This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731664

Melodic
Big data cloud

Big Data Applications on Multi-Clouds
An Introduction to the MELODIC Project

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29 December 2017
Haikou, China

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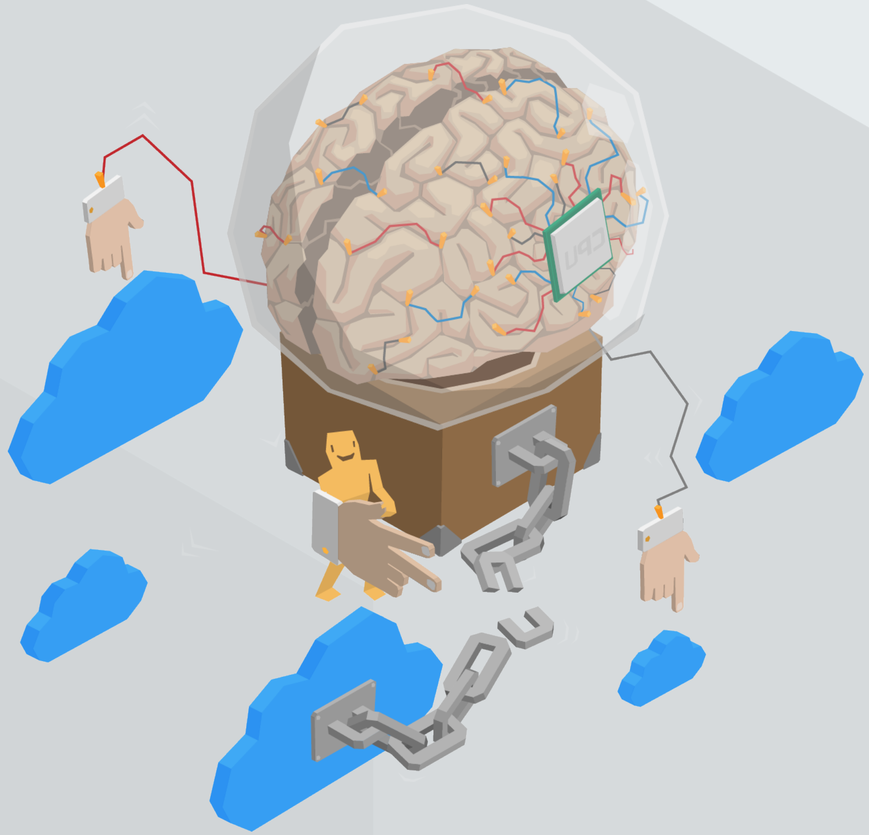

- Motivation
- An Introduction to Cloud Computing
- The MELODIC Project
- Use Cases
- Conclusion

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From PC to Cloud Computing

- In former times:
  - **Powerful desktop PC (personal computer)**
  - Fast CPU, large harddisk(s)
  - Disadvantage: expensive and maintenance-intensive
- Today (or in near future):
  - Laptop or tablet PC
  - **Energy-efficient components** (battery-powered)
  - **Cloud applications**, e.g.:
    - Software as a Service, web mail, calender, office, photo management, ...
    - Storage space (DropBox, ...)

A „normal“ user mainly works in the web browser!

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Smartphone and Cloud Computing

- Smartphone
  - Small storage space (or expensive)
  - Not extensible (e.g. SD card slot)
- Cloud connection
  - **Storage space**
    - Pictures, videos, music
    - Documents
  - **Applications**
    - Computation-intensive applications in the cloud (z.B. voice recognition)

Cloud connection is a major component of smartphones!

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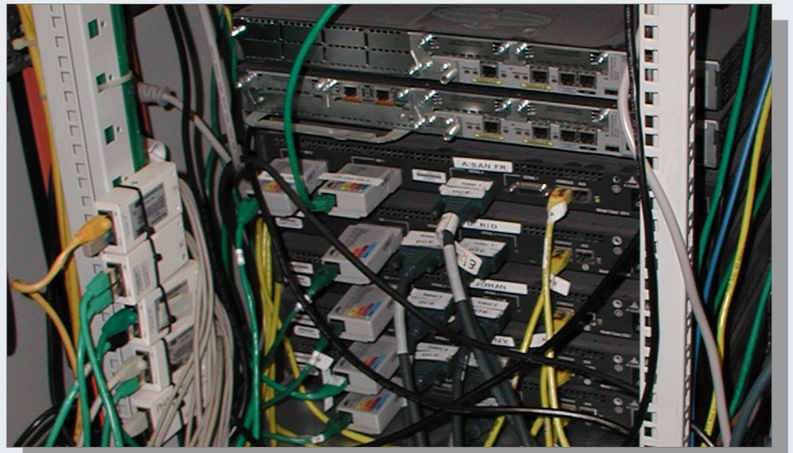
The Challenges

Cloud Computing is convenient with good network connectivity!

- Challenge: network communication
  - Bandwidth
  - Latency
  - Mobility



How does Cloud Computing work?
(and, by the way, what is the „Cloud“?)

What is the „Cloud“?

