

# Mapping and Optimizing Big Space Data: An International, Interdisciplinary and Intercultural Perspective on the Space Related Data Processes

*Jillianne Pierce  
Mitchell Scher  
TP Space Big Data Team*



**TECHNION**  
Israel Institute  
of Technology

# Space Big Data Team

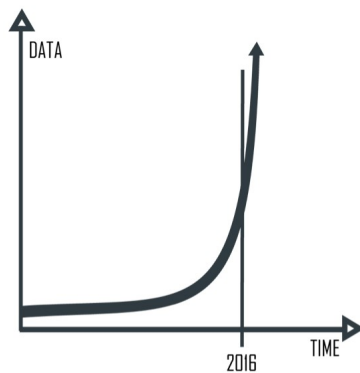
Daniel Brack – Technion, Israel Institute of Technology  
Barak Fishbain – Technion, Israel Institute of Technology  
Sanja Šćepanović – Aalto University

Adam Szeszko - Poland  
Changgui Li - China  
Deepa K. S. - India  
Dimitra Stefoudi - Greece  
Francis Kudjoe - Ghana  
Guanghong Dong - China  
Hendrik Kolvenbach - Germany  
Jifeng Ma - China  
Jillianne Pierce - United States  
Jingjing Peng - China  
Josephine Gull - Finland  
Julia Heurtish - Austria  
Kai Zhang - China  
Kanika Anand - Netherlands  
Kartik Kumar - Netherlands  
Laura Keogh - Ireland  
Maya Bartov - Israel

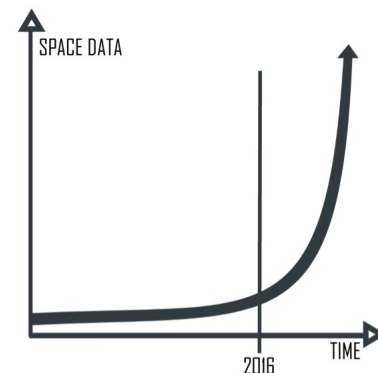
Mingfang Wang - China  
Mitchell Scher - United States  
Naga Sekhar Tammana - India  
Nini Berge - Norway  
Ofra Boim - Israel  
Praskovia Milova - Russia  
Robert Jacobson - United States  
Ujjwal Gangele - India  
Vincent Lochet - France  
Wei Jiang - China  
Xiang Han - China  
Yang Chen - China  
Yongping Zou - China  
Yong Song - China  
Yue Yin - China  
Zezhong Sun - China  
Zhaoyong Ni - China  
Zhiqi Zhou - China

# Recent Developments

- Data volume is increasing rapidly
- Commercialization
- Data Applications
- Internet big data boom



