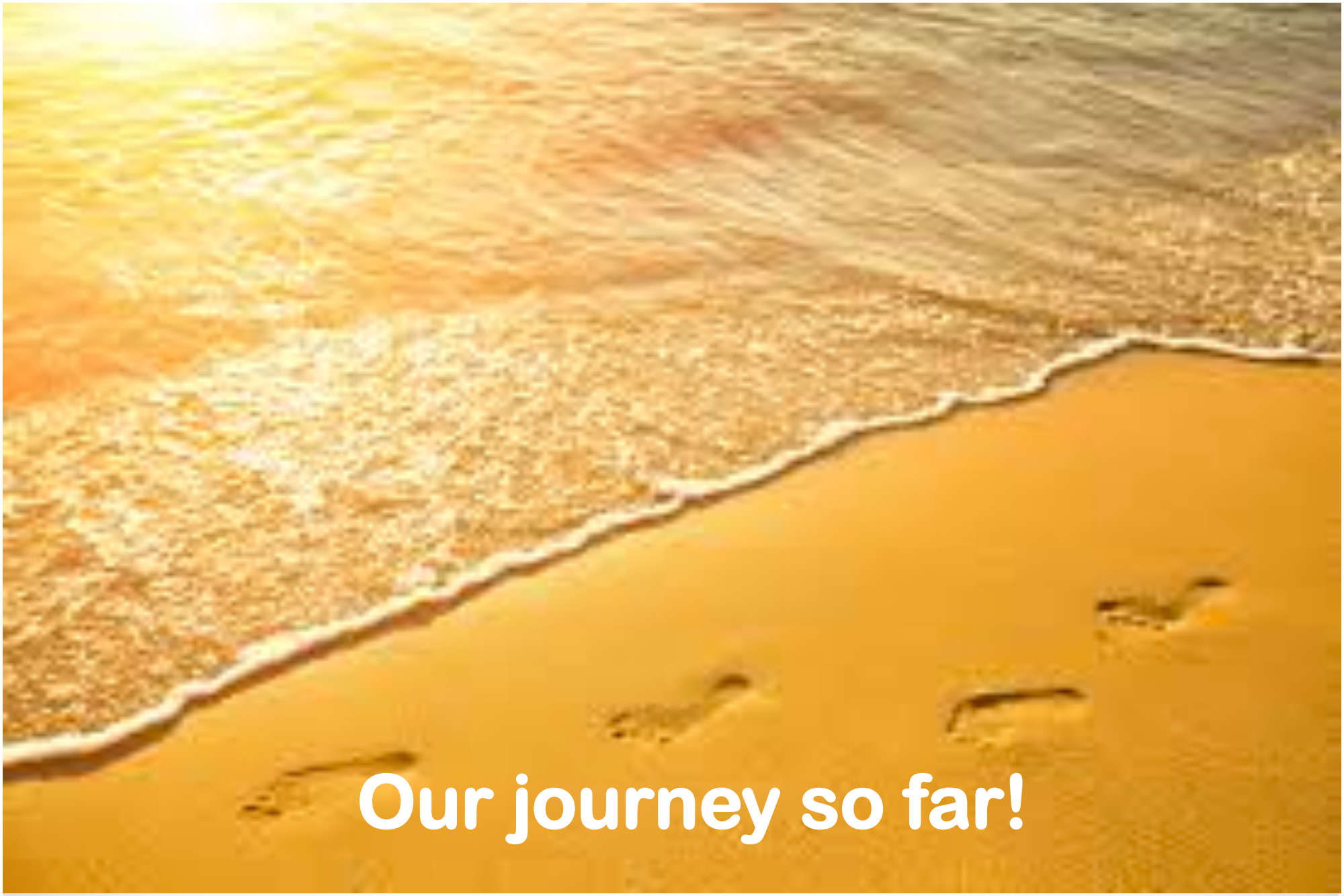
Open APIs for developers

Language independent protocols

Standardized UX

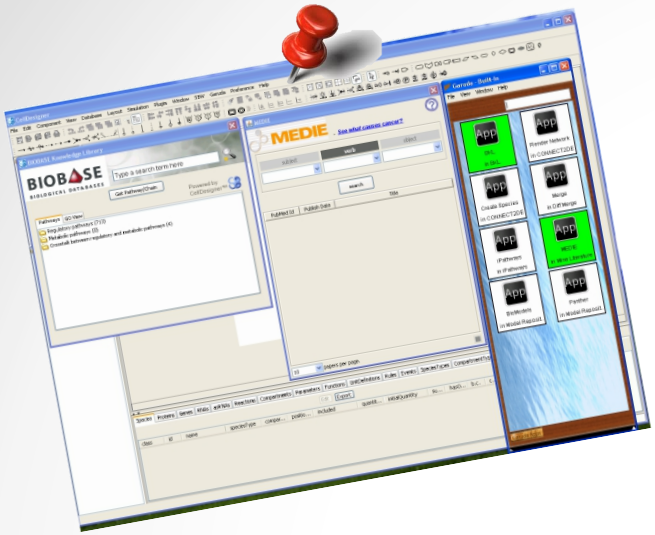
Multi-language bindings

History of Garuda


Our journey so far!

Garuda One, Okinawa, Japan 2010

- ✓ Concept of a common platform
- ✓ Motivation
- ✓ Guiding principles
- ✓ Core members



Garuda Two, Manchester, UK 2010

- ✓ First seeds of Alliance
- ✓ Need of APIs
- ✓ Need of services

Garuda Three, Edinburgh, UK 2010

- ✓ First demo of dashboard
- ✓ Concept of Gadgets
- ✓ Concept of Garuda Core
- ✓ Garuda API (GAPI)

Garuda Four, Okinawa, Japan 2011

- ✓ Garuda platform architecture
- ✓ Formalization of services
- ✓ Formalization of APIs
- ✓ Scrap-built demo
- ✓ Garuda Logo conception

Garuda Five, Heidelberg, Germany 2011

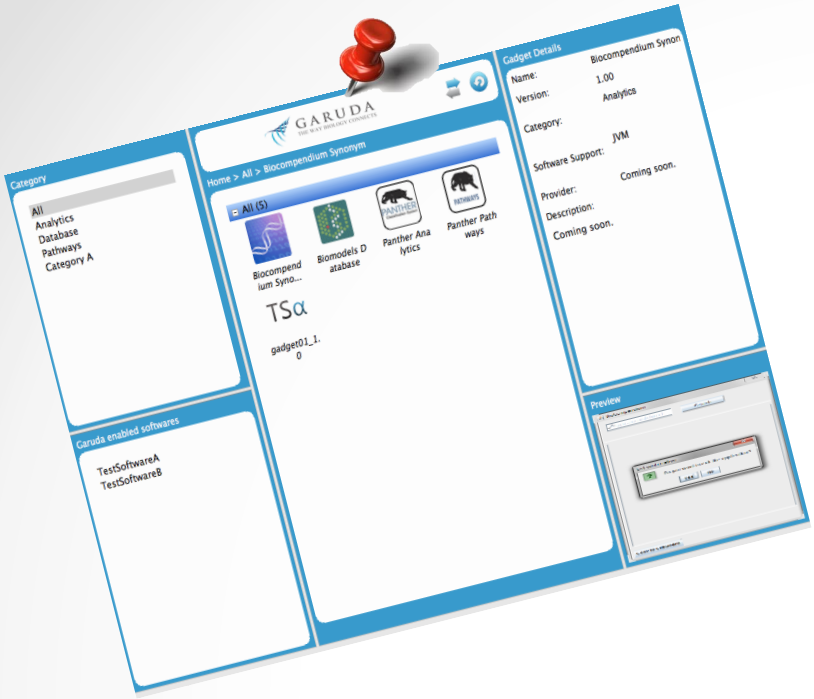
- ✓ Review of new architecture
- ✓ Beta version www.garuda-alliance.org
- ✓ Garuda Logo launch

Garuda Six, LCSB, Luxembourg, 2011

- ✓ Internal release of Alliance website
- ✓ Draft specification of service & core APIs
- ✓ Sample Garuda gadgets development
- ✓ Sample Garuda enabled software

Garuda Se7en, Okinawa, 2012

- ✓ Final specification of Core and API
- ✓ First version of Java SDK
- ✓ New Dashboard design



Garuda 7.5, Long Beach, CA, 2012

- ✓ Garuda 1.0 Community alpha1
- ✓ Beta version of Java SDK
- ✓ C++ and Python bindings samples

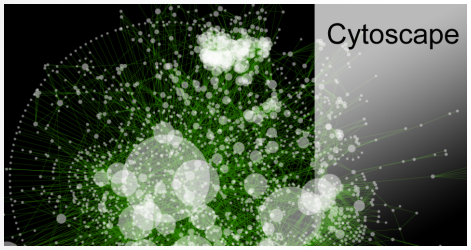
Garuda 8, Toronto, Canada, 2012

- ✓ Garuda 1.0 Community alpha2
- ✓ Beta2 version of Java SDK
- ✓ Concept of Garuda Gateway

Goals

- ✓Hackathon – Enable gadgets on the dashboard
- ✓Community expansion and outreach
- ✓Roadmap for public beta
- ✓Community beta release

Garuda 9 Okinawa, Japan Feb 2013



First public workshop on Garuda!

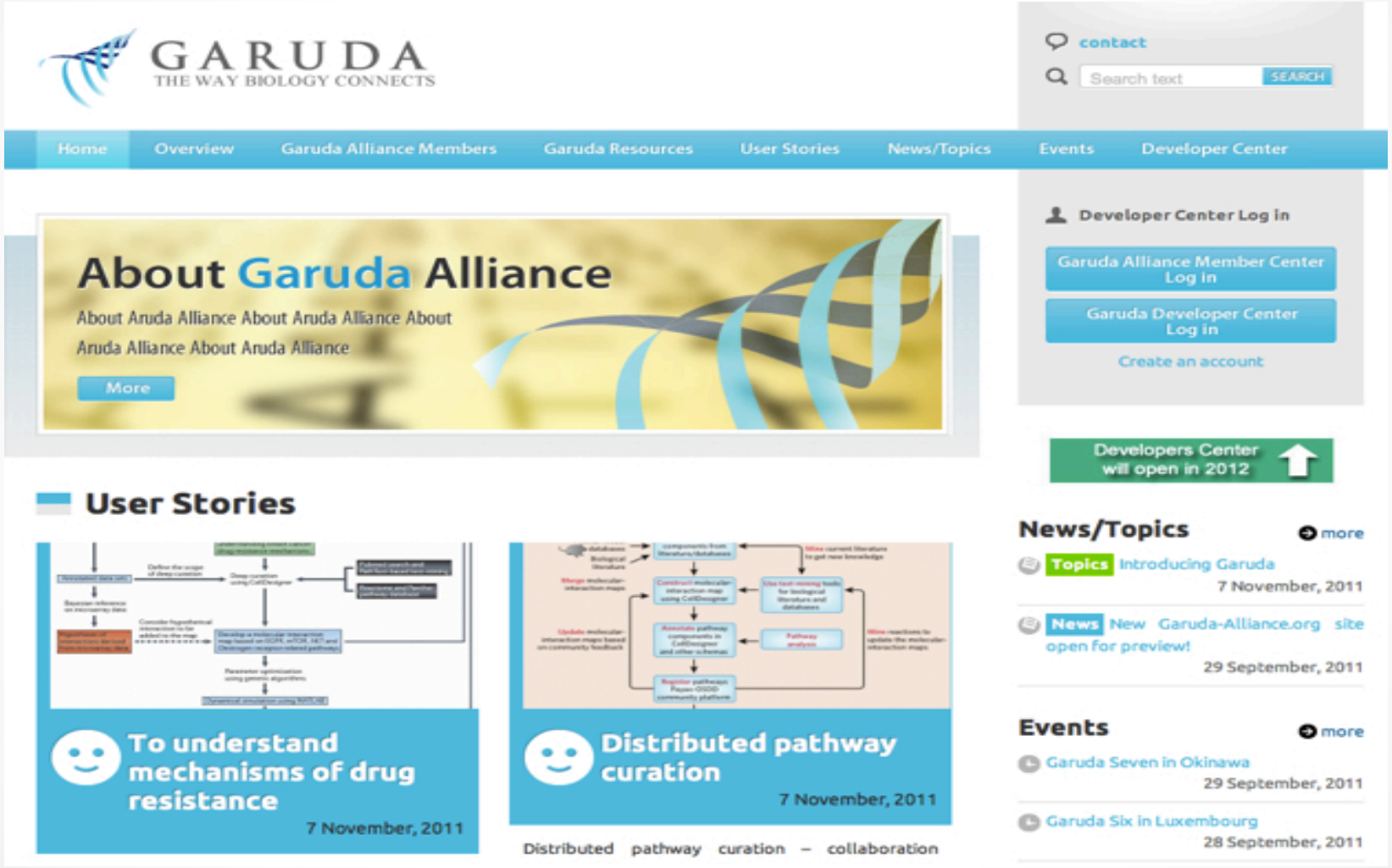
- ✓ Introduction to Garuda
- ✓ Public beta users
- ✓ Comments and Feedback
- ✓ Sign-up for public beta
- ✓ Help us spread and improve Garuda

First public release of Garuda!

Discover and Navigate

Garuda Alliance

www.garuda-alliance.org



Explore new user stories, Resources and Events!

Join the Community!

