Big Data Challenges

Big Data Value Association (BDVA)

ET4HPC SRA preparation
Munich, 20.3.2017
Big Data Value PPP (BDV PPP):

- Create **value** out of the **data**!
- Boost **European Big Data research and innovation**
- Strengthen **competitiveness** and ensuring **industrial leadership**

- **Work together to organize an IMPACTFUL program**
- **Efficiency**: Further develop the EU big data ecosystem (**i-Spaces**)
- **Proof points**: Demonstrate the impact of **Big Data** and show the value in **Lighthouse** projects
- **Innovation**: Create impactful **research results**
Big Data PPP aims at the development of an interoperable data-driven ecosystem as a source for new businesses and innovations using Big Data.

To achieve the BDV SRIA has defined four implementation mechanisms:

- **i-Spaces**: (Innovation Spaces) are cross-organization, cross-sector and interdisciplinary Spaces to anchor targeted research and innovation projects. They offer secure accelerator-style environments for experiments for private data and open data, bringing technology and application development together. i-Spaces will act as incubators for new businesses and the development of skills, competence and best practices.

- **Lighthouse projects**: These are large-scale data-driven innovation and demonstration projects that will create superior visibility, awareness and impact.

- **Technical priorities**: These will take up specific Big Data issues addressing targeted aspects of the technical priorities.

- **Cooperation & coordination projects**: These projects will foster international cooperation for efficient information exchange and coordination of activities.
Who is behind PPP BDVA?

And many more.... An Industry-led growing European community with over 160 members

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BDVA is taking care… of many different aspects of the big data technology

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BDVA is taking care… of many different aspects of the big data technology
ETP4HPC – BDVA cPPPs Position Paper (Autumn 2016)

• Cooperation axis:
  • Technology roadmap interaction
  • Development of HPC usage for extreme data exploitation
  • Democratisation of HPC for data intensive applications

• Interaction and exchange in between associations. The BDVA and ETP4HPC agreed to collaborate on a number of strategic issues:
  • Align their SR(I)As to highlight the complementary nature of their technical roadmaps
  • Provide an update to the relevant governance body of each association at least once a year (meeting BDVA – ETP4HPC) Pdts or/and Se
  • Actively participate in each other’s events (e.g. BDVA Summit, HPC Summit) including workshops
  • to focus on stakeholder interactions
  • Appoint liaisons to support interaction and to increase cooperation
  • Annual Technical interlock workshop between both associations
Big Data Value Reference Model

Cross-cutting functions

Data Protection

Engineering & DevOps

Standards

Data Visualisation and User Interaction
1D, 2D, 3D, 4D, VR/AR

Data Analytics
Descriptive, Diagnostic, Predictive, Prescriptive

Data Processing Architectures
Batch, Interactive, Streaming/Real-time

Data Management
Collection, Preparation, Curation, Linking, Access

(Existing) Infrastructure
Cloud, Communication (5G), HPC, IoT/CPS

Builds on

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Data Visualisation and User Interaction
1D, 2D, 3D, 4D, VR/AR

Data Analytics
Descriptive, Diagnostic, Predictive, Prescriptive
Machine Learning and AI, Statistics,

Data Processing Architectures
Batch, Interactive, Streaming/Real-time

Data Protection,
Anonymisation, ...

Data Management
Collection, Preparation, Curation, Linking, Access
DB types: SQL, NoSQL (Document, Key-Value, Column, Array, Graph, ...)

Sectors: Manufacturing, Health, Energy, Media, Telco, Finance, EO, SE ..
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**Data Visualisation and User Interaction**
1D, 2D, 3D, 4D, VR/AR

**Data Analytics**
- Descriptive, Diagnostic, Predictive, Prescriptive
- Machine Learning and AI, SaaS

**Data Processing and User Interaction**
- Batch, Interactive, Streaming/Real-time

**Data Protection**
- Anonymisation, ...

**Data Management**
- Collection, Preparation, Curation, Linking, Access
- DB types: SQL, NoSQL (Document, Key-Value, Column, Array, Graph, ...)

**Quality of results**, **Quality of processing**, **Quality of experience**

**Added Value**

**Enablers**

(Existing) Infrastructure, other PPPs

Cloud, Communication (5G), HPC, IoT/CPS
CHALLENGES

- New algorithms
- New (more efficient) implementations
- New (Data Science as a) Service
  - Semantics of use / Automated Decision Making
- New (Data Science as a) Methodology
  - Knowledge modeling and representation (for users)
- Self-adaptive big data systems

Quality of results
Quality of processing
Quality of experience
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Quality of results
Quality of processing
Quality of experience

INFRA STRUCTURE

DOMAINT
CHALLENGES RELEVANT FOR HPC

- New algorithms
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**Table 2: Big Data and HPC Workloads**

<table>
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<tr>
<th>Lower &lt;-&gt; higher</th>
<th>Data Intensive</th>
<th>Compute Intensive</th>
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<tr>
<td><strong>Typical Big Data</strong> (Big Data + Small Compute): Analytics intense workloads focusing on inferring new insights from big data-sets e.g. search, streaming, data preconditioning, pattern recognition, etc</td>
<td><strong>Extreme-Performance Data Analytics</strong> (Big Data + Big Compute): Extreme analytics and simulation workloads e.g. near/real-time anomaly detection such as national security or financial services, modelling brain connections or drug efficacy, etc</td>
<td><strong>Typical HPC</strong> (Small Data + Big Compute): Modelling and simulating intense workloads focusing on interaction amongst parts of a system and the system as a whole e.g. physics, biology, chemistry, etc</td>
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<tr>
<td>Traditional Enterprise IT (Small Data + Small Compute): Traditional enterprise IT workloads focusing on typical database and application hosting e.g. cloud, etc</td>
<td>Lower &lt;-&gt; higher</td>
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*’Small’ and ‘Big’ are relative (and not absolute) terms.*
HPDA strong growth over forecasted period

• The High Performance Data Analytics (HDPA) market is estimated to grow from USD 25.71 Billion in 2016 to USD 78.26 Billion by 2021, at a Compound Annual Growth Rate (CAGR) of 24.9%.