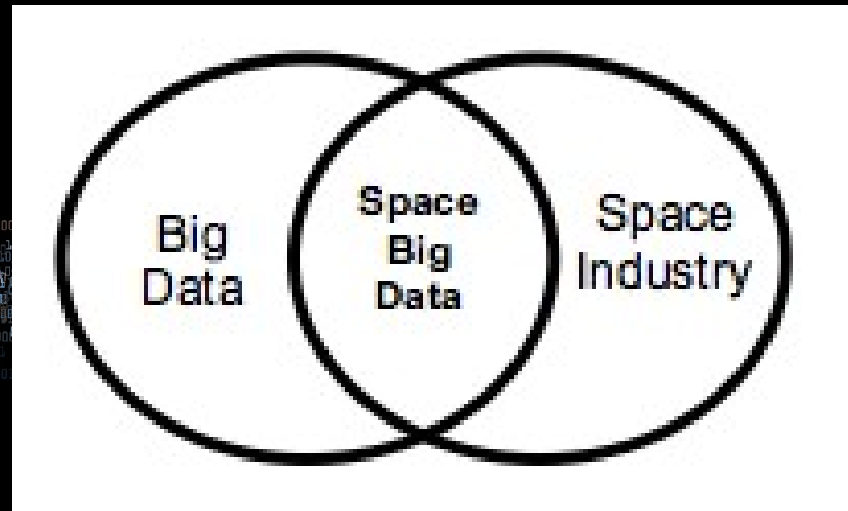
(a) Current state of big data



(b) Current state of space big data

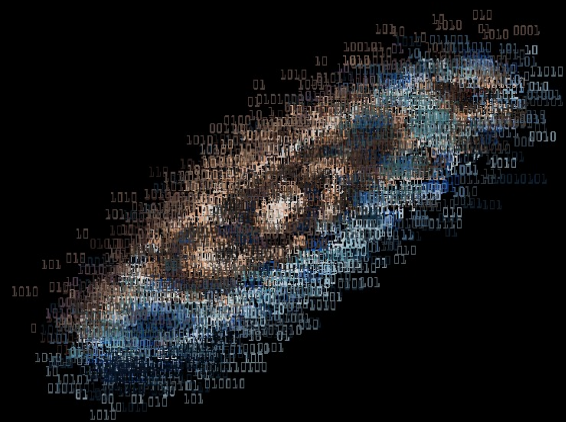
# What is Space Big Data?

- Intersection of big data and the space industry
  - Big data: volume, velocity, variety, veracity, and variability
  - Space industry: data gathered through activities that utilize space assets



# Value Chain

- What is the lifecycle of space data?
- Data Manufacturers
- Data Processors
- Data Applications
- Data Repositories