Community

Community is key to Garuda

Join the Garuda community and –

- Use gadgets in your projects
- Suggest new gadgets and pipelines
- Develop your own gadgets

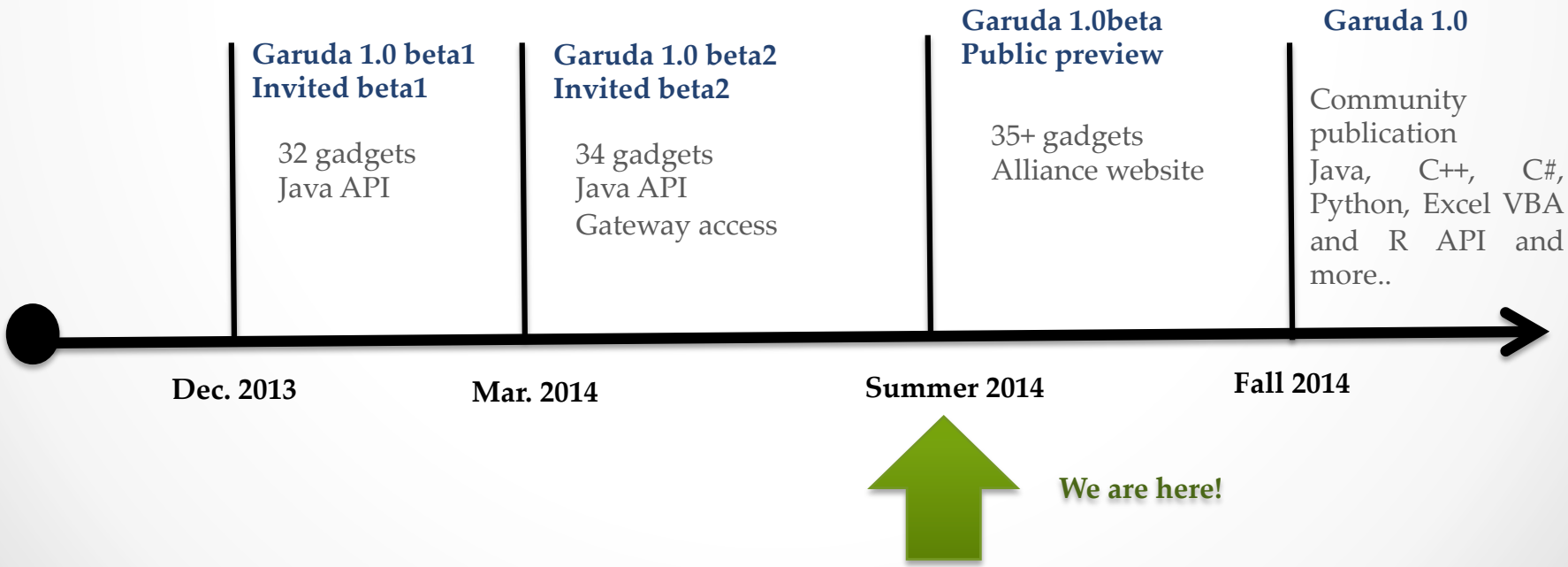

Garuda
Science In Style
Thank you!

Garuda 1.0 beta – A Preview

Release Roadmap

Garuda Platform 1.0 beta public preview :

- Over 30 gadgets from 20 academic partners covering modeling, simulation, visualization, analytics and more.
- Invited access to gadgets from gateway
- Invited access to APIs in Java, C++, C#, Python, R and Excel Macro and more…



Release Notes: 1.0 beta

New 35 **Gadgets** available in 1.0 beta
(33 gadgets with 2 installers)

Available on **OSX** and **Windows**

New

Access to **Garuda Gateway** for download of gadgets on request

Release Notes: 1.0 beta

Integrated access to **Garuda Gateway** from dashboard

Updated dashboard, 2 Installer

Lite : Dashboard with core gadgets

Pack: Dashboard with all gadgets

Free Download!

http://gateway.garuda-alliance.org

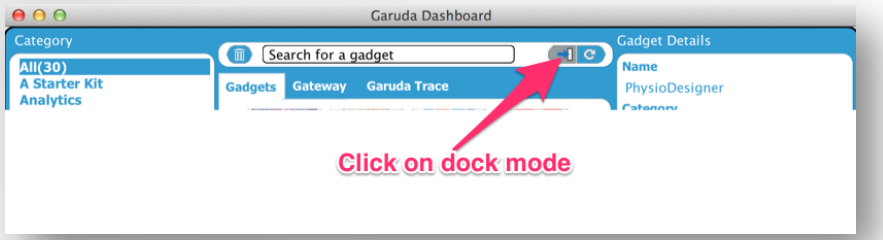
Garuda 1.0 Walkthrough

Getting Started

Garuda Dashboard

On launching Garuda, the Dashboard provides the window to the world of Garuda gadgets

Usability Tips

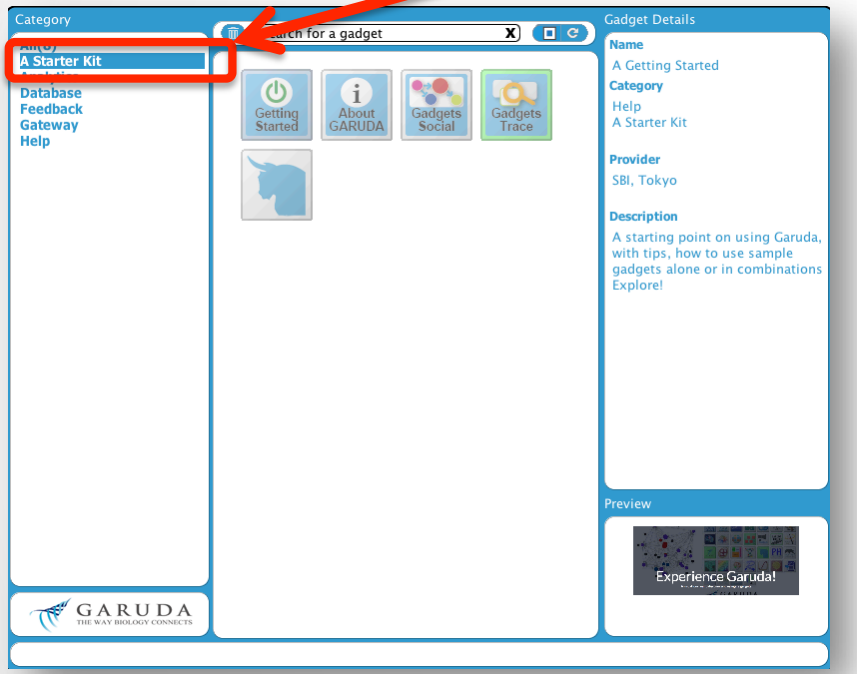


Click on *dock mode* to
"dock" the dashboard

In Dock Mode,
re-size the window
to your desired size.
This will hide the category
and Information Panels!

Where to start?

A good place to start is the "**Starter Kit**" category which has **four** gadgets:



Find the social network of gadgets on your dashboard (who can exchange data with whom)

GadgetSocial

The discovery gadget to load data and find gadgets for your workflow

Nandi

Monitor activities between gadgets as you work on Garuda

Garuda Trace

Opens the gateway of new gadgets

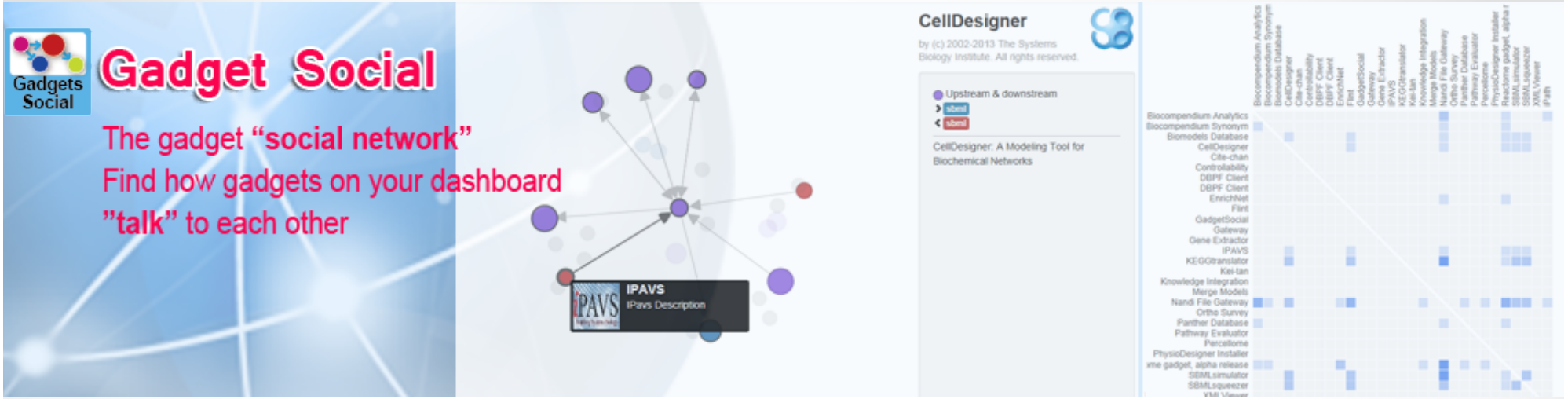
Gateway

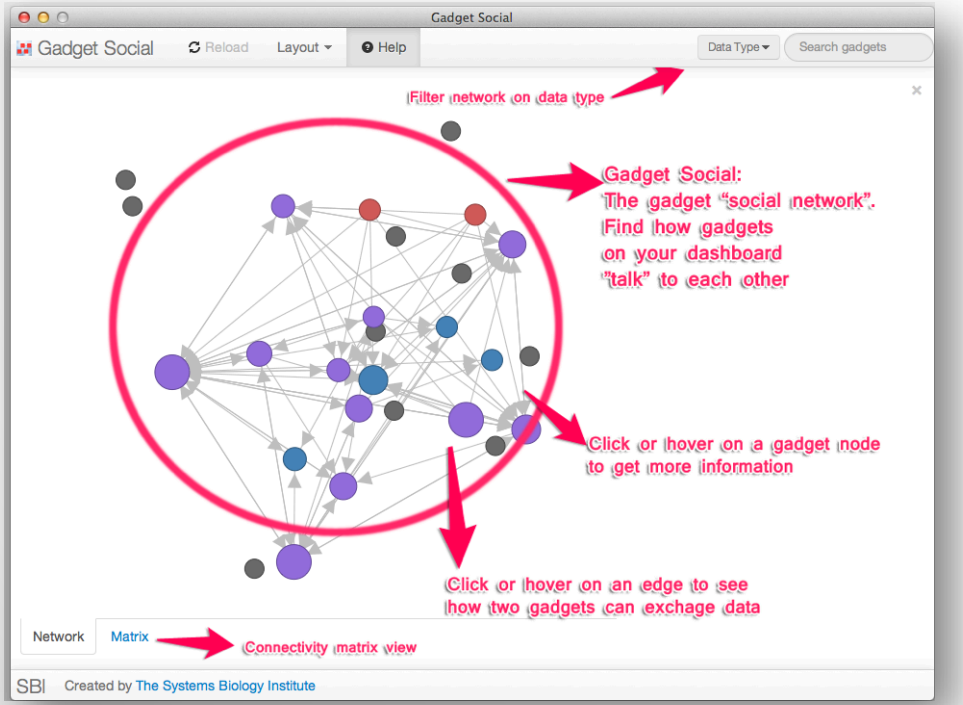
How "social" is your gadget?

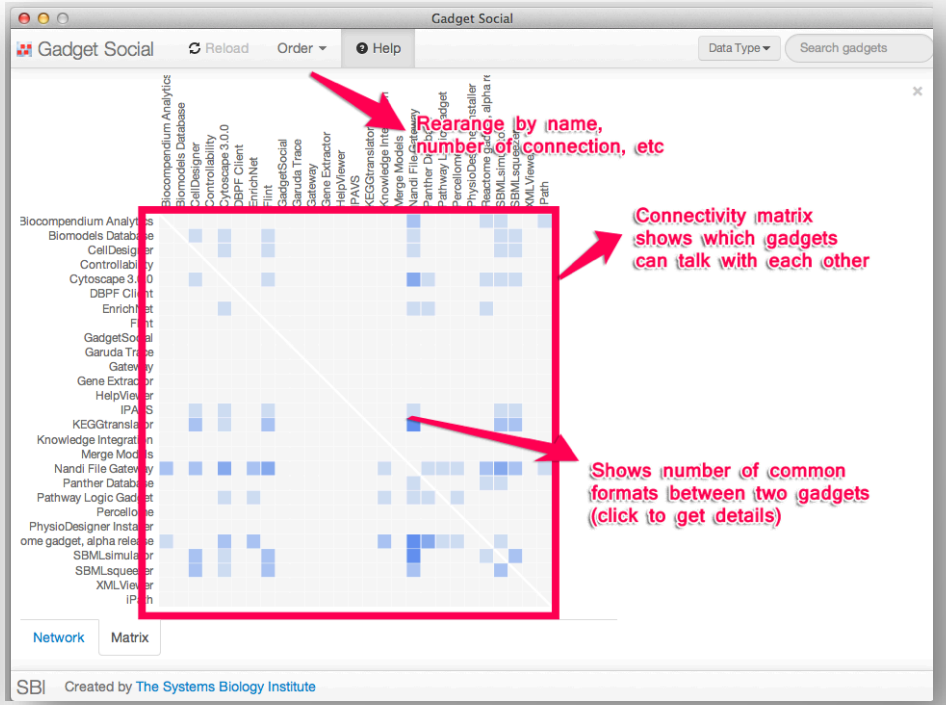
Pipelines of gadgets in Garuda are built dynamically depending on the data and analytics workflow

- Build your own pipeline of gadget starting with your own files
- How can I know which gadgets can "talk" with other gadgets ?

