

*Visualization of Archeological Data
with
the Astronomical Objects*

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Monuments, Art, and Human B
Out of Eurasia @Teotihuaca
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We've often been asked:

**How people of the ancient civilizations
see the astronomical objects?**

**Is there any relationship between the archeological
structures and the positions of stars?**

These are good questions and worthy of an answer.





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- Who am I?

Brief self-introduction

- Astronomy in the ancient world

What astronomy good for?

- Data driven discovery

The importance of image visualization



Who am I?

Kaz (Kazuhiro) Sekiguchi

Executive Advisor to the Director General and
Professor of Research Enhancement Strategy Office,
National Astronomical Observatory of Japan (NAOJ)

I am an astronomer:

Ph.D. in Astronomy & Physics from New Mexico State University.

- One of the pioneers using entirely archival data for research in the modern history of astronomy .

Senior Researcher at the SAAO (1987-1994).

- Obtained the first spectrum of Super Nova 1987A

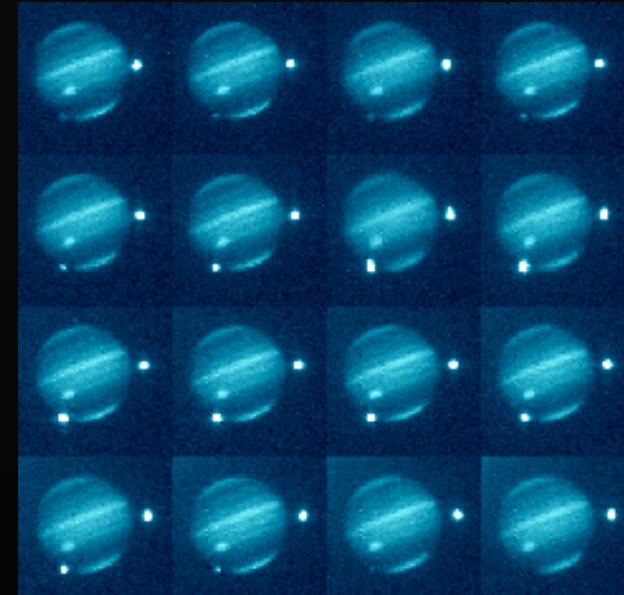
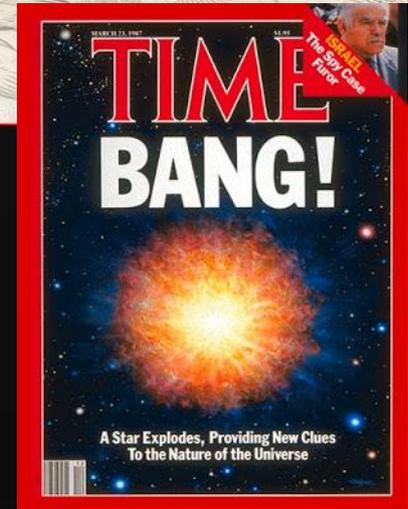
- Observer of the first impact images

of comet Shoemaker-Levy 9 with Jupiter

Associate professor at the NAOJ (1994 - 2007).

Professor at the NAOJ (2007 ~)

My area of specialization is observational astronomy.



Astronomy in the Ancient World

Astronomy is the oldest of the natural sciences, dating back to antiquity, with its origins in the religious, mythological, and astrological practices of the ancient civilizations.



Egyptian Sun god "Ra"

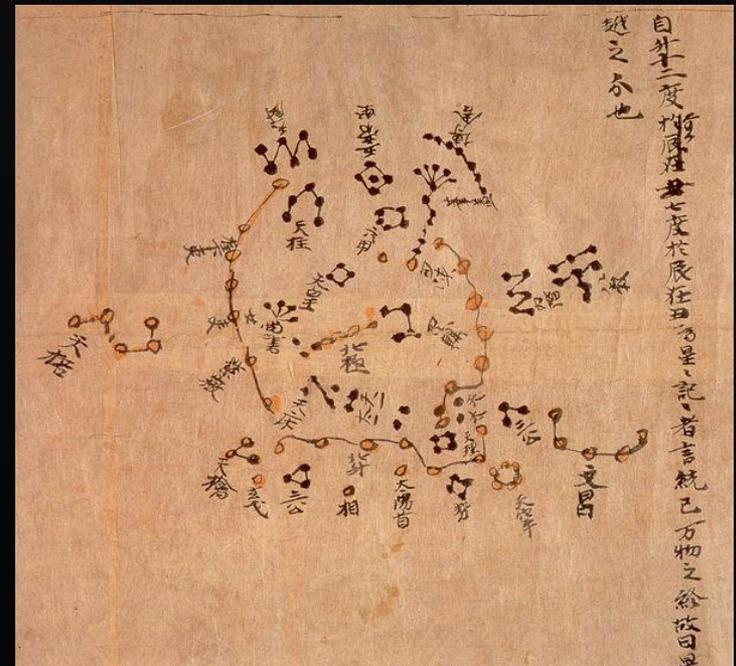


Egyptian Moon god "LAH"