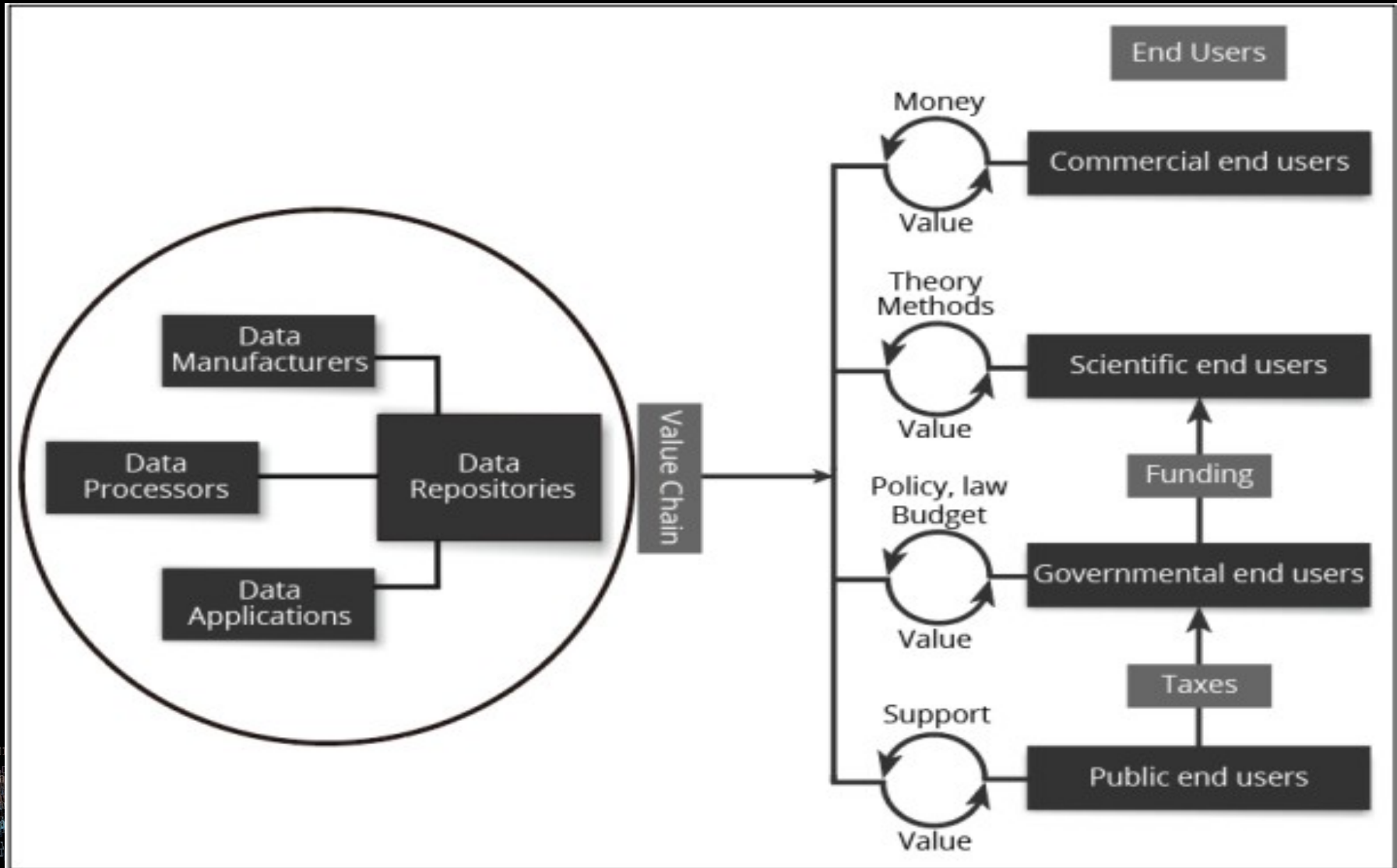


# End Users

- Drives collection and initial application
- Government
  - Public good
- Commercial
  - Provide products to market
- Scientists/Institutions

– FAST

# Integrated Value Chain





# Manufacturers – Generating Data

- Ground Based
  - Observatories
- Space Based
  - Earth imaging
  - Space telescopes
  - Rovers
- Data Downloading





# Manufacturers' Challenges

- Data Downloading
  - Direct download vs satellite relay
    - Time limitation
    - Resources
  - Downloading vs storage
- Standardization
  - Data format is for one customer's intended use



# Processing Levels

Level	Description
0	Reconstructed, unprocessed instrument/payload data at full resolution; any and all communications artifacts - e.g., synchronization frames, communications headers, duplicate data removed.
1a	Reconstructed, unprocessed instrument data at full resolution, time-referenced, and annotated with ancillary information, including radiometric and geometric calibration coefficients and geo-referencing parameters.
1b	Level 1A data that have been processed to sensor units (not all instruments have Level 1B data products).
2	Derived geophysical variables at the same resolution and location as the Level 1 source data.
3	Variables mapped on uniform space-time grids, usually with some completeness and consistency.
4	Model output or results from analyses of lower level data, e.g., variables derived from multiple measurements.

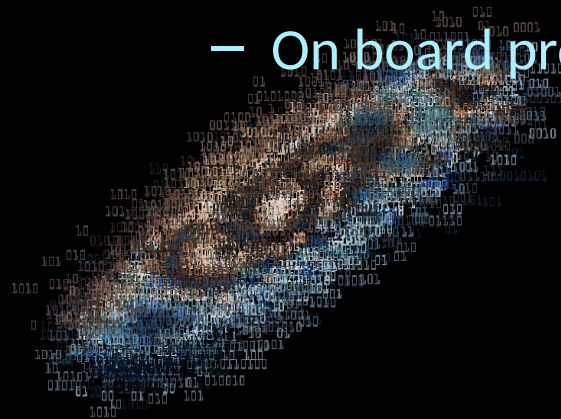
# Processors – Creating Information

- Levels of processing
- Space Agencies
  - Rovers
  - Hubble
- Commercial
  - API Providers
- Academia
- Crowdsourcing
  - Zooniverse



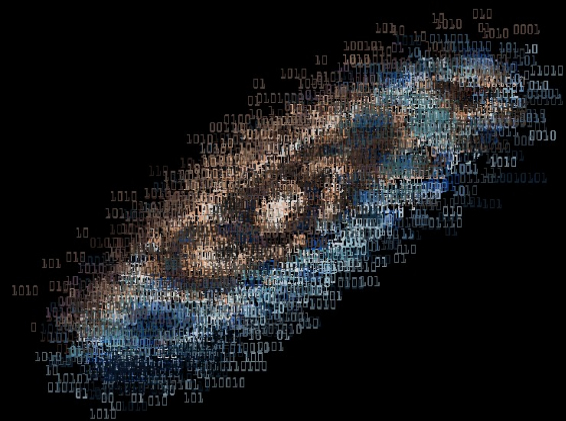
# Processors' Challenges

- Lack of standardization
  - Difficult to identify and organize data
  - Cannot create strong APIs
- Accessibility
  - Open vs Restricted data
  - Disorganization
- Technical challenges
  - Non-text processing
  - On board processing