GadgetSocial:
Builds dynamically the "social network" of gadgets based on their connectivity


Gadgets Social
Gadget Social
The gadget "social network"
Find how gadgets on your dashboard
"talk" to each other
IPAVS
IPavs Description
CellDesigner
by (c) 2002-2013 The Systems Biology Institute. All rights reserved.
Upstream & downstream
CellDesigner: A Modeling Tool for Biochemical Networks


Gadget Social
Gadget Social
Reload
Layout
Help
Data Type
Search gadgets
Filter network on data type
Gadget Social:
The gadget "social network".
Find how gadgets
on your dashboard
"talk" to each other
Click or hover on a gadget node
to get more information
Click or hover on an edge to see
how two gadgets can exchage data
Network
Matrix
Connectivity matrix view
SBI
Created by The Systems Biology Institute

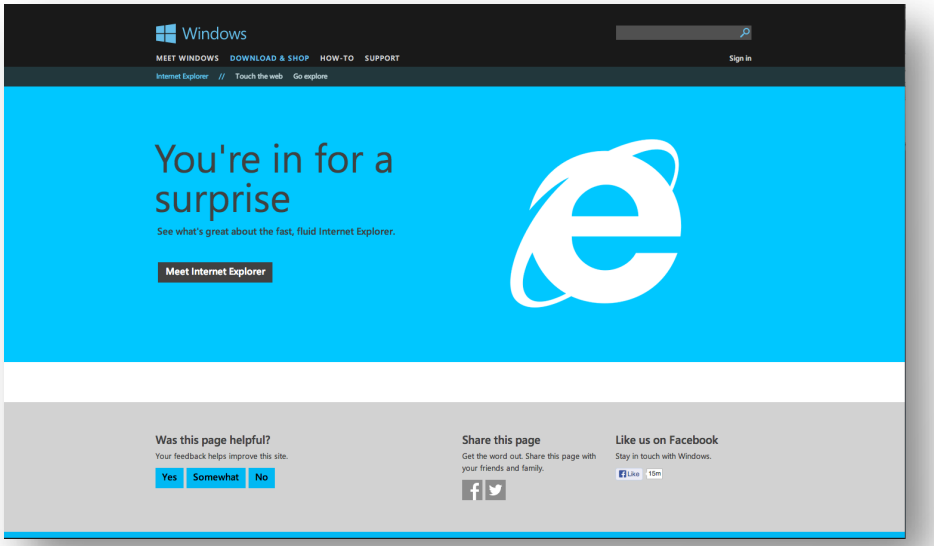

Gadget Social
Gadget Social
Reload
Order
Help
Data Type
Search gadgets
Rearange by name,
number of connection, etc
Connectivity matrix
shows which gadgets
can talk with each other
Shows number of common
formats between two gadgets
(click to get details)
Network
Matrix
SBI
Created by The Systems Biology Institute

Usability Tips

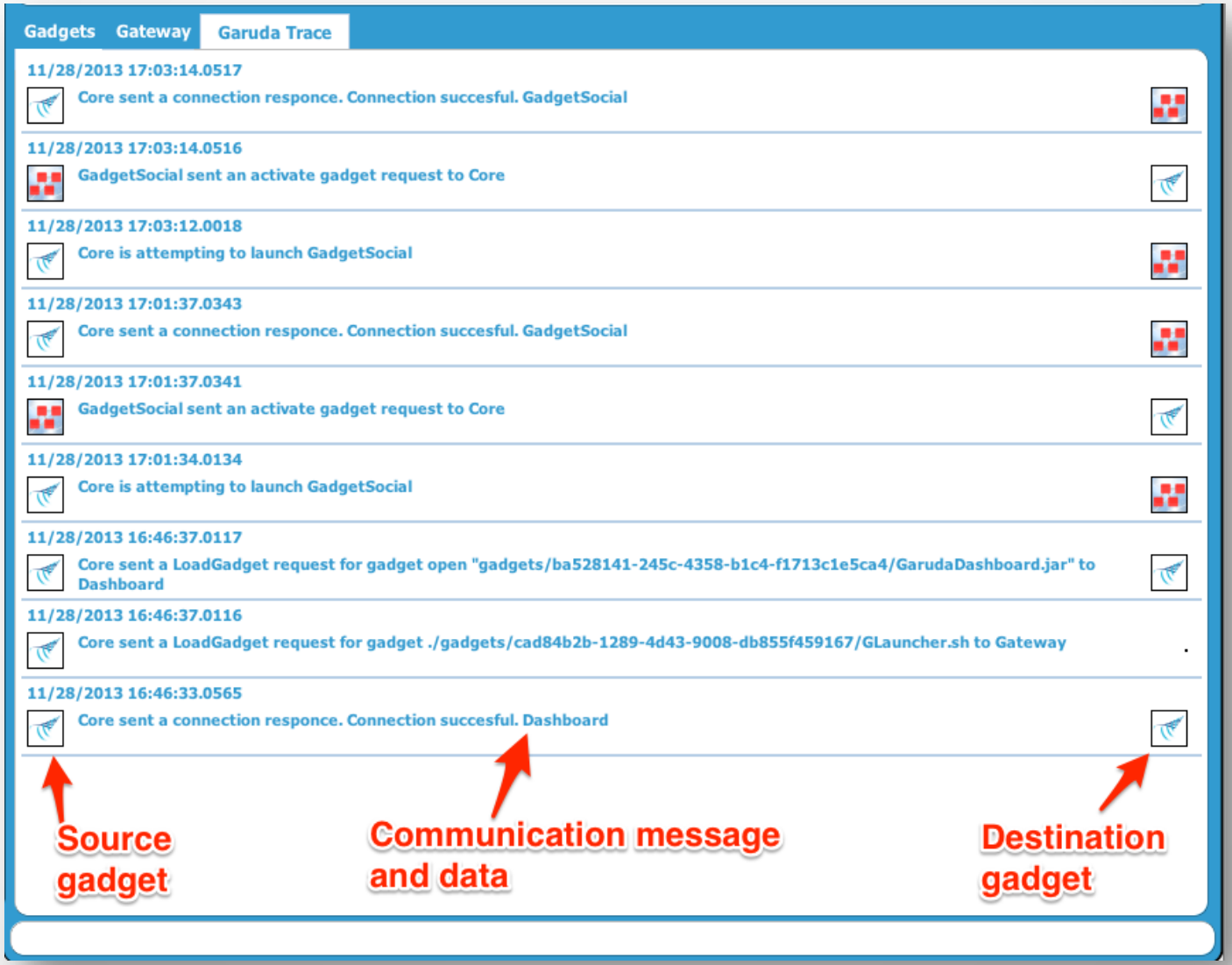
If you are running a Windows machine (Windows 7, 8 or 8.1),

Please ensure that your Internet Explorer (IE) version is 9.0 or above (the latest version is 11.0)

GadgetSocial does not work if the IE browser version is less than 9.0

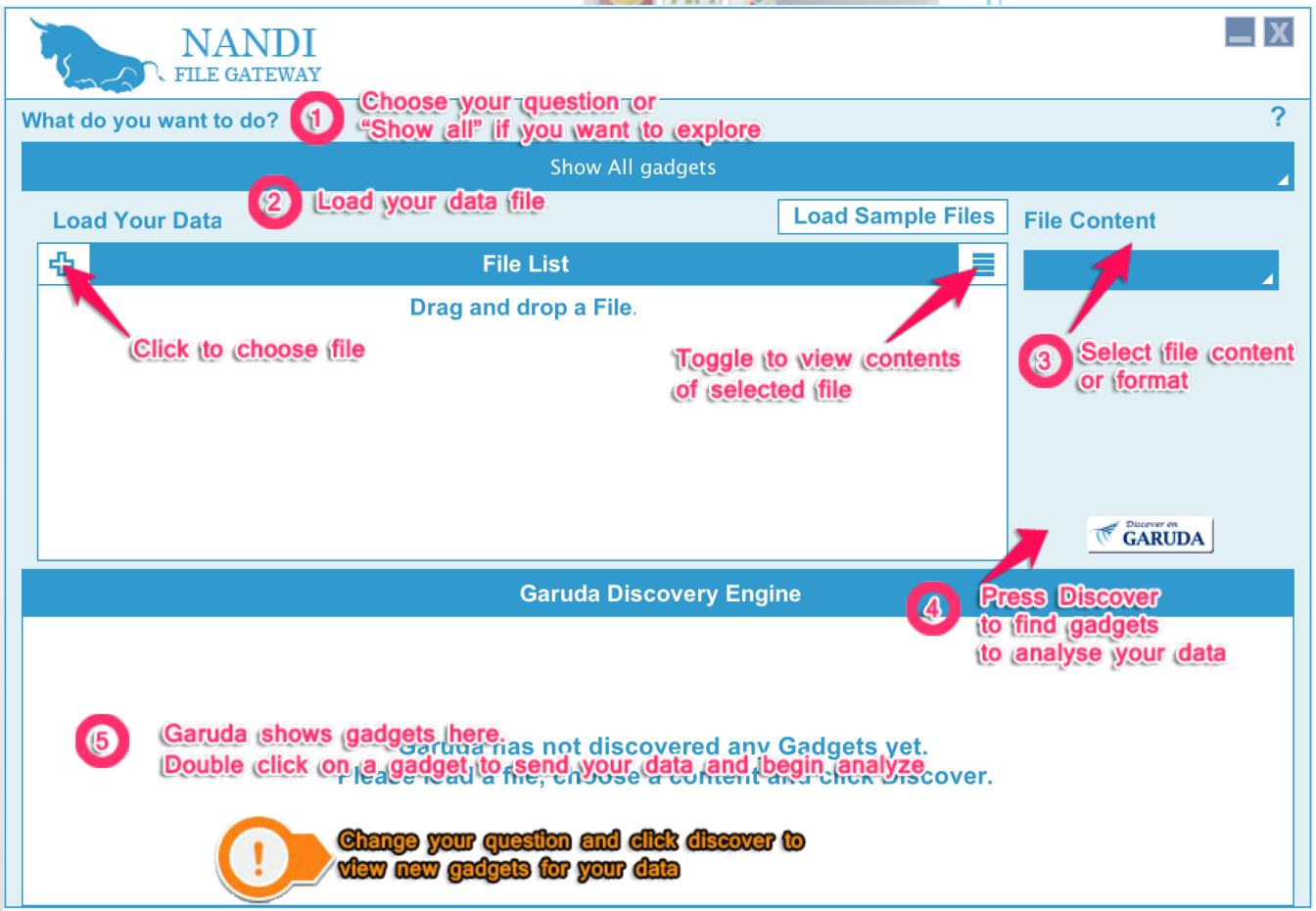


Monitor activities between gadgets as you work on Garuda



NANDI
FILE GATEWAY

An entry point gadget
for the rest of the Garuda gadgets

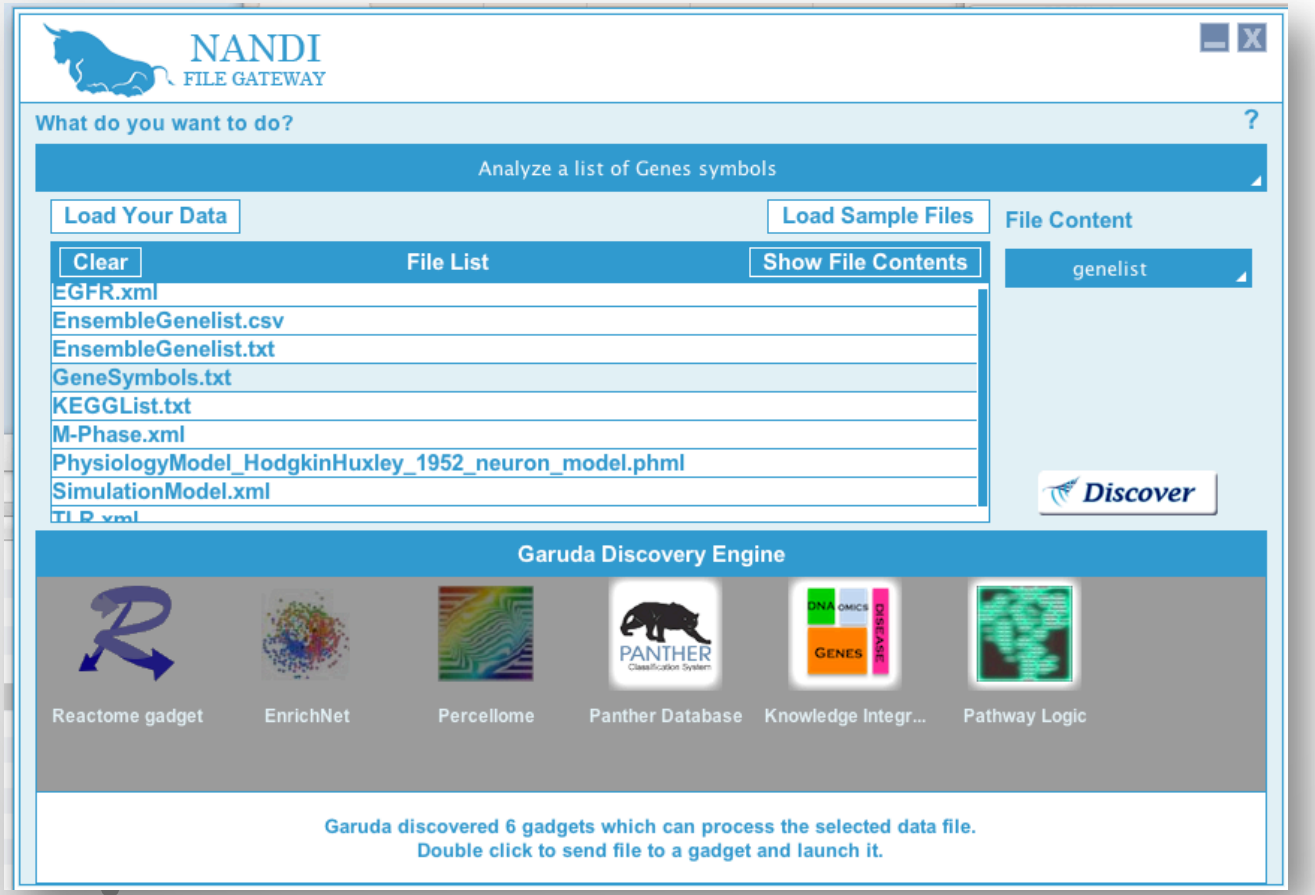


1. Choose a question or "show all gadgets"
2. Load your data or choose from sample files
3. Select file content or unknown if not sure
4. Press "discover"
5. Double click on discovered gadgets to start

New

NANDI
FILE GATEWAY

An entry point gadget
for the rest of the Garuda gadgets



Spotlight Feature

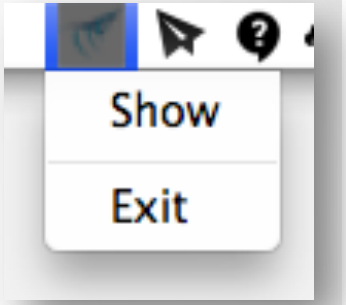
After discovering gadgets for a selected file and file content, select your question from the drop-down to automatically highlight recommended gadgets for the question!

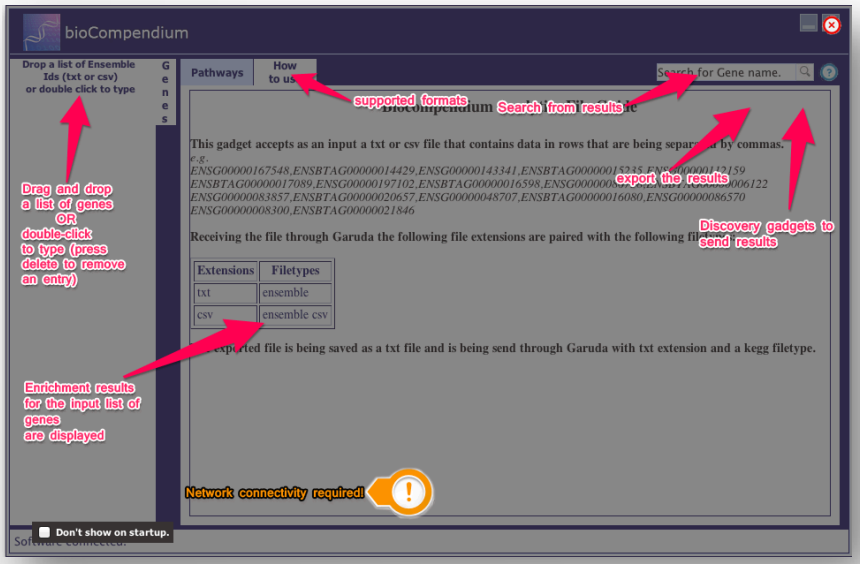
Productivity Tips

Closing the Dashboard window does not close Garuda Core.