Image sources:
CompuServe advertisement 1988
Chris Watterston

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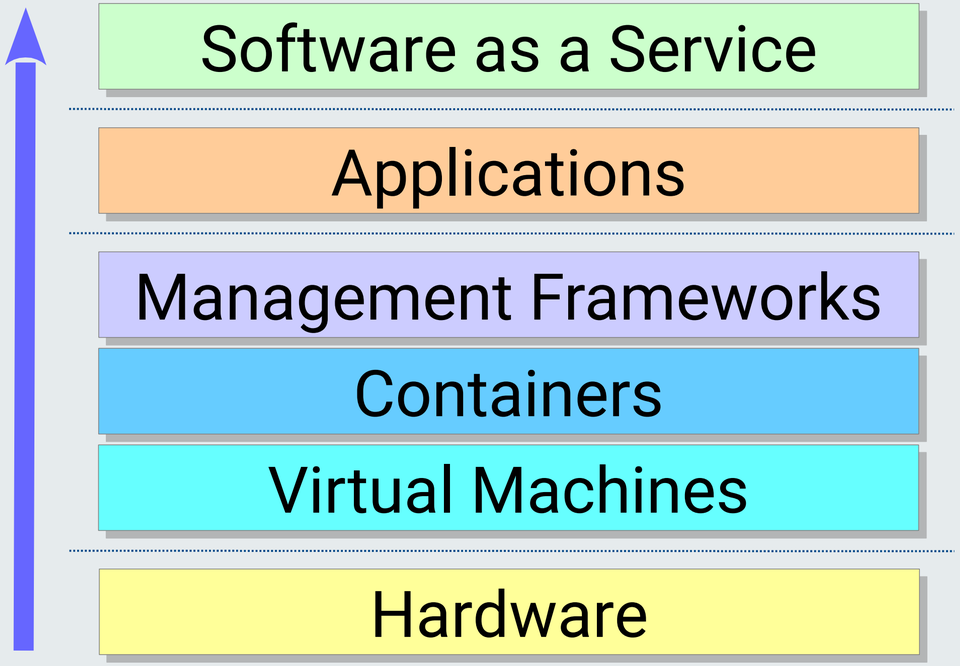
Cloud Computing – A Technical Overview

- From bottom to top
  - Hardware
  - **Virtualisation**
  - Management Frameworks
  - Applications
  - Software as a Service (SaaS)



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Hardware in External Data Centres

- User's Local PC:
  - Low utilisation
  - Main task: do nothing!

- Idea: many computers, for very many users!
  - **Computers in a data centre**
  - Usage by many users
    - Temporal distribution of the users
    - High utilisation
    - Low costs

Multiple customers per computer?