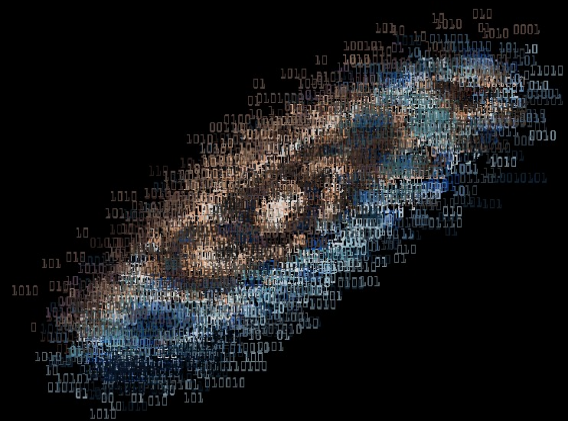
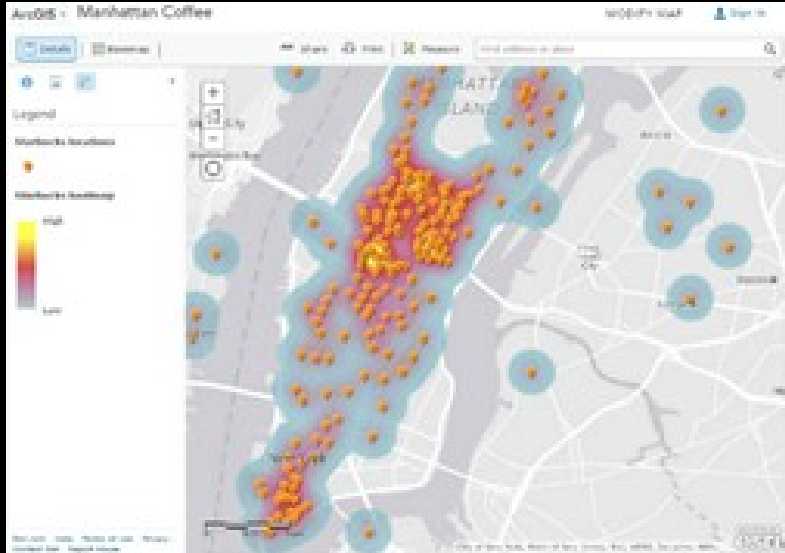
# Applications – Creating Value

- Upstream technology improvements have created downstream opportunities
  - Technologies
  - Processing abilities
  - New data sets
- (Start of) Normalization of market