To Close Garuda,

1. Locate the Garuda icon on your taskbar and
2. click to show Dashboard to **Exit** Garuda Core.





Alt + H also brings the Help

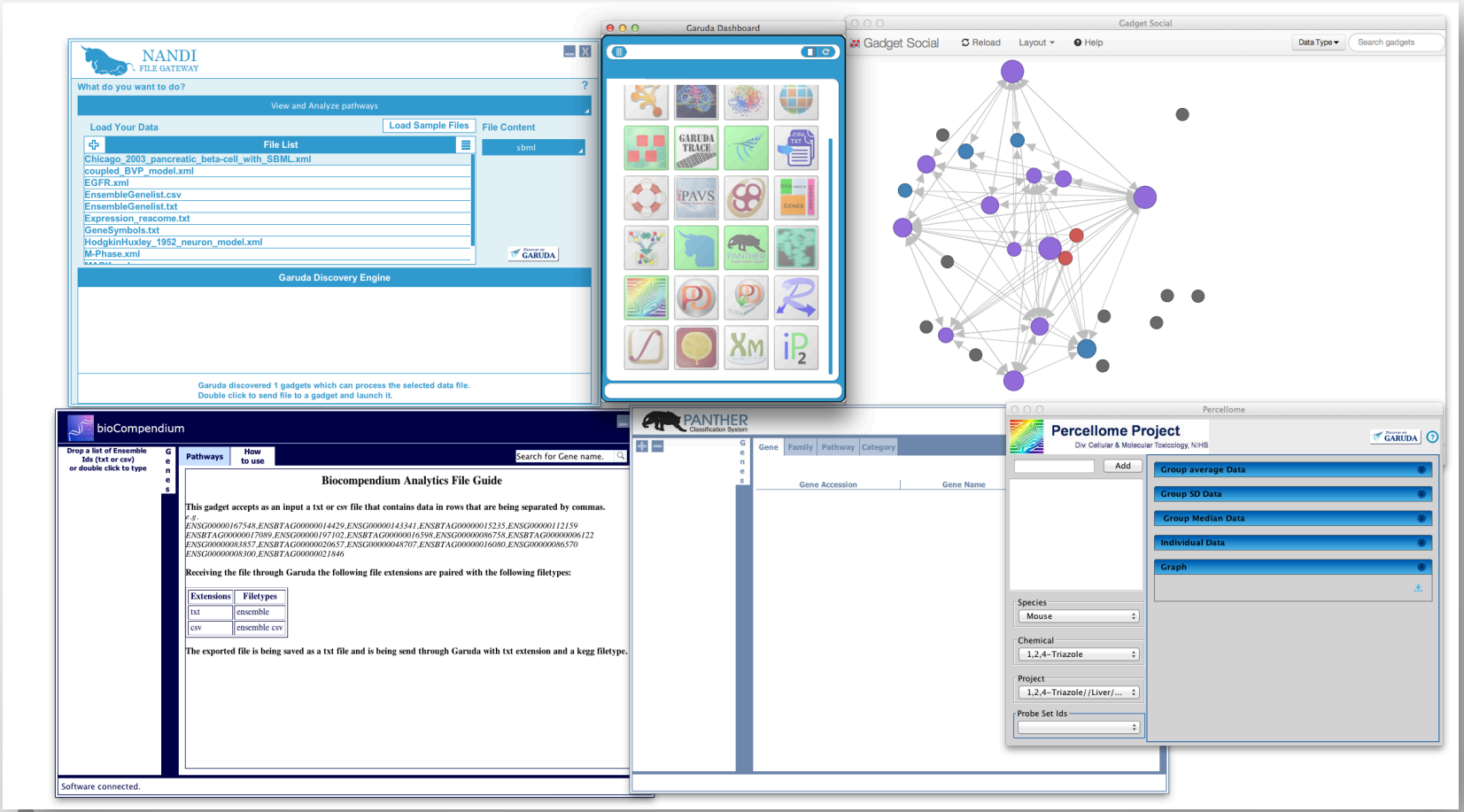
Clicking the **help icon** on most gadgets bring the help view.

Click on red cross to **close help**.

Check "**Don't show on startup**" to prevent auto launch of help view.

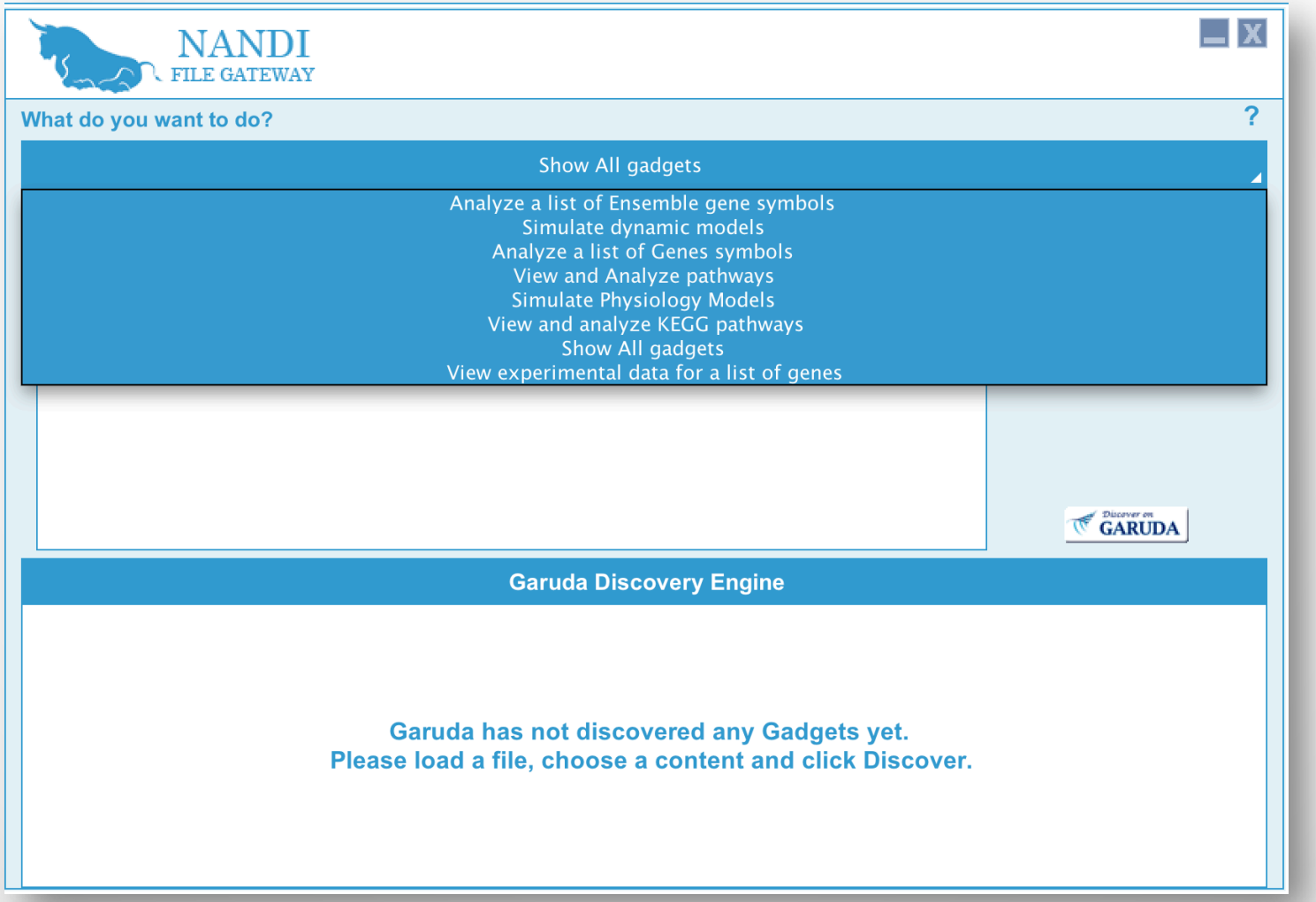
What can I do?

Garuda does not refine any specific analytics workflows. It is an "**open**" **platform** where you ***discover*** and ***navigate*** through different gadgets depending on your question



What can I do?

Nandi as the gate-keeper gadget can provide a starting point with a pre-defined set of analytics



Myth Tip: Nandi

Nandi (bull)

From Wikipedia, the free encyclopedia

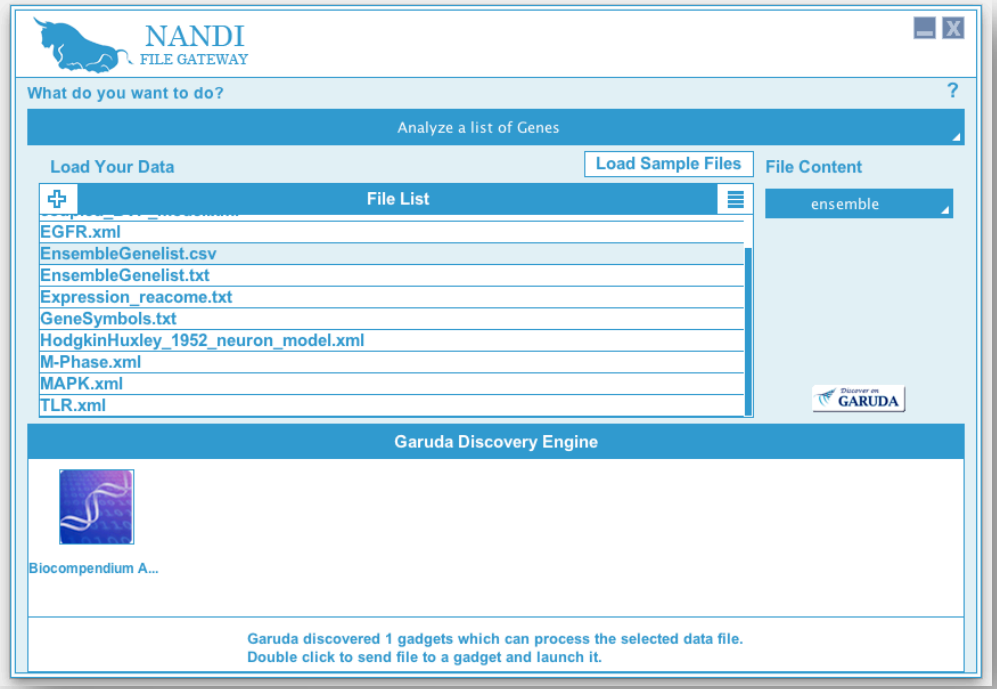
Nandi (Sanskrit: नन्दी, Tamil: நந்தி, Telugu: నంది) is the name for the bull which serves as the mount (Sanskrit: *Vahana*) of the god Shiva and as the gate keeper of Shiva and Parvati. In Hindu mythology, he is the chief guru of eighteen masters (18 siddhas) including Patanjali and Thirumular.[1] Temples venerating Shiva display stone images of a seated Nandi, generally facing the main shrine. There are also a number of temples dedicated solely to Nandi.

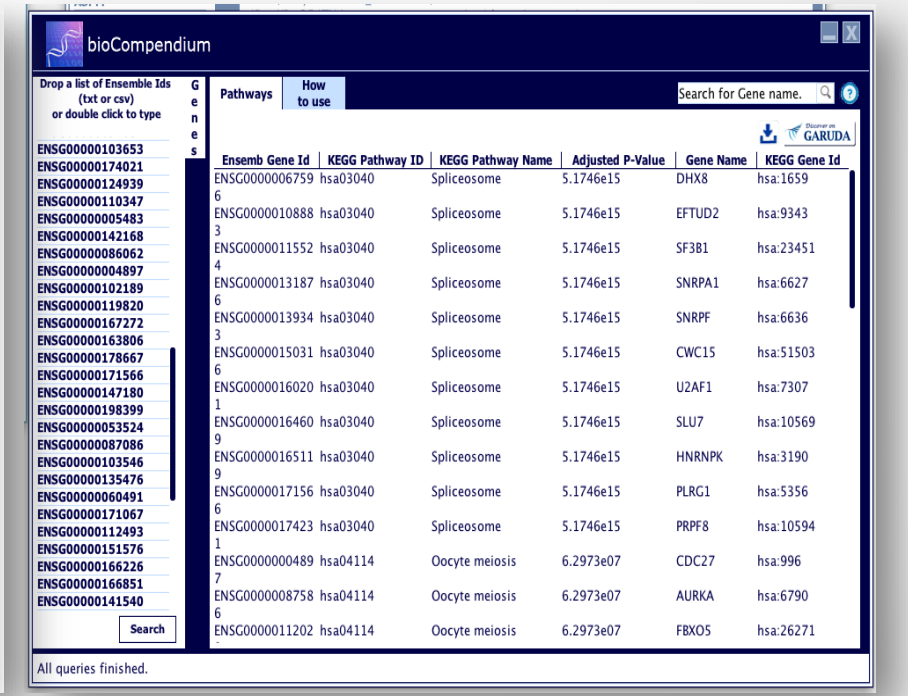
2nd Century A.D sculpture of Nandi bull.

The application of the name Nandi to the bull (Sanskrit: *vṛṣabha*) is in fact a development of recent centuries, as Gouriswar Bhattacharya has documented in an illustrated article entitled "Nandin and Vṛṣabha".[2] The name Nandi was earlier widely used instead for an anthropomorphic deity who was one of Shiva's two door-keepers, the other being Mahākāla. The doorways of pre-tenth-century North Indian temples are frequently flanked by images of Mahākāla and Nandi, and it is in this role of Shiva's watchman that Nandi figures in Kālidāsa's poem the *Kumārasambhava*.

What can I do?