Astronomy in the Ancient World

Early astronomy involved observing the regular patterns of the motions of visible celestial objects, especially the Sun, Moon, stars and naked eye observations of the planets.

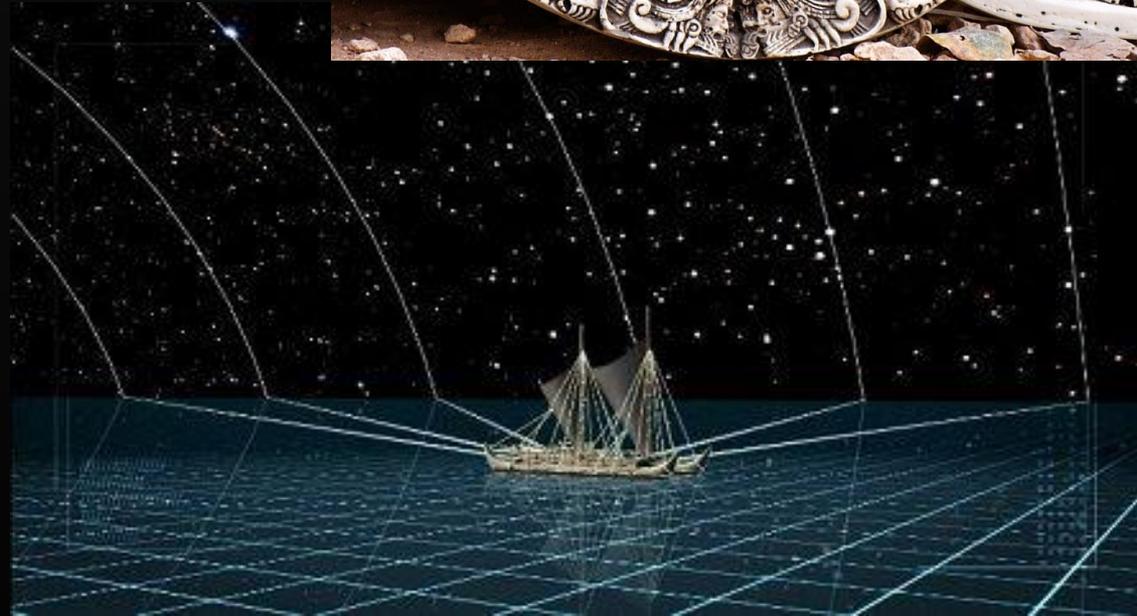
The changing position of the Sun along the horizon or the changing appearances of stars in the course of the year was used to establish agricultural or ritual calendars.



Calendar and Navigation

Sophisticated calendars were developed by measuring positions of the astronomical objects.

The ancient navigator was able to determine his latitude by observing the height of the sun during the day and the star at night.





Astronomy is the Oldest of the Sciences

Astronomy is the oldest of the sciences in a simple taxonomic sense – such as recording eclipses, comets, or elongations of Venus for astrological purposes, as in Babylon and ancient China.

- **Astronomy was the first science to develop a mathematical and geometrical foundation**
- **Astronomy was also the first science to develop sophisticated instrumental procedures**

(These gave astronomy a firm basis for the collection and verification of precise data.)

Greek Astronomy

Aristotle made observations of the Moon during an eclipse. He said that the circular shadow that the Earth cast on the Moon during an eclipse proved that the Earth was a sphere.

The ancient Greek philosophers, such as Aristotle and Ptolemy, assumed that the Sun, Moon, planets and stars circled the Earth. Established “the **geocentric model**”.