# Applications – Creating Value

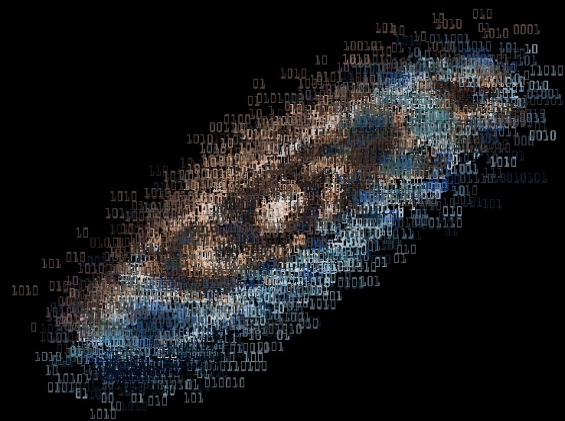
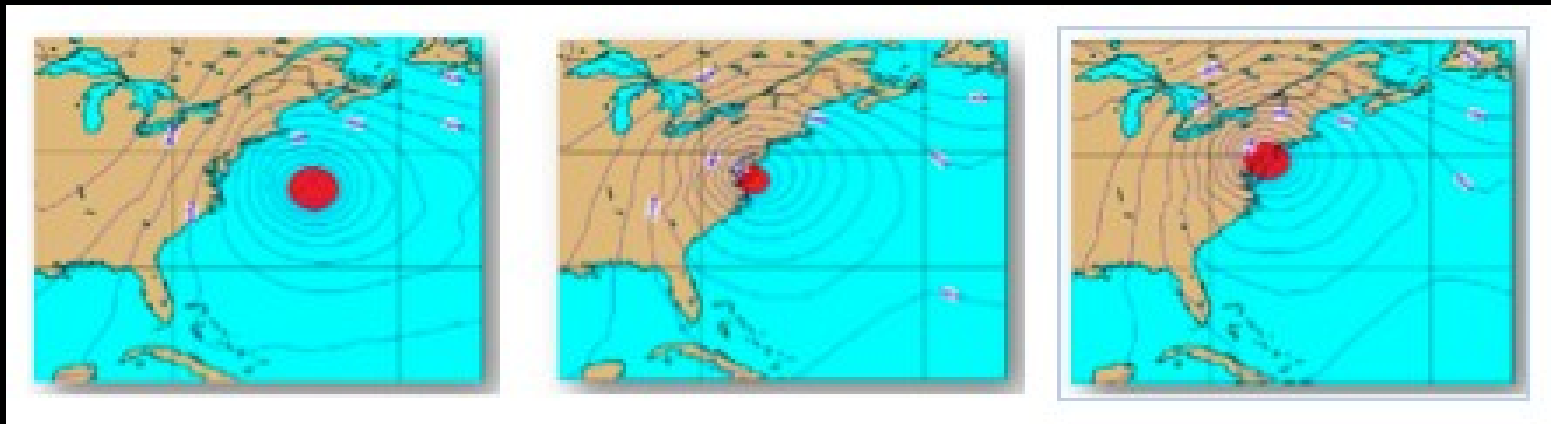
## Private vs Public





# Applications – Creating Value

## Disaster Relief



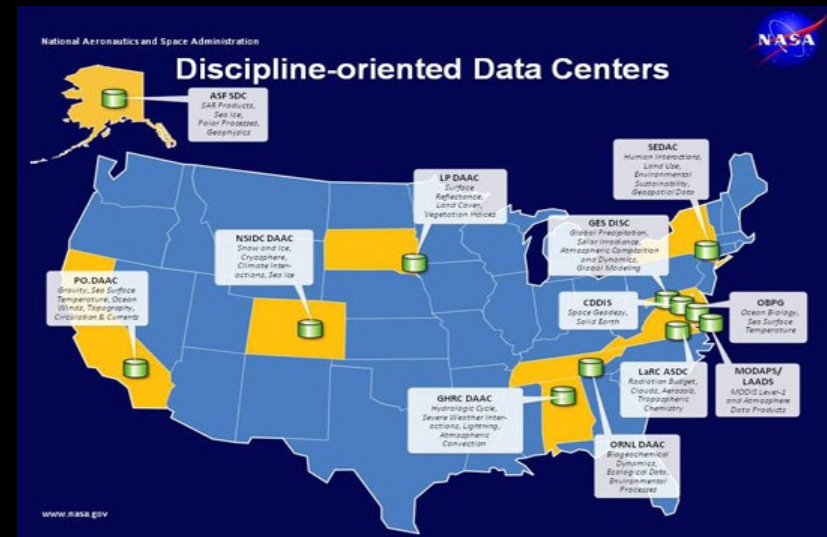
# Application Providers' Challenges

- Financial
  - Costs of new data
  - Securing rights to restricted data
- Marketability
  - Space data is not common enough
- Legal
  - Privacy and Openness
    - The Sunlight Foundation
  - International vs National policy