Perform enrichment analysis on a list of Ensemble gene identifiers

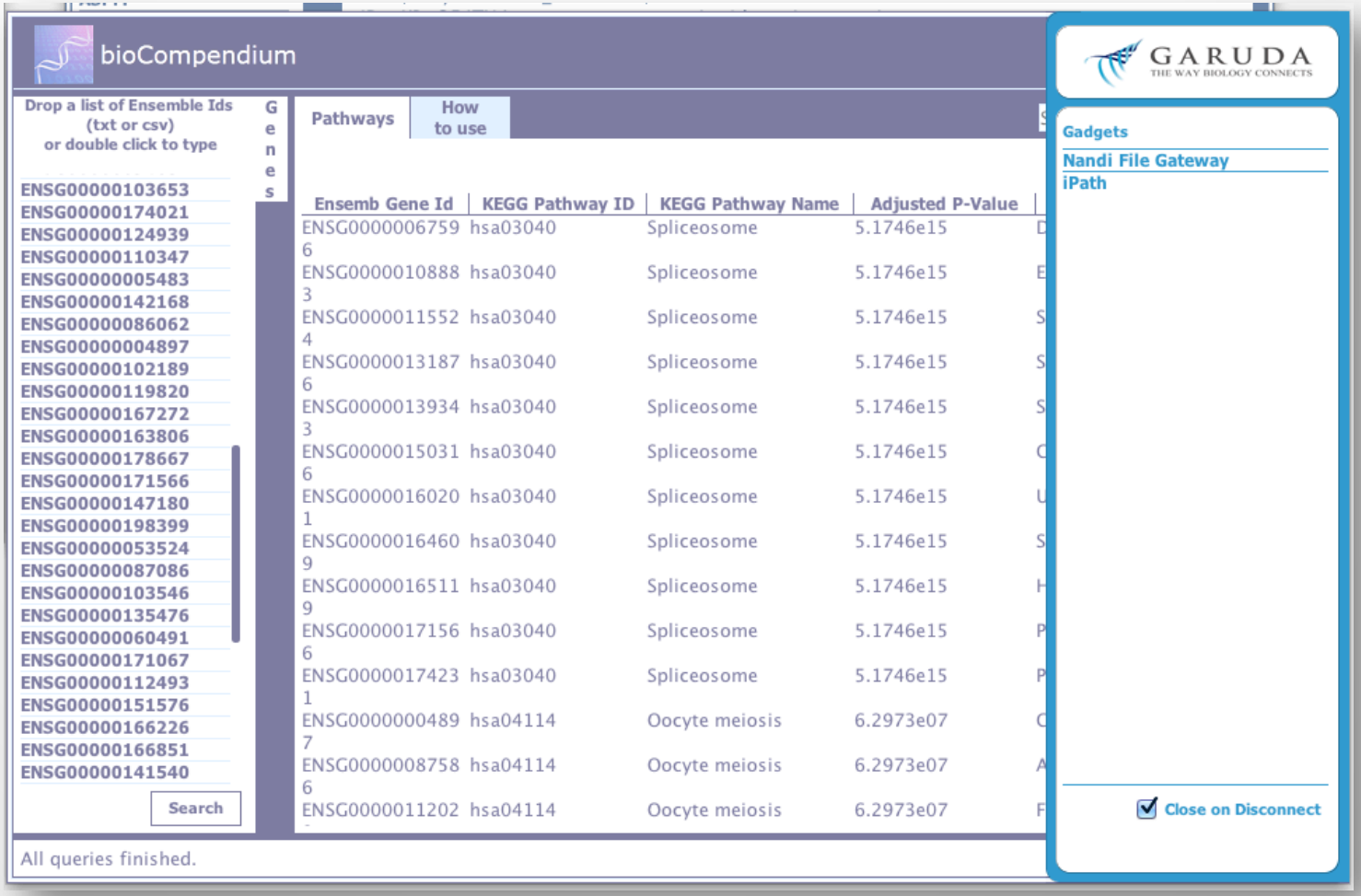




1. Choose Ensemble gene from sample data and discover **BioCompendium gadget**
2. Click **Search** to perform enrichment analysis on BioCompendium

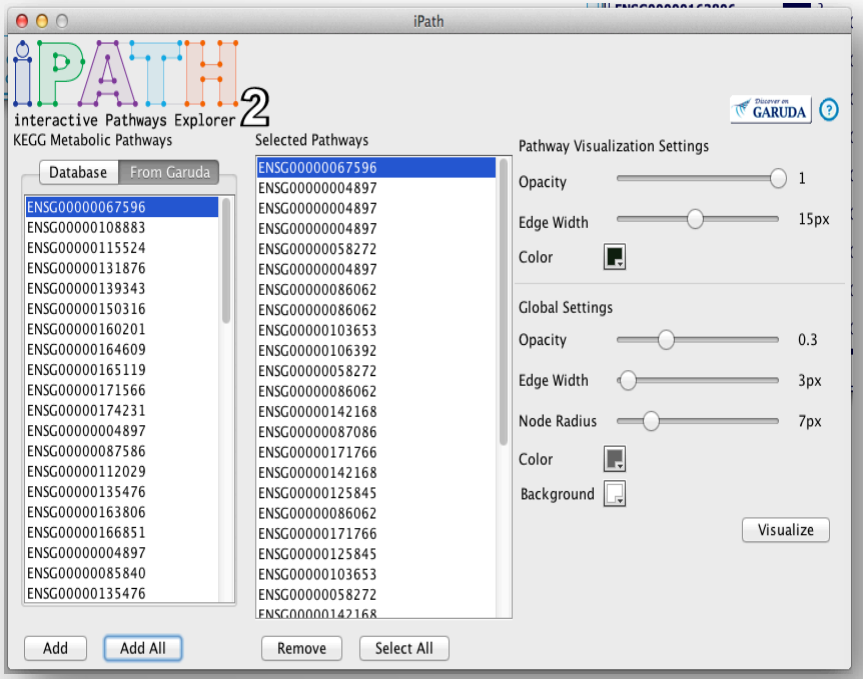
What can I do?

Continue the analysis for pathway enrichment by clicking on **Garuda Discover** and selecting **iPath gadget**

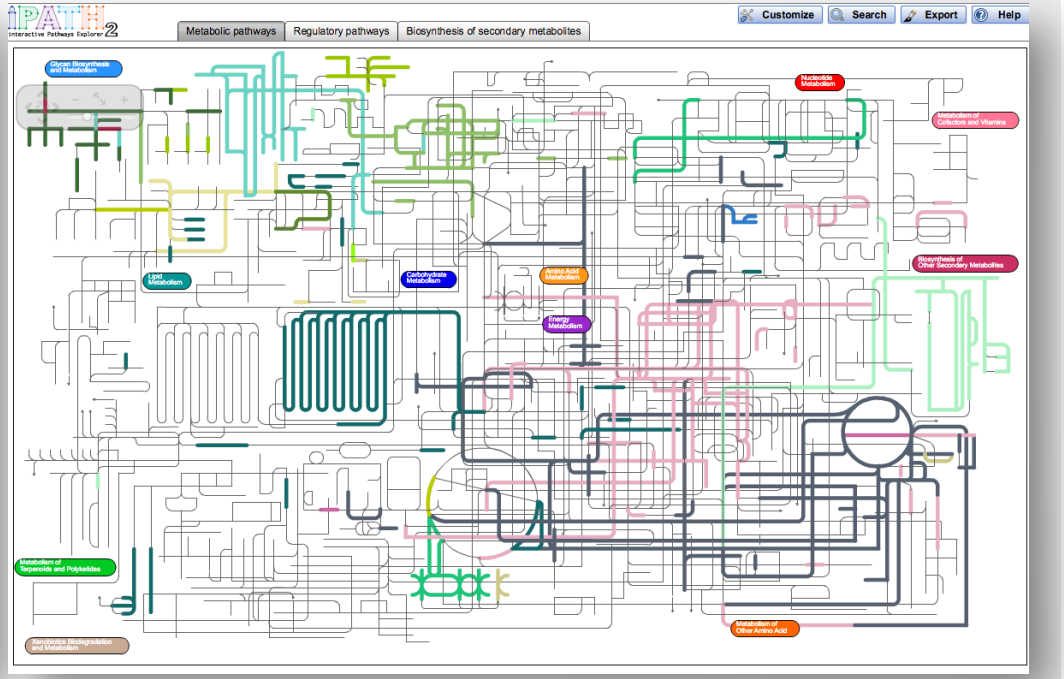


What can I do?

Continue the analysis for pathway enrichment by clicking on **Garuda Discover** and selecting **iPath gadget**



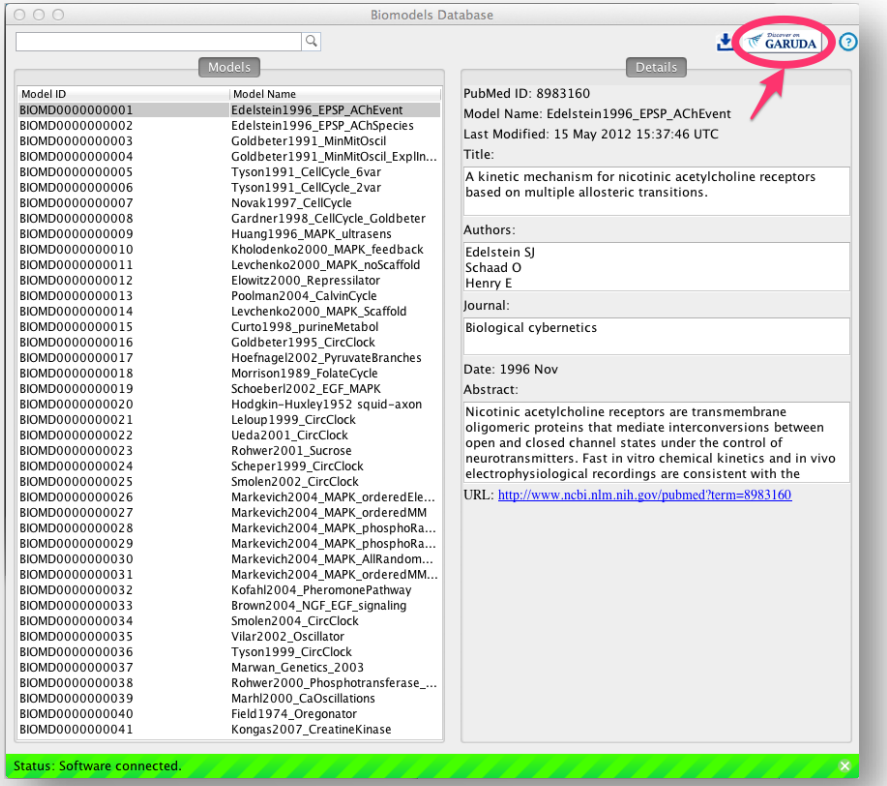
1. **Configure KEGG pathways on iPath gadget**

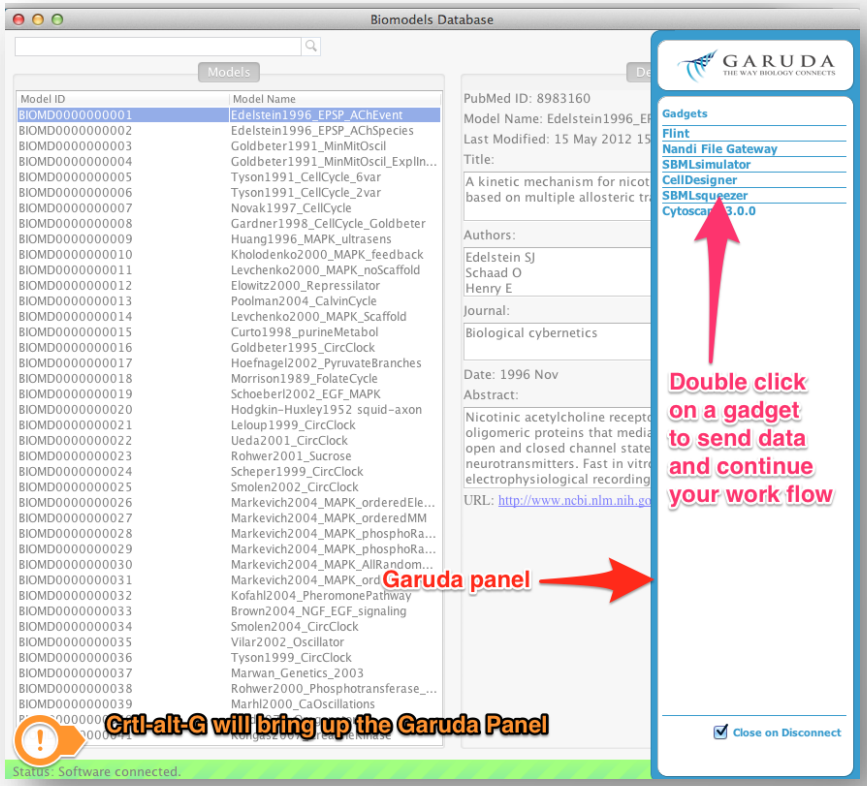


2. **Click Visualize to view on browser**

Navigability Tip

To navigate from one gadget to next,
locate the **"Discover on Garuda"** button and click to show **Garuda Panel**

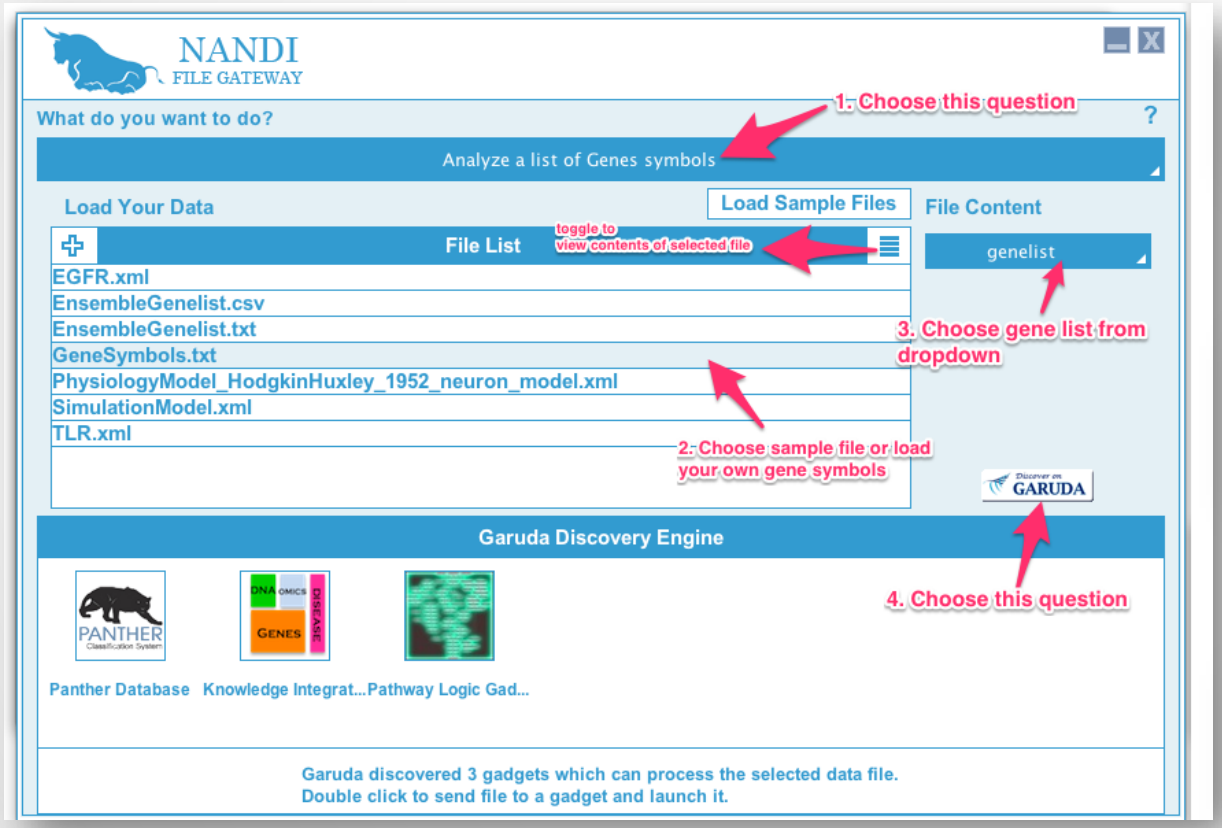




Cntrl + Alt + G also brings the Garuda Panel
Click anywhere outside the panel to hide it

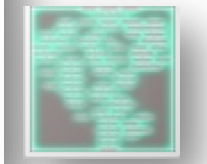
What can I do?