• The proliferation of open source frameworks for big data analytics and the ability of powerful High Performance Computing (HPC) systems to process data at higher resolutions are the key driving forces of HPDA market.

• HPDA applications are used for computational analysis, information escalated research, rich media, 3D-modelling, seismic handling, data mining, and large scale simulation.

• By: marketsandmarkets.com
  Publishing Date: November 2016

However, **high investment costs and government rules & regulations** are acting as the restraining factors for the HPDA market.
HPDA Market Drivers

- More input data (ingestion)
  - More powerful scientific instruments/sensor networks
  - More transactions/higher scrutiny (fraud, terrorism)

- More output data for integration/analysis
  - More powerful computers
  - More realism
  - More iterations in available time

- The need to pose more intelligent questions
  - Smarter mathematical models and algorithms

- Real time, near-real time requirements
  - Catch fraud before it hits credit cards
  - Catch terrorists before they strike
  - Diagnose patients before they leave the office
  - Provide insurance quotes before callers leave the phone

Semantics-based Predictive systems

Big Data opportunities
Use Case: PayPal Fraud Detection

The Problem

Detecting fraud in 'real time' as millions of transactions are processed between disparate systems at volume.

Finding suspicious patterns that we don’t even know exist in related data sets.

Knowledge-based

Ability to create and deploy new fraud models into event flows quickly and with minimal effort.

Self-adaptive systems

Provide environment for fraud modeling, analytics, visualization, M/R, dimensioning and further processing.

Big Data opportunities
There Are New Technologies That Will Likely Cause A Mass Explosion In Data – Requiring HPDA Solutions
HPDA – analytics challenges

- Affordable Deep Learning analytics
  - Algorithms to extract complex data models. Training becomes very complex due to the significant increase in the number required layers in the network.

- Large scale predictive analytics
  - Find Unknown Unknown in high dimensional, heterogenous spaces

- Continuous real-time analytics
  - Ensure freshens of data in analytics

- Edge Analytics
  - Autonomous analytics
Examples
Continuous real-time analytics Challenges

• Continuous analytics deals with unknown unknowns (proper models are not available).
• Continuous analytics is sliding window based data analytics which should be supported by appropriate data staging.
• Scaling out continuous data analytics with parallel and distributed infrastructure (e.g. to calculate distance).

Which metrics can find similarities?
Emerging HPDA Segments

1. **Fraud and anomaly detection.** This "horizontal" workload segment centers around identifying harmful or potentially harmful patterns and causes using graph analysis, semantic analysis, or other high performance analytics techniques.

2. **Marketing.** This segment covers the use of HPDA to promote products or services, typically using complex algorithms to discern potential customers' demographics, buying preferences and habits.

3. **Business intelligence.** The workload segment uses HPDA to identify opportunities to advance the market position and competitiveness of businesses, by better understanding themselves, their competitors, and the evolving dynamics of the markets they participate in.

4. **Other Commercial HPDA.** High-potential workload is the use of HPDA to manage large IT infrastructures, ranging from on premise data centers to public clouds and Internet-of-Things (IoT) infrastructures.
(instead) CONCLUSION

Traditional BigData

Data-intensive workloads
Infrastructure and software are optimised for cost (IOPS) first, rather than maximum performance

Enterprise IT

‘Regular’ workloads
Infrastructure and software are optimised for lower-cost, lower-performance

EPDA

Compute- and Data intensive workloads:
Design principles for infrastructure and software are optimised for minima cost (IOPS) and maxima performance (FLOPS)

HPC

Compute-intensive workloads:
Design principles for infrastructure and software are optimised for performance (FLOPS) first, rather than for minimal cost.

Quality of results of processing of experience

USER

Lower <----- higher

Data Intensive

Lower <----- higher

Compute Intensive

Lower <----- higher

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ETP4HPC – BDVA cPPP cooperation

- **Existing BDV-PPP Projects**: Inviting an ETP4HPC representative to attend Technical Board meetings which will encompass all BDV-PPP funded projects, including Lighthouses and Innovation Spaces.
  - The presence of an ETP4HPC representative can assist with identifying where HPC capabilities may assist big data analytics within these projects.
- **Cross SR(I)A Influence**: Identify and align research themes common to HPC and Big Data research interests in the area of Extreme Performance Data Analytics (EPDA).
- **Extreme-Scale Demonstrator (EsDs)**: Make a joint recommendation for an ‘extreme Big Data’ related theme to upcoming Extreme-Scale Demonstrator (EsDs) call for input.
- **Centre of Excellence (CoE) in Computing Applications**: Make a joint recommendation for a themed Big Data/HPC investigation in forthcoming call for input.
- Additionally, both associations will collaboratively schedule a set of forthcoming interactions involving both ecosystems (e.g. joint events, workshops, and conferences) to advance understanding and definition in these areas.
THANKS

Questions?