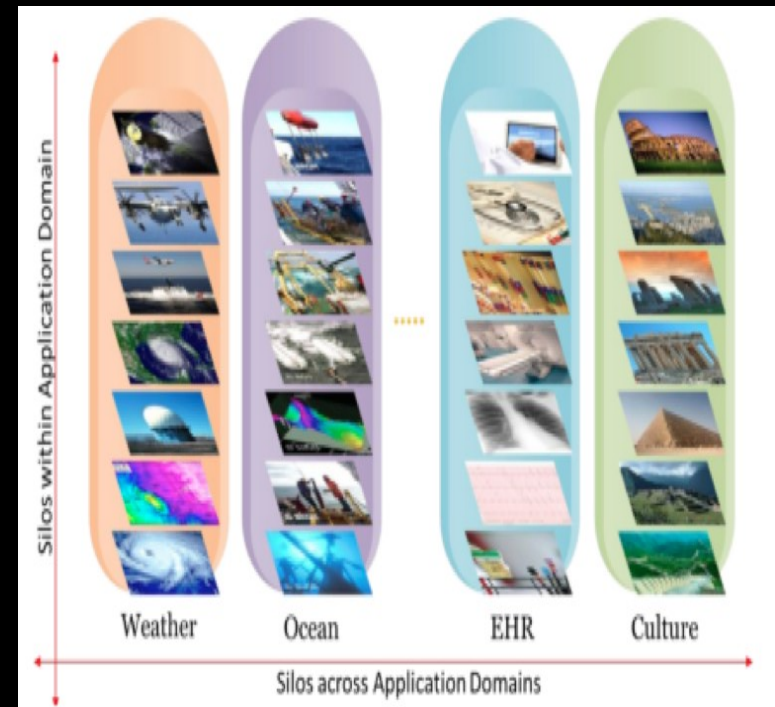
# Repositories – Storing Data

- Government, Commercial, Institutional
- Government Moving Towards Open
  - ESA to Cloud
  - OpenNASA
- Data Split by Discipline
- Each Has its Own Policies

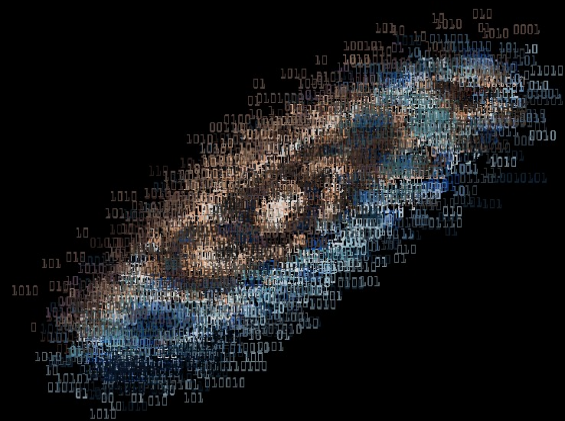


# Repositories Challenges

- Unstructured Data
- Access Control
- Data Type Siloing
- Security Concerns

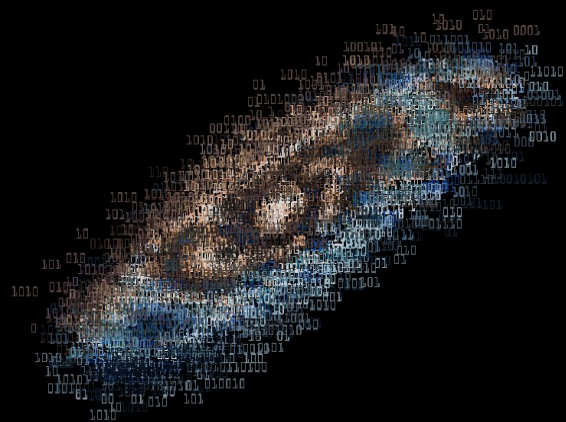


# Core Challenges



# Marketability

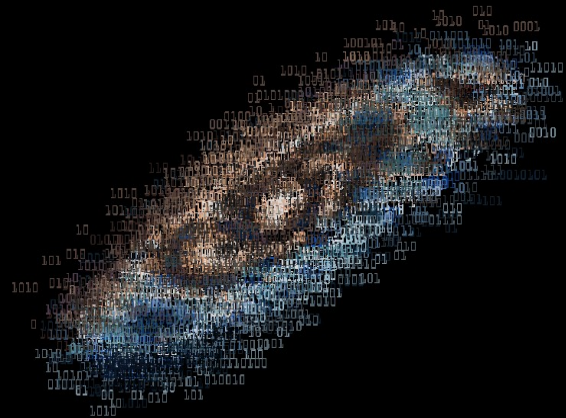
- Cost of Entry Remains High Across Value Chain
  - Payload vs Launch Costs
  - CubeSats, SmallSats
- Niche Market
- Mission Driven Results
- Lacks Flexibility of Data