I have **a list of Gene Symbols.**
What kind of analytics can I perform?



Perform enrichment analysis

Explore semantic enrichment

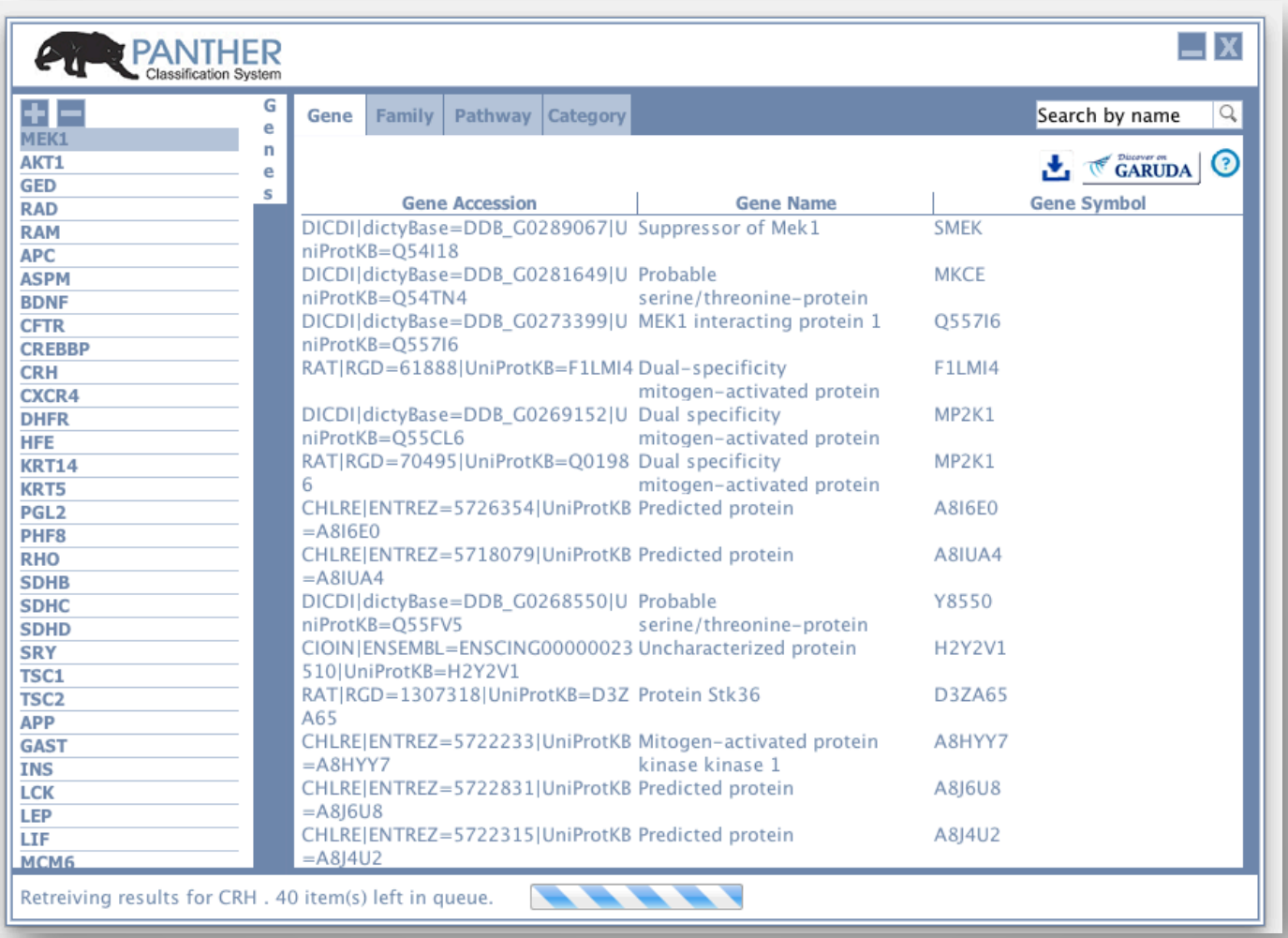


Explore literature mining

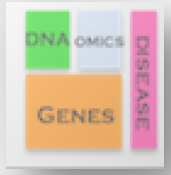
Tip: If no results are found,
choose "Show All gadgets" from question list and click Discover again!

What can I do?

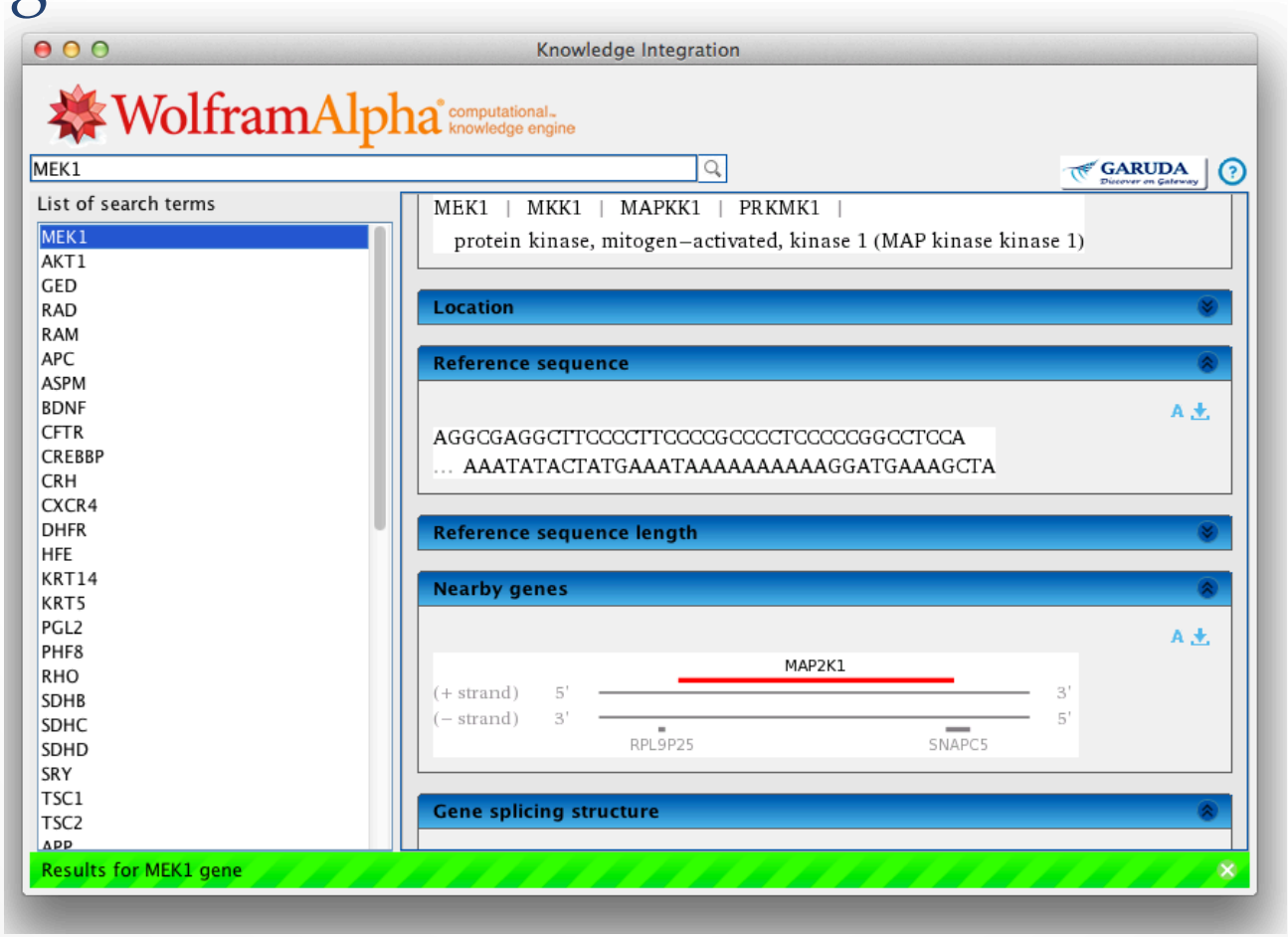
Panther gadget performs enrichment across genes, families, pathways and GO category



What can I do?



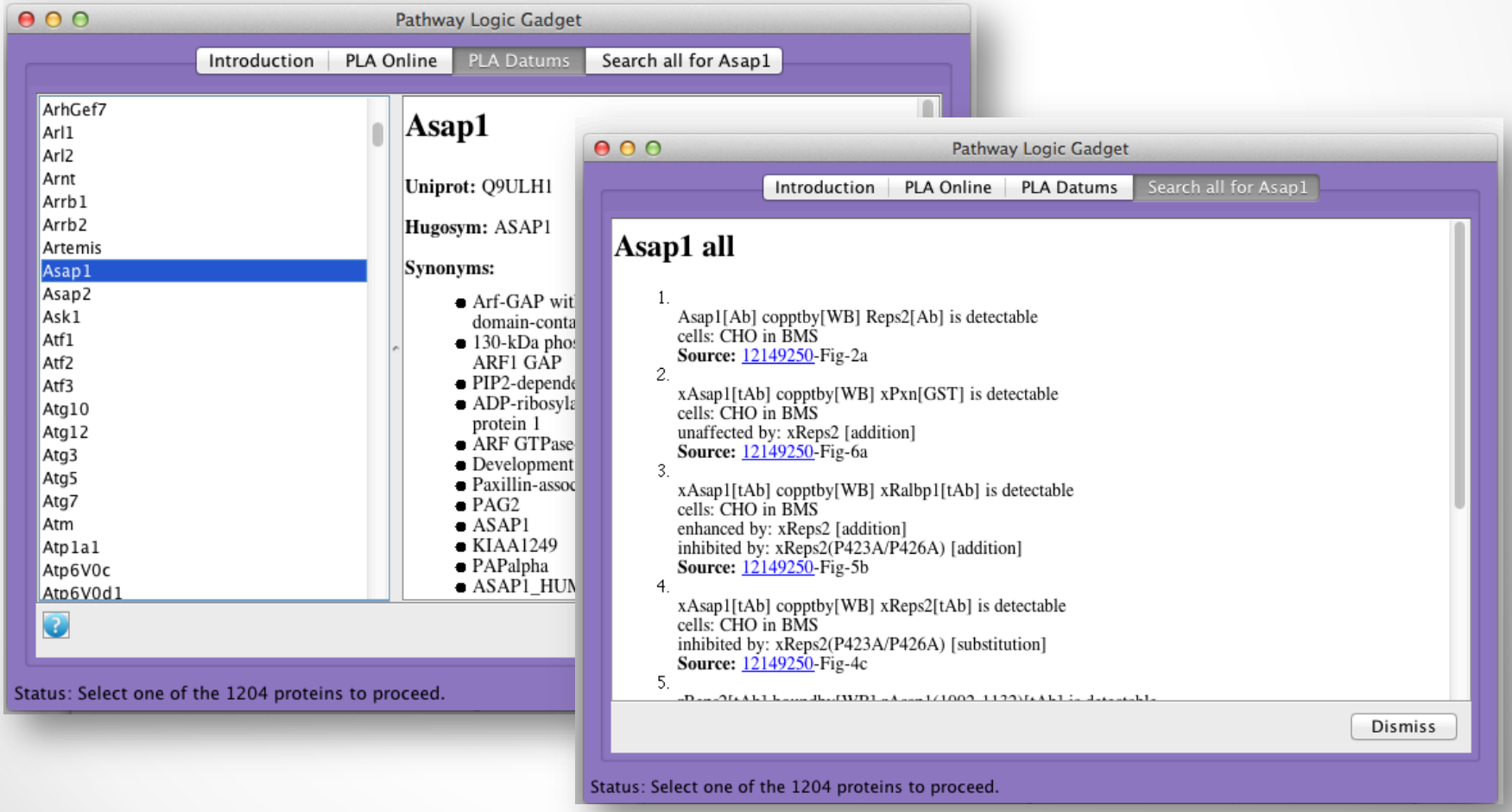
Knowledge Integration uses the Wolfram Alpha semantic engine API to retrieve enriched information on genes



Note: Knowledge Integration requires an API key registration to work
It will not launch on Mac OSX 10.6 or below

What can I do?