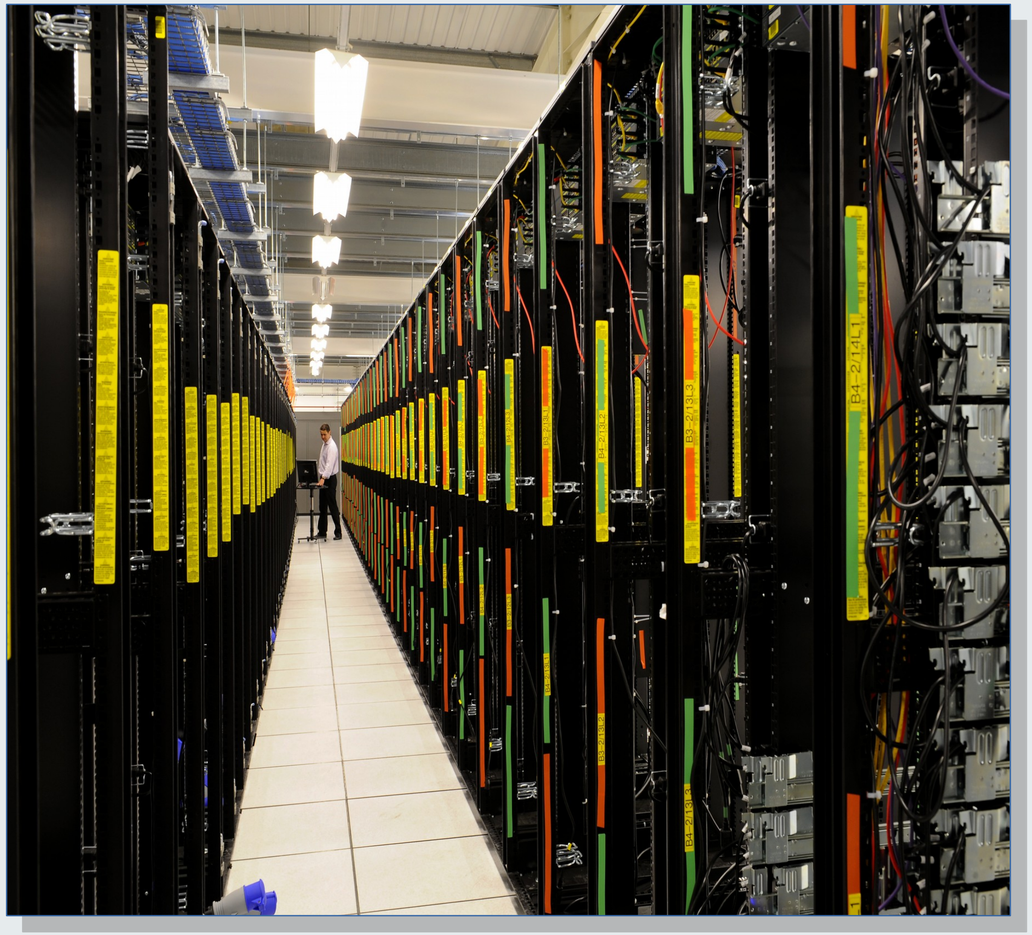

Image source: Wikimedia

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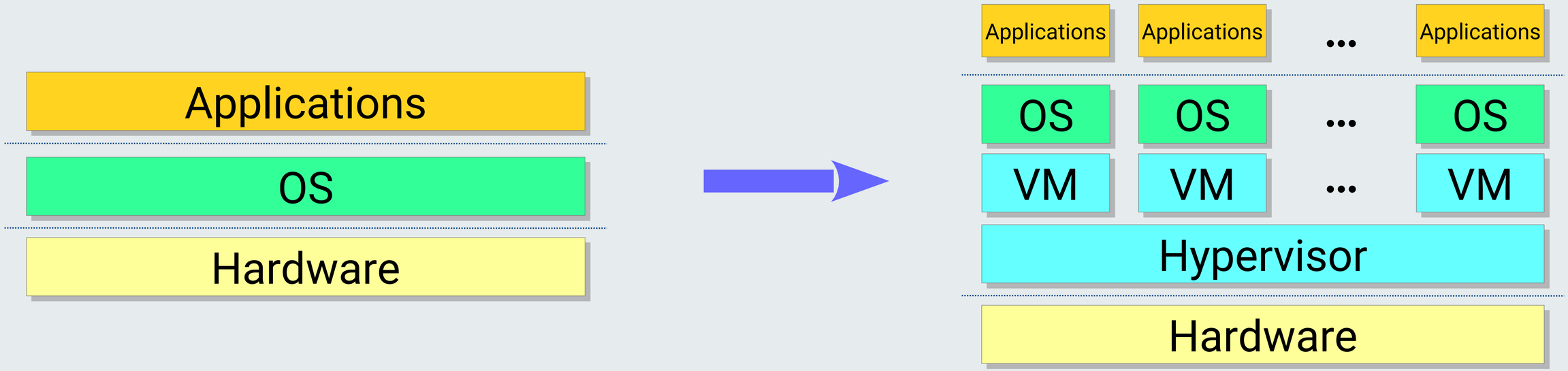
Virtual Machines: Basics

- Virtualisation: „sharing“ of hardware by using a hypervisor
- Virtual Machines (VM):
  - Own virtual hardware (CPUs/cores, memory, network, storage)
  - Own operating system (OS) within the VM
  - Hypervisor may emulate “standard” hardware → no problems with drivers



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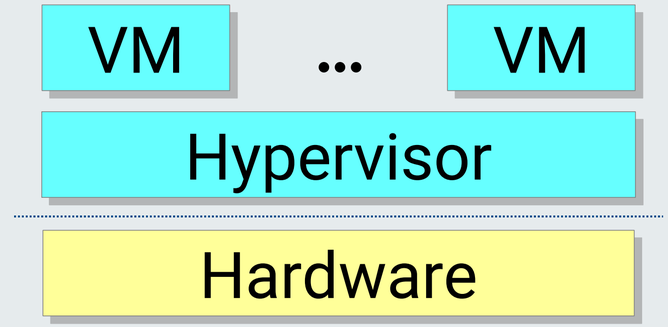
Virtual Machines: Different Variants

- Hypervisor
  - **Type 1**: Runs directly on the hardware
    - e.g. VMware ESXi
  - **Type 2**: Part of "normal" operating system
    - KVM (Kernel-based Virtual Machine) in Linux,
    - VirtualBox, etc.



- Para-virtualisation
  - Instead of emulating virtual hardware: just pass through OS calls
  - Requires OS adaptation/drivers

Full operating system in every VM → overhead

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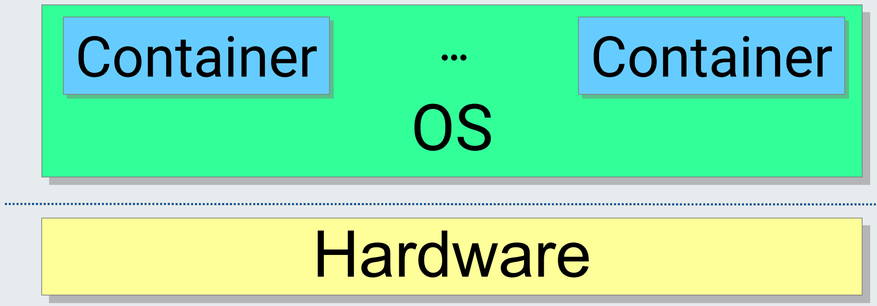
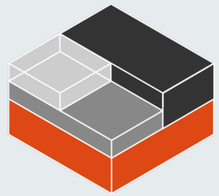
Containers

- Container
  - One OS kernel, multiple restricted areas (containers)
  - Each container „sees“ only
    - Own processes
    - Own virtual network interfaces
    - Own view on file systems
    - …
  - OS manages containers – has access to everything
- Widespread implementations:
  - Linux Containers (LXC) and FreeBSD Jails





Low overhead, but restriction to the same kernel

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Management Frameworks

VMs and containers are convenient! But how to manage them?

- Orchestration
  - Instance management:
    - create, remove, migrate, backup, restore, configure, ...
  - Service monitoring:
    - Is everything running, or are there problems somewhere?
- Well-known management frameworks:
  - OpenStack
  - Docker
  - Kubernetes
  - and many more!

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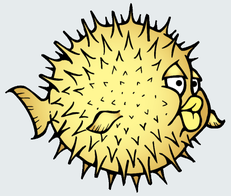
Applications for VMs and Containers

- „I need a web-server with database“
  - New container from template
    - Ubuntu Server + Apache + PostgreSQL
    - …
  - VM with Windows + IIS + Oracle
- „I need a FreeBSD system for kernel tests“
  - FreeBSD-VM from template
  - Snapshot/restore possible
- …



The „normal“ user just wants to use his application!

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Software as a Service (SaaS)

- Instead of own VMs/containers:
  - Subscribe to a complete service (e.g. as web application)
  - Provider takes care for everything

- Examples:
  - Microsoft Office 365
  - Google Apps (Mail/Drive/Photos/...)
  - Yahoo (Mail/Flickr/...)
  - GitHub, BitBucket, ...

Very simple and convenient for the "normal" user!

