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The Data Observatory, a vehicle to foster digital economy using natural advantages in astronomy in Chile

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Abstract. The Astroinformatics Program is funded by the Chilean Economy Ministry's (FIE Grant FIE-2016-V022, CORFO Grant 16IFI6626) with the mission to identify and initiate investments to foster Chilean Digital Economy, using Astronomy data-centric tools (known as astroinformatics). Over 2017 we worked with communities across sectors identifying opportunities to achieve the program mission, the Data Observatory vision emerged from that work and will guide design activities throughout 2018.

Keywords. large facilities, capacity building through astronomy, digital transformation, innovation policy

1. Astronomy and Chile

Astronomy Digital Transformation. Over the last century the technology of astronomical observatories has improved dramatically. The understanding of the origin and destiny of our universe has evolved accordingly, now we know how limited is our ability to explain most of it; there is so much more to discover. Progress in technology ignited a transformation in astronomy: knowledge that emerged from individual's minds, now flows from multi-disciplinary teams using data-centric tools. On one hand, data blooms from observatories; on the other, data bursts from cosmological simulations on computing clusters. Telescopes will produce zetta-scale datasets over next decade (Quinn *et al.* 2015), and theoretical astrophysics will generate similar data volumes and challenges.

The Capital of Ground Astronomy. Over the last decades, collaboration between the Chilean government and international observatories has brought 40% of Earth's telescopes to our territory. That share will grow to up to 55% in 2021 (Catanzaro 2014). The inauguration of instruments in the next decade will further enshrine the Atacama Desert as a capital of ground astronomy. According to our work, the volume of astronomical data acquired in Chile will go from ∼1 $^{\mathrm{Pb}}$/year today, to ∼20 $^{\mathrm{Pb}}$/year in 2021.

2. The Data Observatory

Our work shows that Chile has two main strategical advantages to achieve the astroinformatics program mission: a) the ability of the Chilean Government to establish a neutral-broker institution at the heart of astronomy, academy, and productive sector

collaboration, embedded in our astronomy-interested-society and its natural environment, and b) the proximity of this institution to observatories, their teams and its users.

The Data Observatory (DO) vision emerges as a vehicle to exploit these advantages and achieve the program mission. The DO will honor the legacy of telescopes in our territory and will be a cross-continental system for both current and historical data and data-centric technology for storage, access, analysis, exploration, and visualization of the data produced here. The DO will operate under a quintuple-helix model (Carayannis *et al.* 2012), to coordinate the relationships between diverse actors and their contexts, and foster digital economy in Chile.

The DO & Astronomy. The DO will work with the global astroinformatics community and international observatories in Chile to be involved in the data-centric challenges of astronomy in the era of multi-messenger and large survey instruments.

The DO & the Virtual Observatory. The DO will foster and grow IVOA capacities, helping in the application of those standards for Chilean observations.

The DO & Academy. The DO will offer a unique data-centric fellowship system to form the talent of the future, providing hands-on training in challenges related to sophisticated analysis on high-value and volume datasets.

The DO & Cloud Computing Companies. An international consulting firm conducted research in the productive sector and showed that even though astronomy has obvious differences with industry, it's similar to it in the data-centric tasks (see next section 3). The DO will work with cloud providers to improve the region's industry capacity for data-centric challenges, through a bi-directional technology transfer system between astronomy and the productive sector.

The DO & Society. The DO will work for a very enthusiastic general public. Astronomy has a great position in Chile, it is by far the most productive scientific field, and also the field that produces more interest from the general public considering publications both at national and international level (Fundación MarcaChile 2018).

The DO & Natural Environment. The Atacama desert has the highest levels of solar irradiance on Earth, due to the same reasons that make it great for astronomy (Rondanelli *et al.* 2014). As of May 2018, the government has awarded generation contracts that will produce power at $24/MWh for photo-voltaic systems, and at $48/MWh for concentrated solar power systems, world's best prices for solar energy, motivated by the green mining demand. The DO will work with the emerging Solar industry in the Atacama desert to create green infrastructure.

3. Astronomy data-centric tasks

Working with the international community, we identified a set of data-centric tasks critical for the production of knowledge in astronomy. A component diagram of these tasks is introduced in Fig. 1, and we introduce each set of tasks in the following paragraphs.

Data acquisition and generation tasks. Data-centric challenges demand data that comes from scientific experiments, curated data archives or simulations. Quality assured data has to be processed enough for conversion to appropriate physical units for it to be used.

Data access and governance tasks. To use and re-use data, it has to be standardized, stored and indexed, enabling to be searched and filtered by either the initial project that demanded it, or others that require it.

Data analysis tasks. Data obtained from curated systems or from simulations or observations is analyzed (in real-time or not) to get new knowledge from it. The process does not end with this task, new data and insights may be ingested in curated systems and made available for other users.

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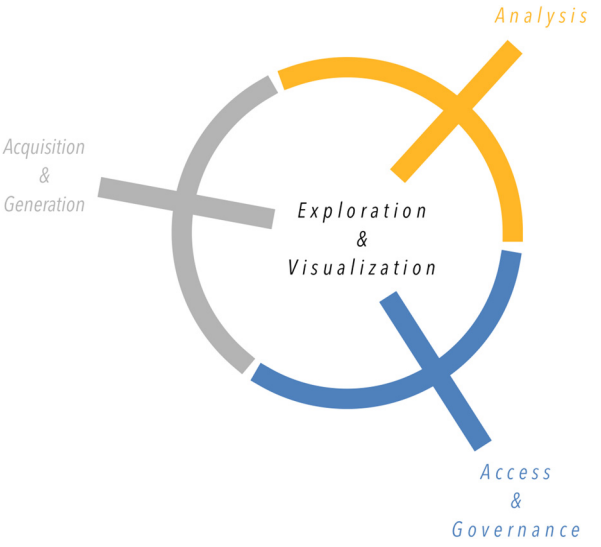

Figure 1. data-centric tasks in astronomy

Data exploration and visualization tasks. In performing each of the tasks above, exploration and visualization of the data is required, at minimum to enable humans work with it, at more sophisticated levels to enable discovery.

4. Conclusion

As mentioned before, over 2017 we worked with communities across sectors identifying opportunities to achieve the program mission of growing Chilean Digital Economy, using Astronomy data-centric tools. The DO vision emerged as an investment able to achieve this mission, and we will proceed to a next step of design of the DO throughout 2018, aiming to start its implementation in 2019.

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