Pathway Logic performs specific search on curated literature and logical connections derived from the data



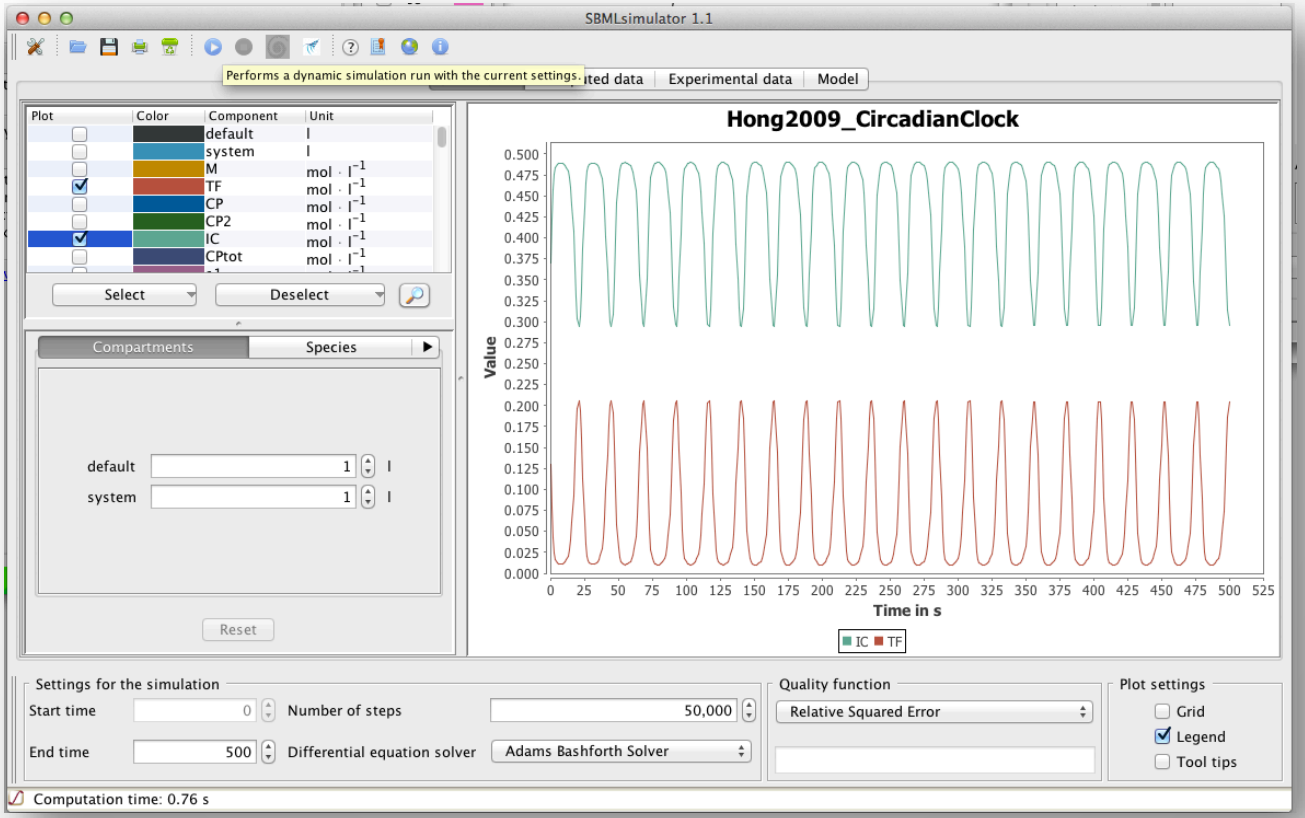
What can I do?

Simulate biochemical models based on Ordinary Differential Equations to study molecular dynamics

What can I do?

Compare simulation results for a single biochemical model across different engines by using the different gadgets

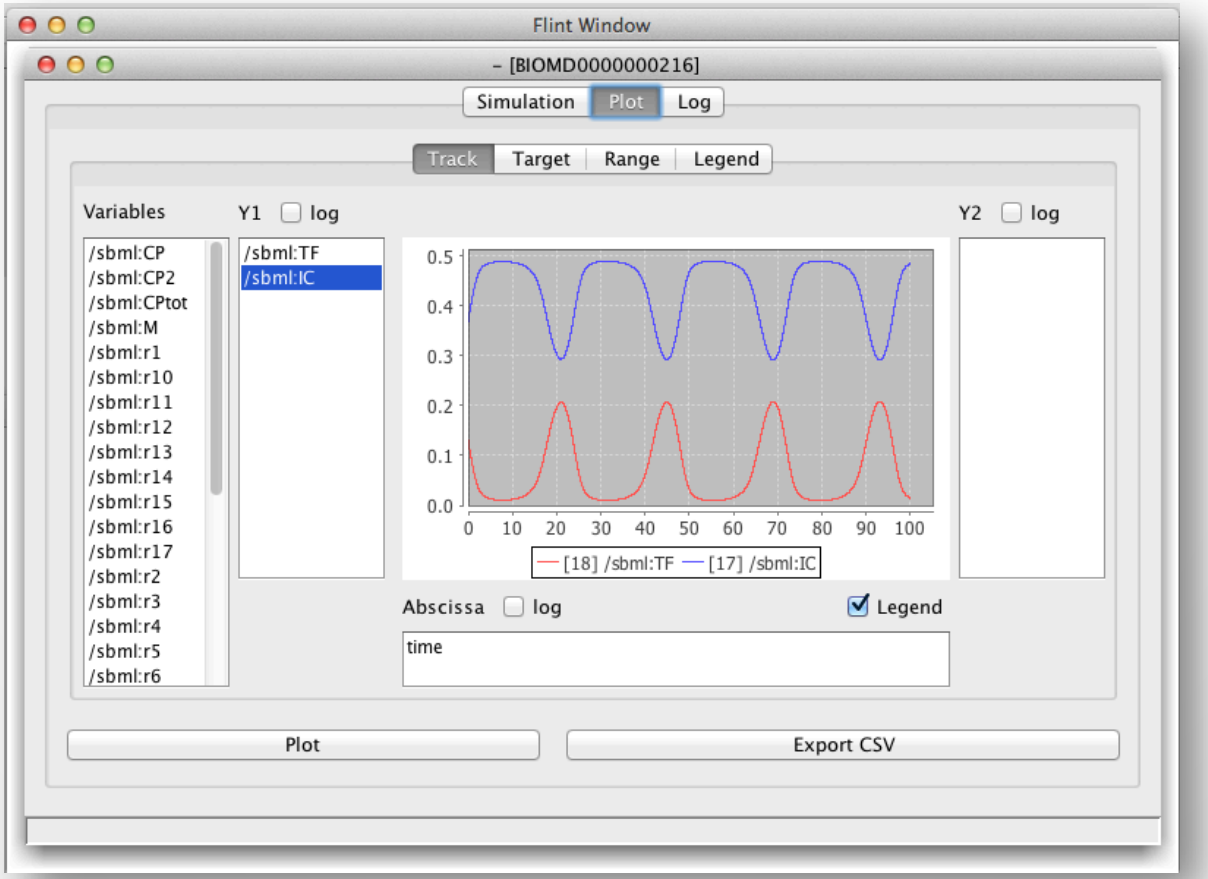
Simulate the model using **SBML Simulator**



What can I do?

Compare simulation results for a single biochemical model across different engines by using the different gadgets

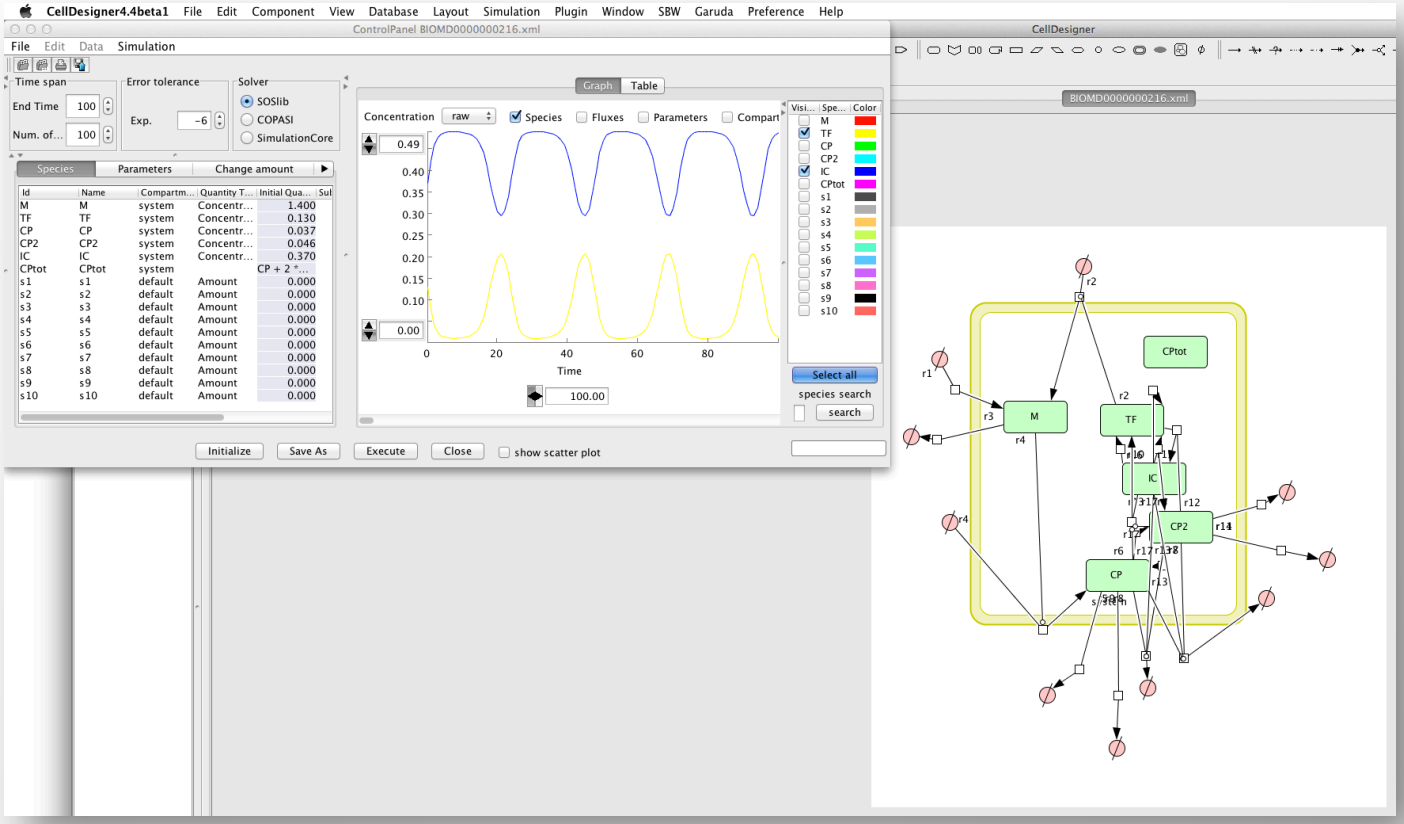
Simulate the model using **Flint**



What can I do?

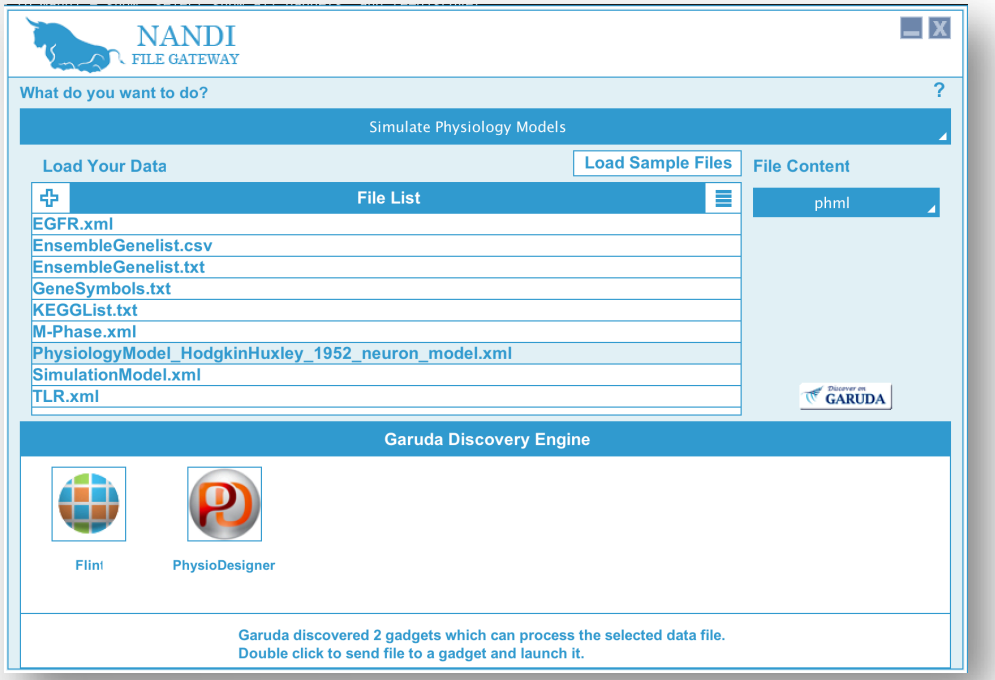
Compare simulation results for a single biochemical model across different engines by using the different gadgets

Visualize the model in **CellDesigner** and simulate using the **in-built simulators**



What can I do?

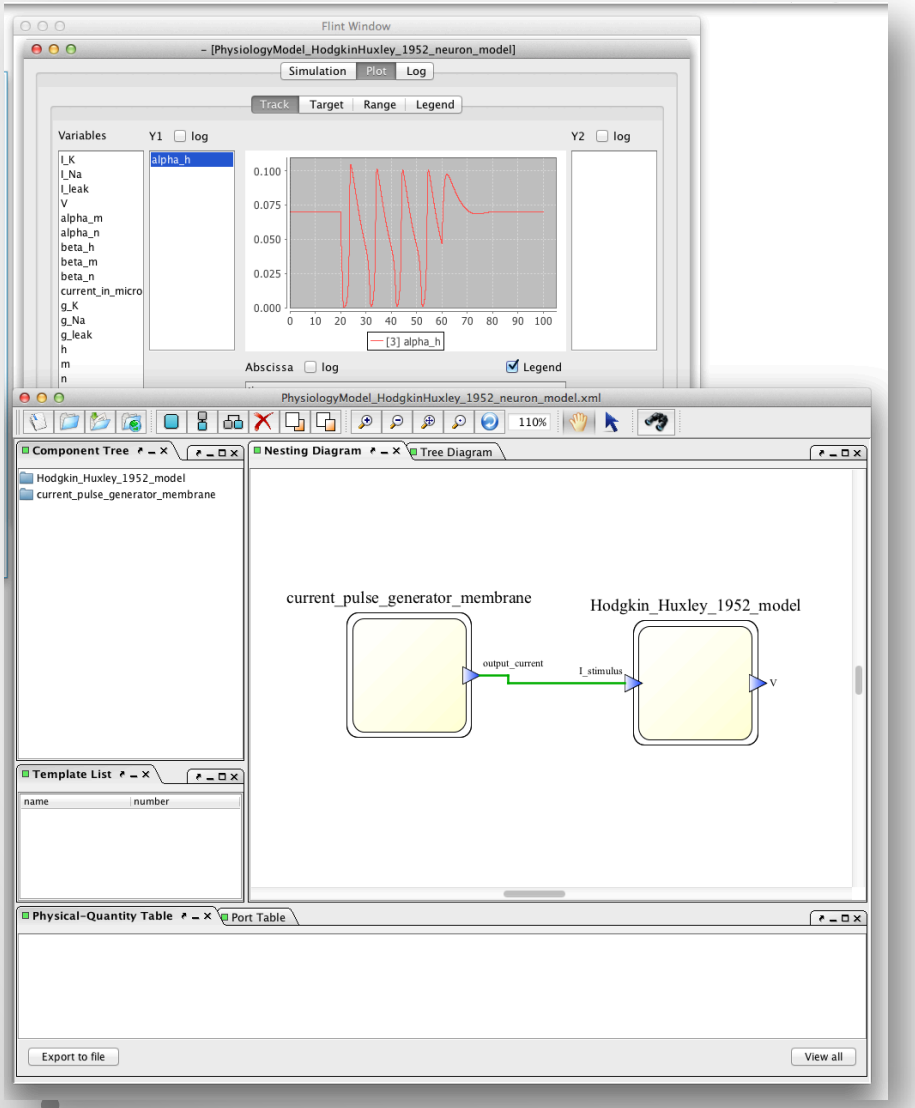
How can I **simulate Physiological Models?**



1. Load your own model (e.g. PHML file) or choose *Hodgkin Huxley model* from Sample data.
2. Choose "**Simulate Physiology Models**" from question list
3. Click **Discover** button to discover **Physiodesigner** and **Flint** gadgets

What can I do?