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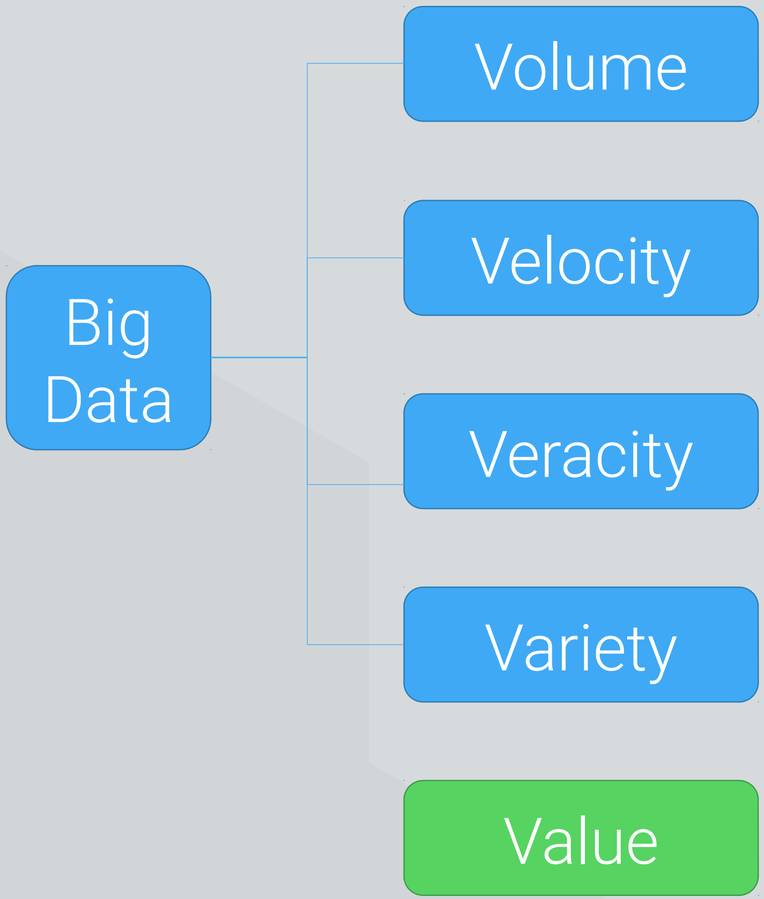
Social innovations in modern era increasingly rely on our capacity to process large datasets



Big data needs big resources!

- **Digital Universe** – Expected to grow to 44 ZiB in 2020
- **Internet-of-Things** – 30.7 billion devices by 2020
- **Social Networks and Multimedia** – 500 million tweets per day; 510,000 comments and 136,000 photos per second on Facebook!
- **Biological Data** – Vast amount of data available for researchers, 1000 Genome project, 100,000 Genome project, TiB to EiB!

1 TiB = 1024^4 = 1,099,511,627,776 bytes
1 EiB = 1024^6 = 1,152,921,504,606,846,976 bytes

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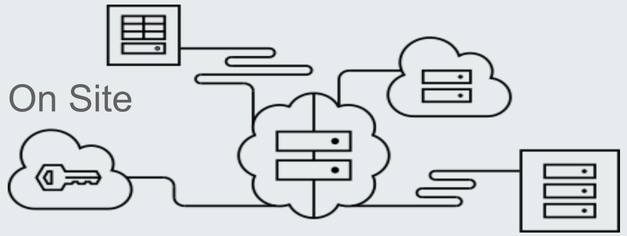
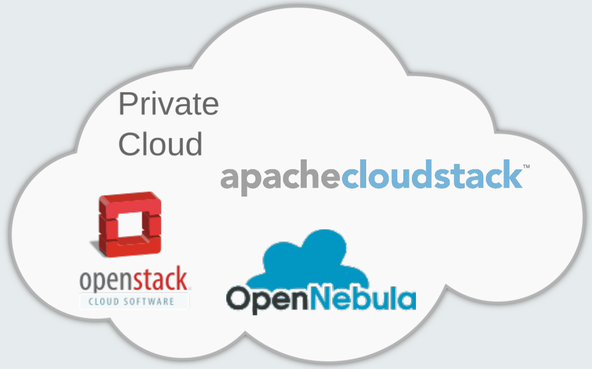
Currently, users are restricted to static deployment choices for data-intensive applications



- ✗ Cost Effectiveness
- ✗ Management Flexibility
- ✗ Resource Utilization
- ✓ Privacy and Confidentiality



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- ✓ Cost Effectiveness
- ✓ Management Flexibility
- ✓ Resource Utilization
- ✗ Privacy and Confidentiality
- ✗ Vendor Lock-In