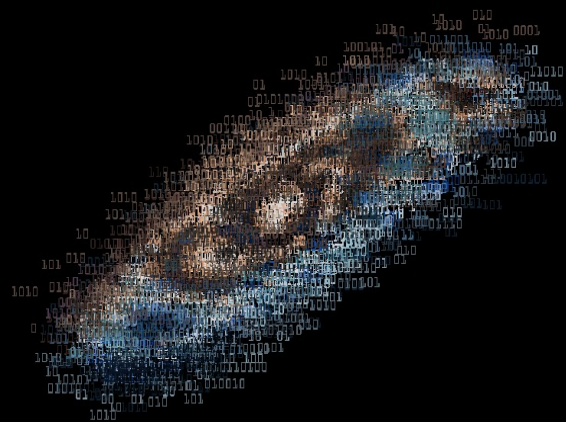
# Engineering

- Data Downloading
- Data Access
  - Lacks Framework to Share Data
  - Data Mining Capabilities
- Non-text Data Processing
  - Requires Visual Representation and Processing



# Standardization

- Analysts spend 80-90% of their time preparing data for analysis
- No Universal API
- International Organization of Standardization (ISO)
- International Resistance to Standardization
  - Would not Resolve Existing Data Issues

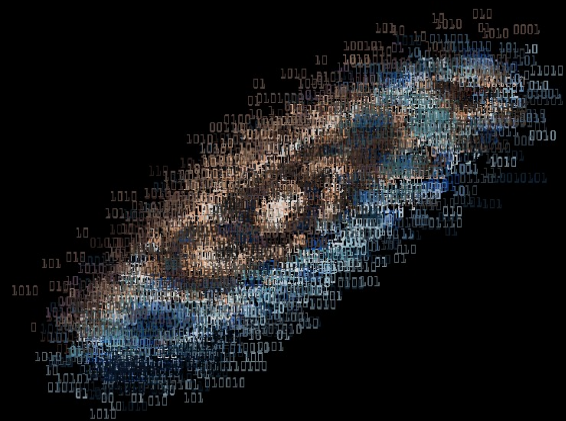




**BIG BROTHER IS  
WATCHING YOU**

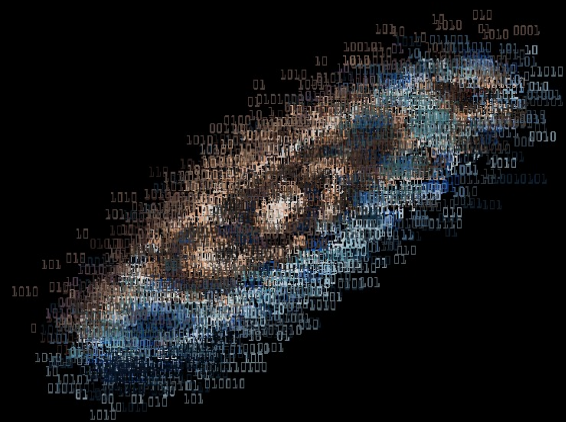
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# Roadmap to Effective Utilization



# Market Entry and Commercialization

- Governmental Normalization of SBD Use in Projects
  - Infrastructure
  - Resource Utilization
- Normalization in Ancillary Markets
- Investment in Related Technologies
- Risk Mitigating Political Framework



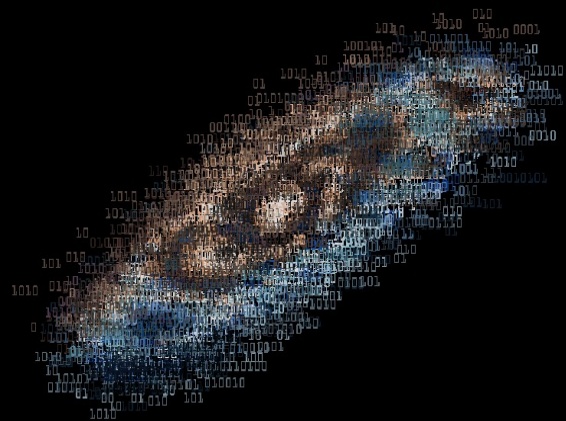
# Engineering

- Increased Use and Investment
  - Laser Communication (Data Downloading)
  - AI, Machine Learning (Data Processing)
  - Quantum Computing (Data Mining)
- ~~Global Dissemination System~~
- Hadoop, Cloud Computing Framework Implementation