How can I simulate Physiological Models?



- Launch **PhysioDesigner** to view, edit the model
- **Flint** can be launched from Physiodesigner

*For simulation only, choose Flint

Garuda Pipeline

Garuda Pipeline

Pipelines of gadgets in Garuda are built dynamically depending on the data and analytics workflow

I have a gene list and I want to -

Find information on genes

Gene list → Knowledge Xplorer

Gene exploration pipe

View expression patterns

Gene list → Percellome

Gene expression analysis pipe

Perform gene and pathway enrichment

Gene list → BioCompendium → iPath

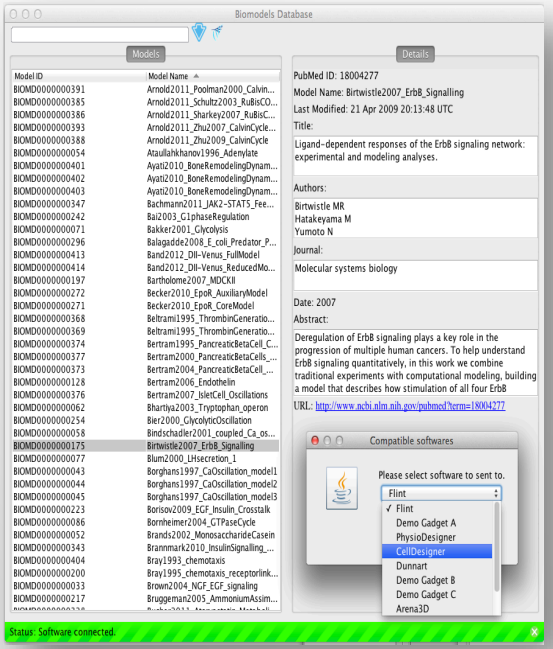
Enrichment pipe

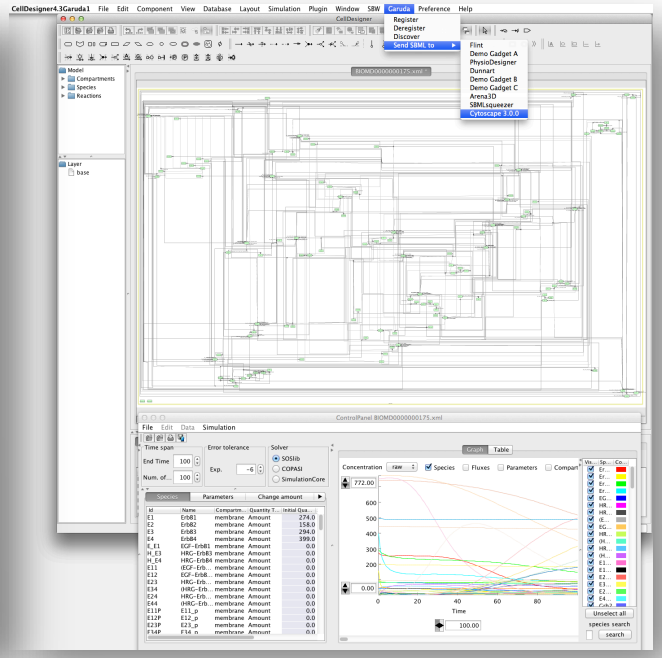
Garuda Pipeline

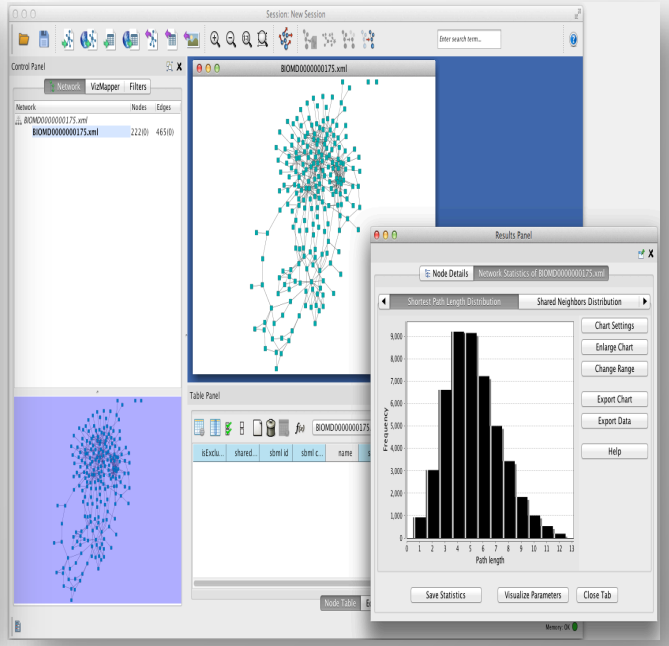
Build and explore complex analytics pipelines

I want to view a published mathematical model, visualize and simulate its dynamics, then analyze network properties

BioModels → CellDesigner → Cytoscape



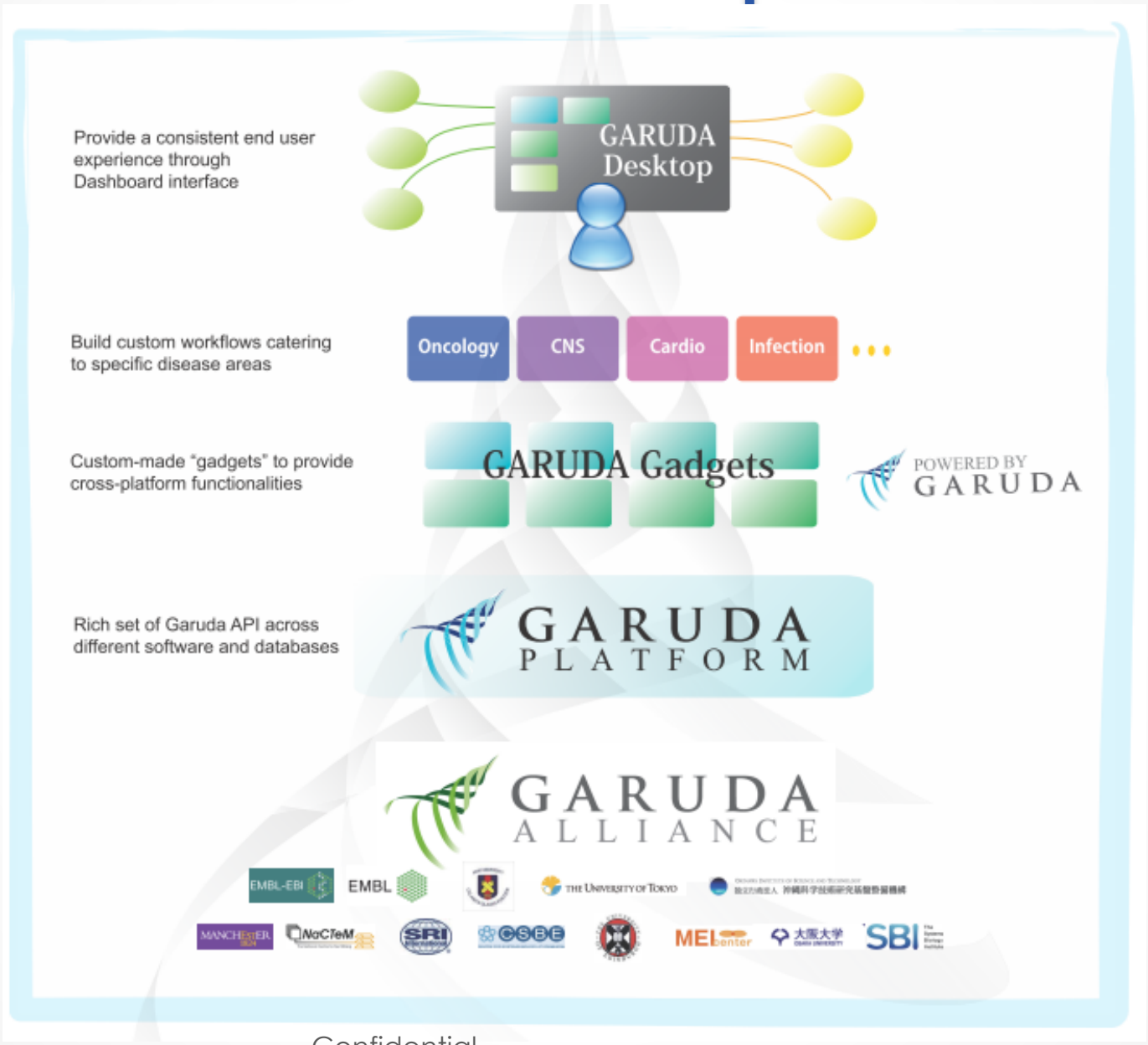




Backup

Garuda Architecture

Garuda Concepts



Platform Principles

1. Provide end-users with a single platform for implementing their varied biological workflows
    1. Each workflow constitutes different software modules to implement specific functions
    2. Users can download, install and use the modules from the single platform interface
    3. The platform should support inter-operability of Garuda powered software tools and services

2. Provide developer community with a set of APIs, UX guidelines and manuals to develop their own Garuda Apps by leveraging the APIs to access multiple functions of the Garuda Alliance tools and services
    1. Provide Garuda APIs
    2. Provide Garuda UX design guidelines
    3. Provide ease of testing Apps and enabling them on the Garuda Platform for the end-users

Platform Principles

End-Users

1. Plug and Play (PnP) architecture for the deployment of Apps

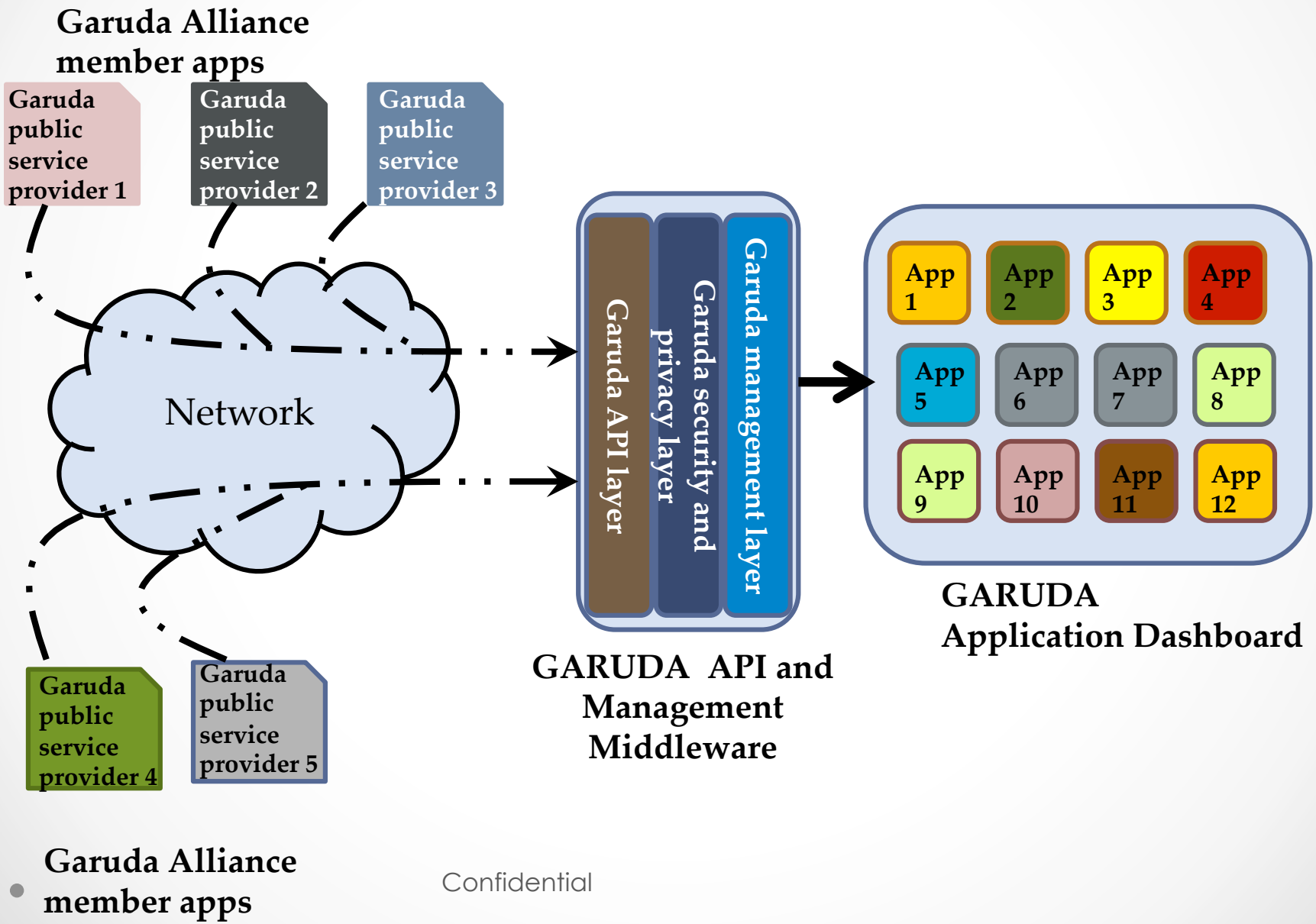
2. Zero Configuration (ZeroConf) installation, maintenance and updates for the end-users

Developers

3. Provide a secure management and configuration layer (Garuda Service Layer) to all Garuda powered tools and services to facilitate deployment and use of Garuda gadgets

4. Free the developer of book-keeping and management layer functionalities for enabling their gadgets on the Garuda Platform

Platform Architecture



Platform Stack

Core Components

1. API
    1. The Garuda API should provide a clean and consistent interface to the functionalities of the Alliance software and services

    3. It should also provide the interface to the Alliance members to enable their software and services to comply and use the Garuda Platform

2. Management Services Architecture (GSL)
    1. Provide the ability to register, manage and maintain Garuda Apps

    2. Provide zero-conf broker services to the various Garuda Alliance software for inter-operability and inter-tool communication