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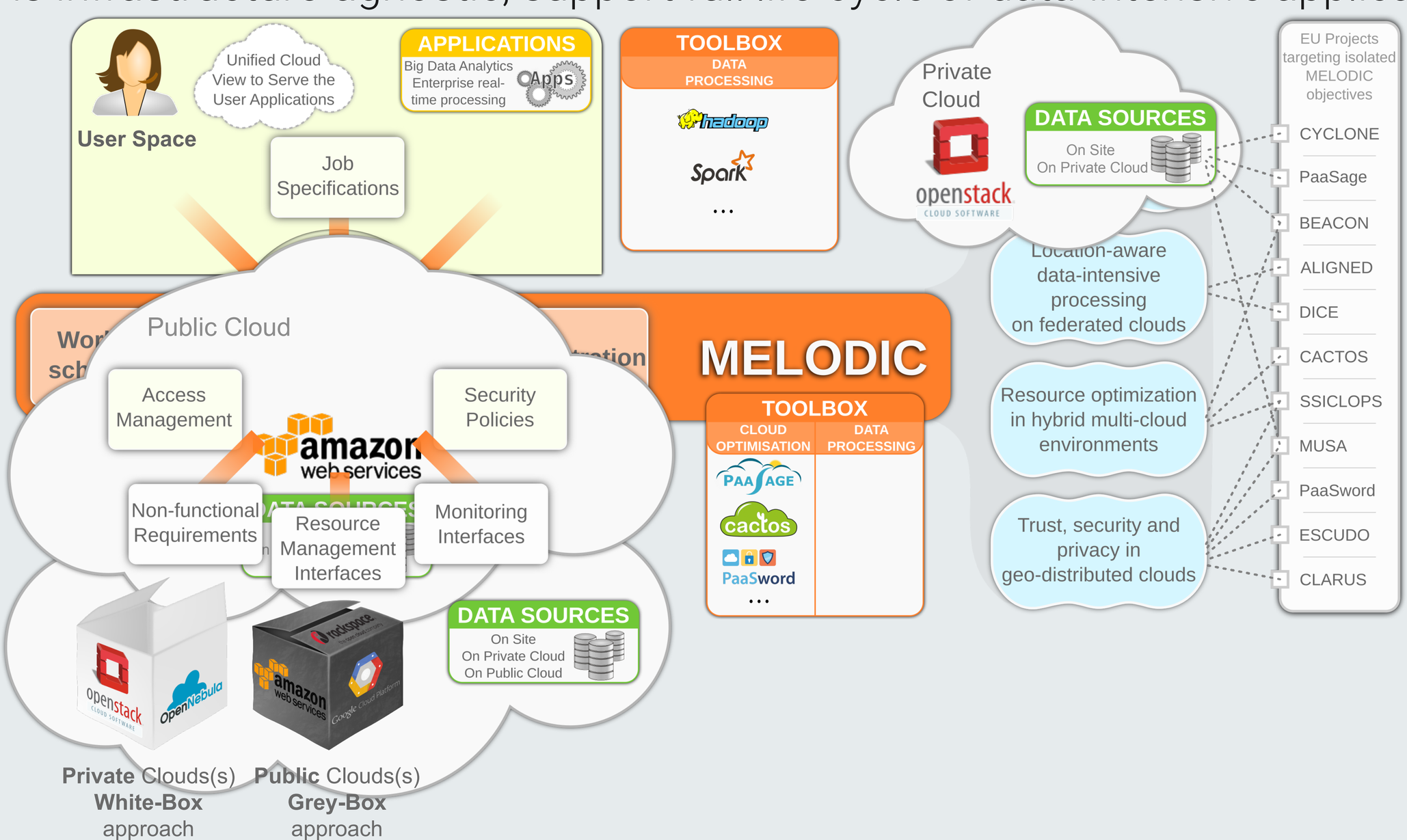
Melodic is infrastructure-agnostic, support full life-cycle of data-intensive applications



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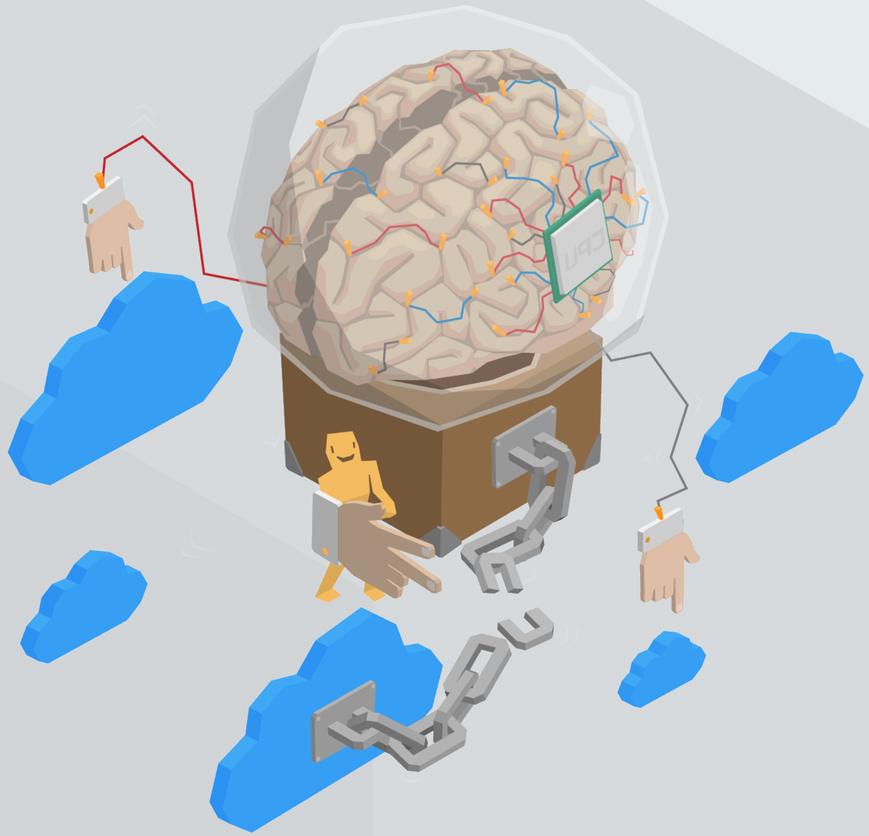

A Complete solution for data-intensive applications

- Transparent deployment and execution of data-intensive applications on multi-clouds
- Holistic data life-cycle management
- Runtime adaptation and automatic elasticity for cloud applications
- Secure and privacy-aware data access
- Optimal usage of distributed private infrastructures with federated clouds