# Openness and Privacy

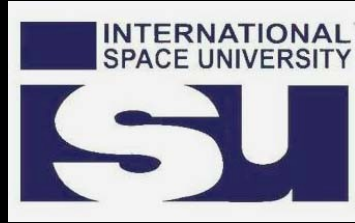
- International Discourse is Ineffective/not Time-Efficient
- Create Political Framework for Future Decisions
  - Grow Policies with Technology and Issues
- Clear Set of Basic Standards for Commercial Entities
  - Mitigate Some Risk of Market Entry



# Concluding Thoughts

- Space big data is already here
  - When and how will we use it?
- Space big data is not a problem to solve
  - It must be adapted to
- Problems and next steps are not siloed
  - Government, industry, academia, and scientists are all needed

# Acknowledgements



**TECHNION**

Israel Institute  
of Technology

Dan Green, Harvard

Nimrod Kozlovski, HFN

Ilan Porat, Elbit Systems

Pier Giorgio Marchetti, ESA

Ayelet Baram-Tsabari, Technion

Romi Mikulinsky, I-CORE

Francesc Guim Bernat, Intel

Hagit Messer-Yaron, Tel-Aviv University

Philippe Armbruster, ESA

Kerrie Dougherty, Endeavour Consulting

David Cohen, Informatix

Laura Rose, ISU

Jonathan Faull, ISU

Irina Thaler, ISU

# Questions?



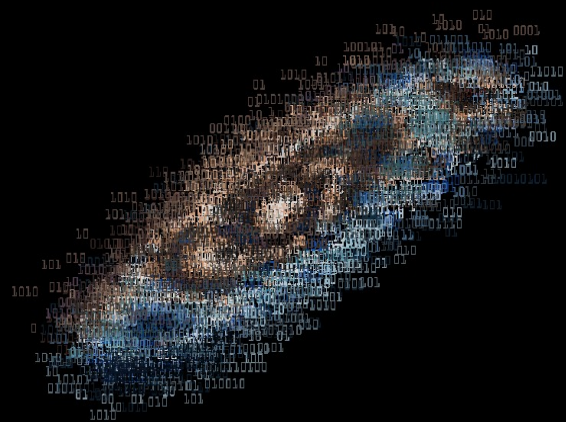
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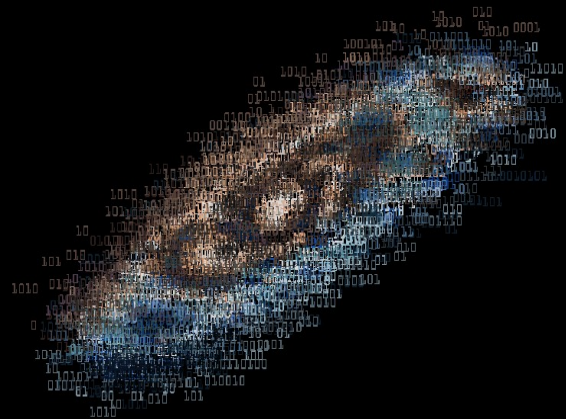
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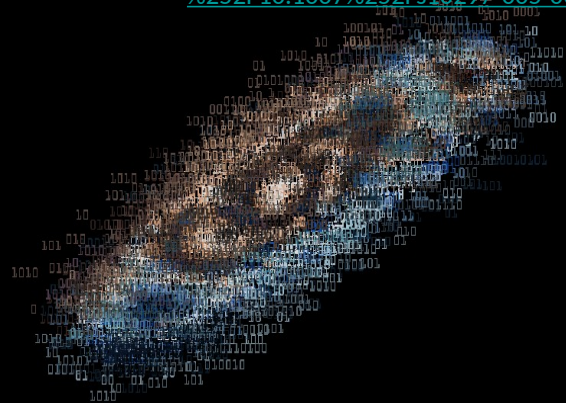
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