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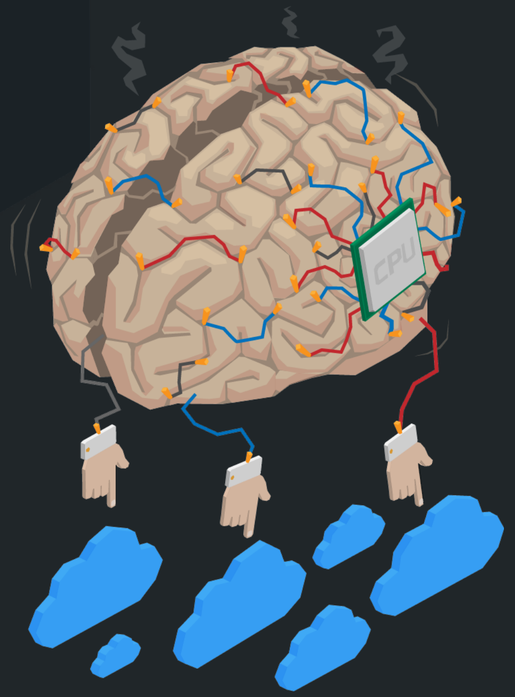
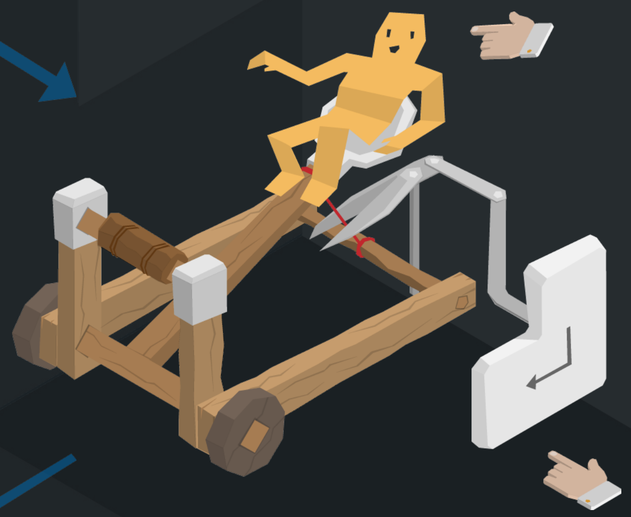
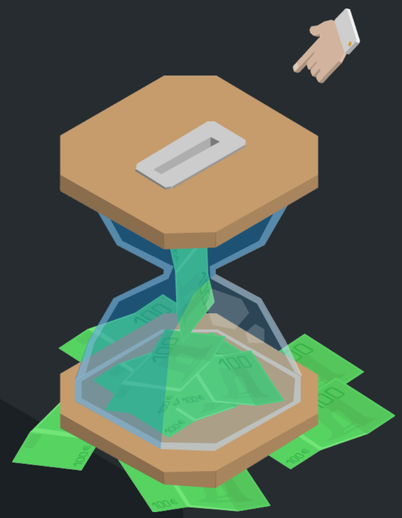
Big Data Cloud Made Easy!

Melodic calculates **best multi-cloud options** for your applications





Automatic deployments **and Adaptation**



Improved **performance** at lower **costs!**

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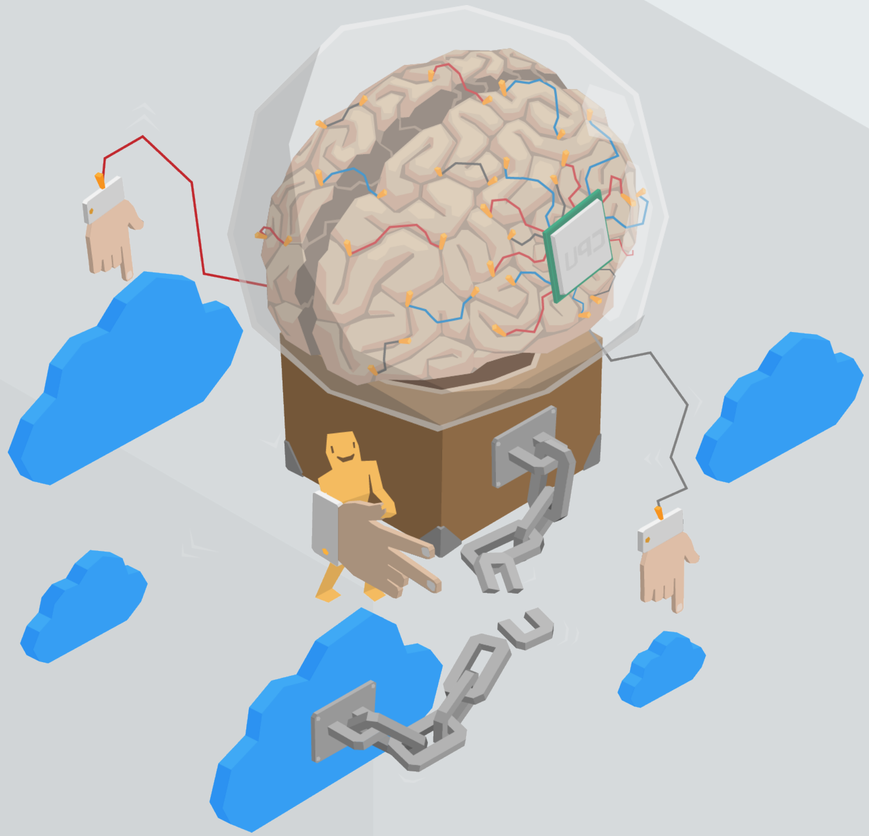

BIG IDEA:
AVOID VENDOR LOCK-IN

This is what we believe in:

- Cloud-future with competition not monopoly.
- Choice, change & opportunities.
- Multi-cloud complexity made simple and manageable.

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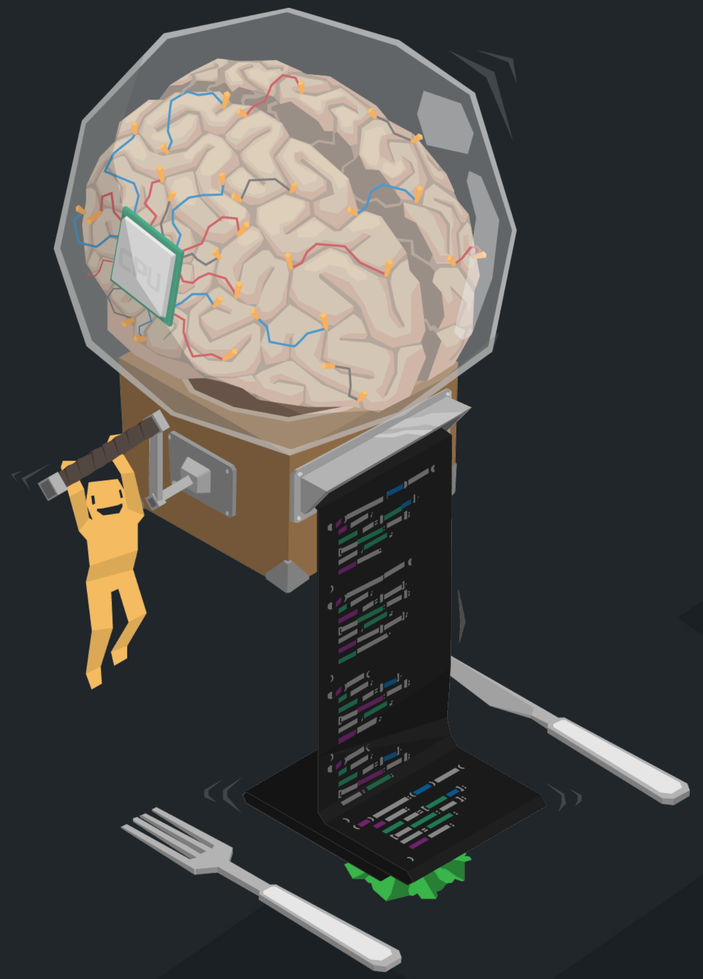
OPEN SOURCE
OPEN STANDARDS

We believe that open source projects promote innovation faster than proprietary solutions.



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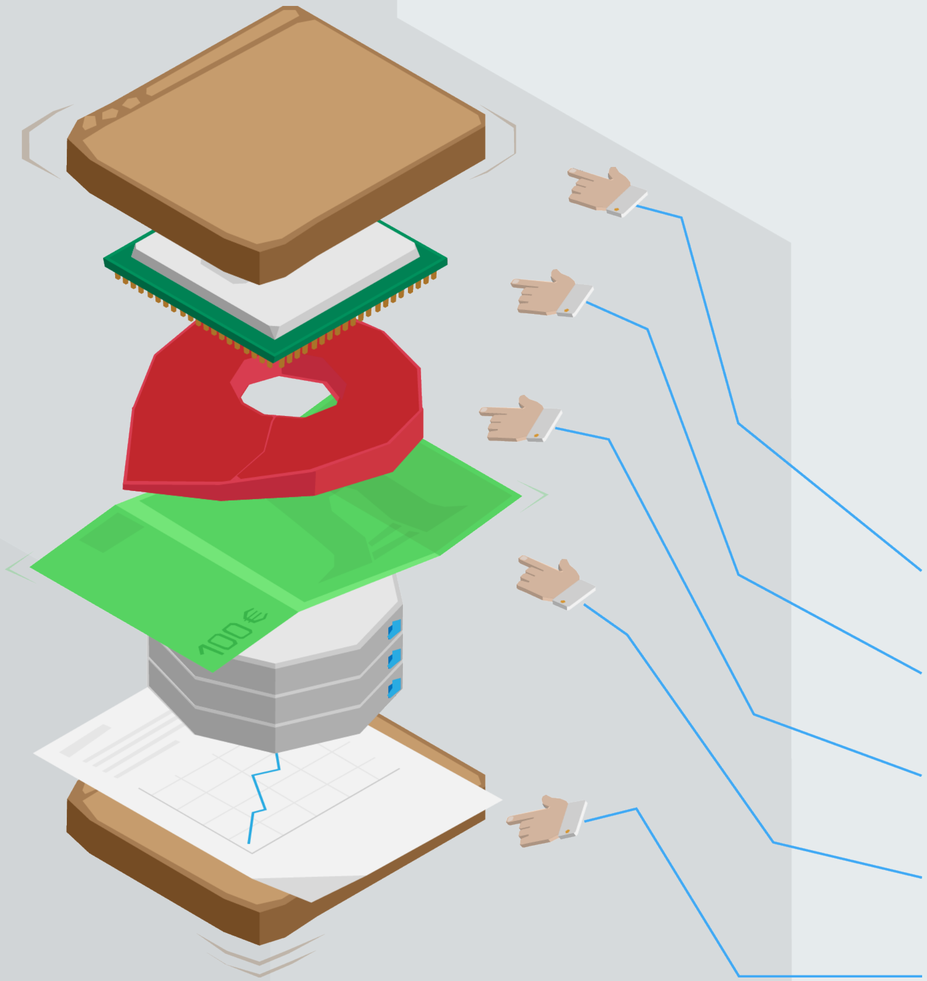

JUST TELL MELODIC
WHAT YOU NEED

Specify your needs once and forget about differences between cloud operators, multiple admin panels and other headaches.

- provisioning? deployment?
- scalability? service level?
- jurisdiction?
- cost concerns?
- monitoring?

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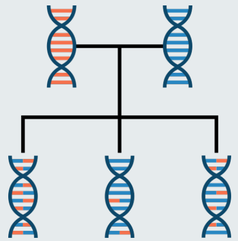
Melodic will be demonstrated with four selected use-cases (covering different deployment aspects and user requirements)



Genome Analysis

- Strict Data Confidentiality, Performance Optimization, Cost Effectiveness

Road Traffic and People Flow Monitoring

- Real-time Processing, On-Demand Processing, Geo-dispersed Big Data, Data privacy

Secure Document Management

- Data Life-cycle Management, Performance Optimization, Commercial Exploitation

Marketplace for Data-Intensive Apps

- Transparent Deployment, Runtime Adaptation, Automated Elasticity

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Use Case:
Genome Analysis

Białystok University provides application prototype enabling robust approach for the discovery of synergistic variables in biological datasets, with a main focus on data from gene expression studies and genome-wide association study (GWAS).

Melodic enables:

- Utilize cloud computing processing power and scalability
- Minimize data processing costs
- Use innovative solutions (like GPUs) to speed up data processing capacity

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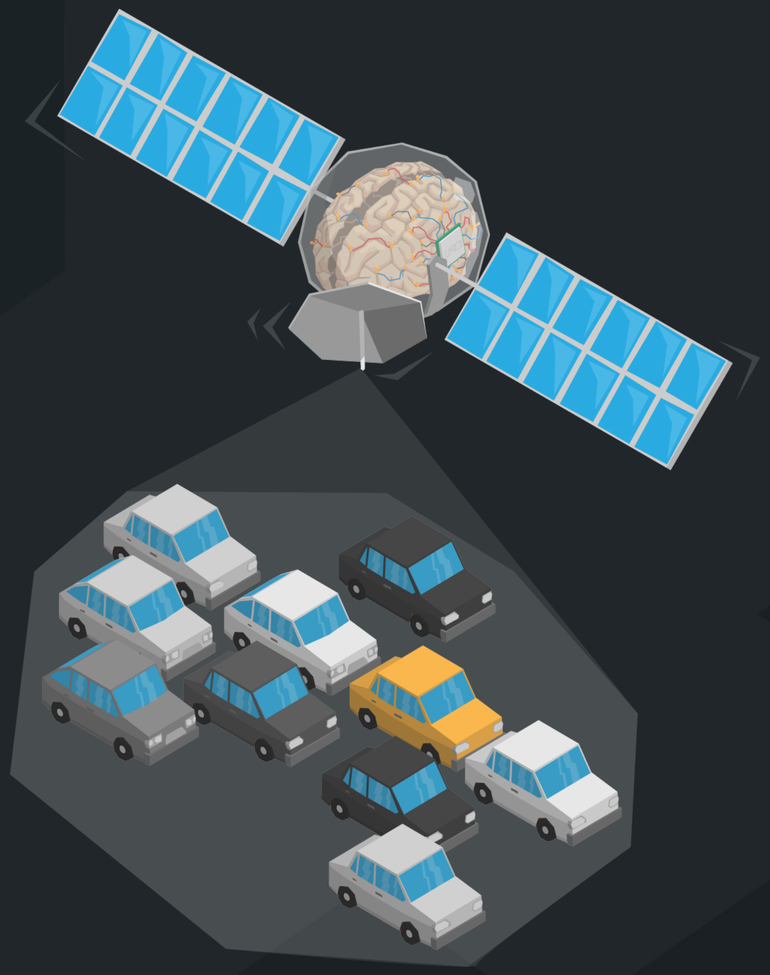
MELODIC CASE STUDY: CE-TRAFFIC

Melodic **helps CE-Traffic calculate road traffic** and people flow information

- Effortless switching between cloud providers minimizes cost.
- Big-data-cloud complexity made easy.
- On-time results.

CE-Traffic



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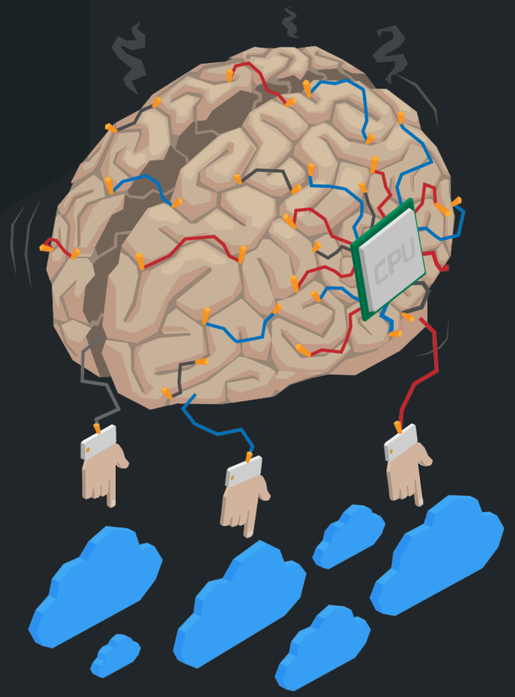

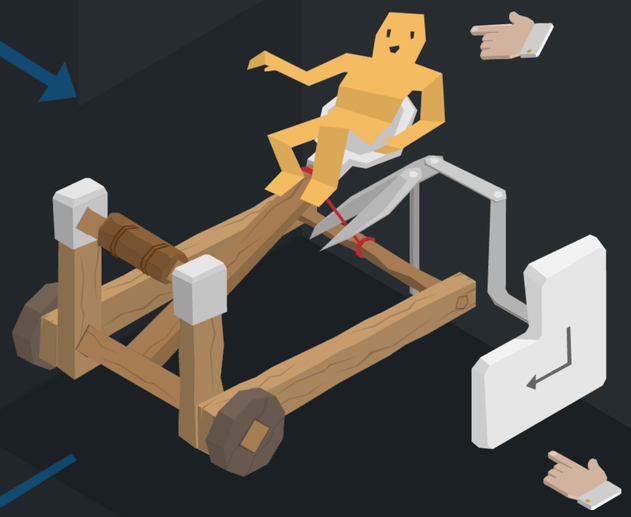

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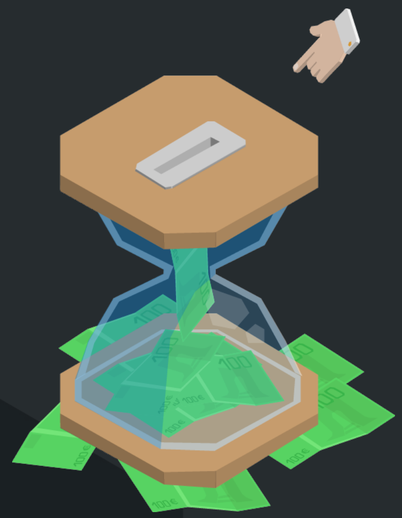

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Date:
29 December 2017

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Merry Christmas!
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MELODIC
Multi-cloud Execution-ware for Large-scale Optimised Data-Intensive Computing
MELODIC / NorNet Core
Simula Research Laboratory
http://www.melodic.cloud | https://www.nntb.no