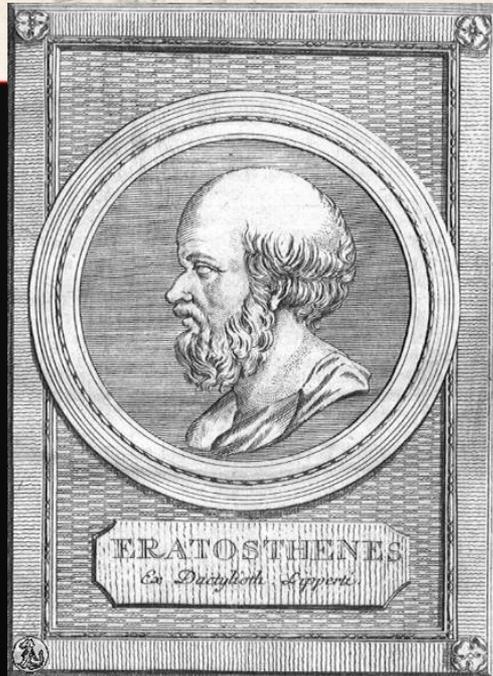


http://www.astroarts.co.jp/special/20040505lunar_eclipse/index-j.html

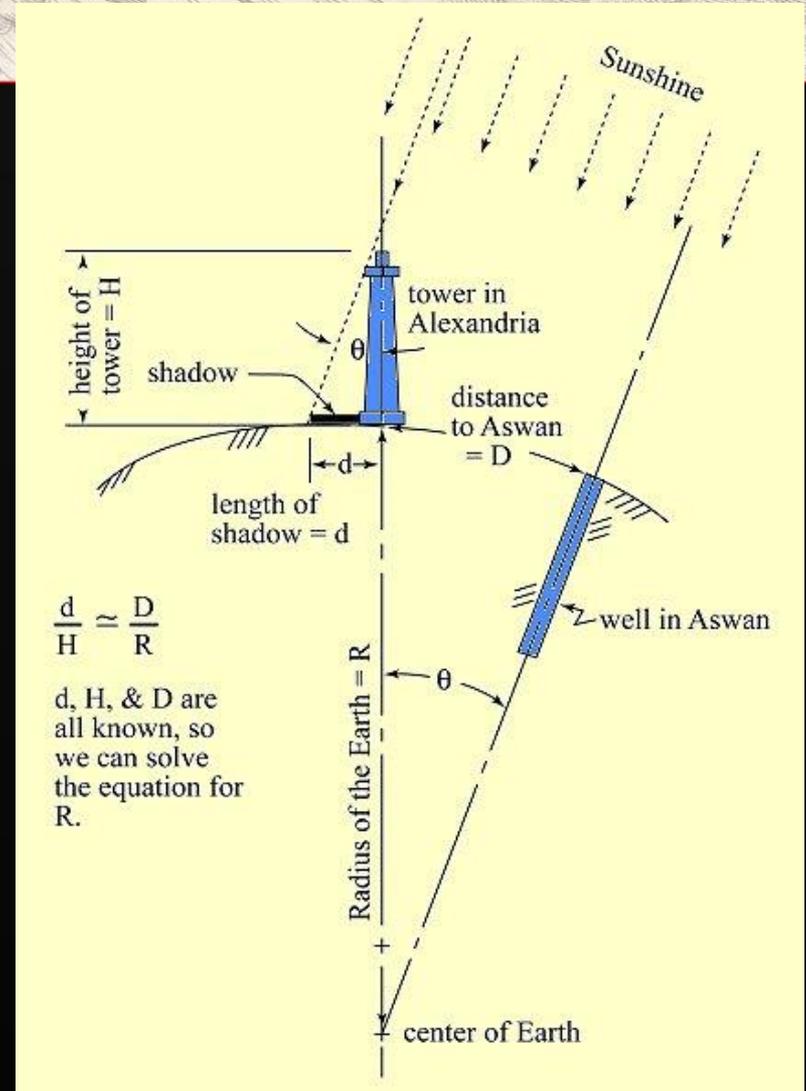


<http://www.astron.pref.gunma.jp/kyozai01/tendou/image/ptolemaios.jpg>

Greek Astronomy



Eratosthenes calculated the circumference of the Earth by using a measuring of shades at Aswan and at Alexandria.



A historical astronomical chart or star map. On the left, a detailed engraving of a horse's head is shown, with several stars marked by small star symbols and faint lines connecting them. On the right, a winged figure, possibly a cherub or angel, is depicted with large, feathered wings and a human-like face. The background is a light-colored grid or map of the sky.

Ancient Astronomers



Ancient Astronomers



A historical astronomical chart or star map. On the left, a horse's head is depicted, with several stars marked on its face and neck. On the right, a winged figure, possibly a cherub or angel, is shown with large, detailed wings. The background is filled with various stars and constellations, some labeled with letters and numbers. The title "Alignment with Sky" is overlaid in blue text.

Alignment with Sky

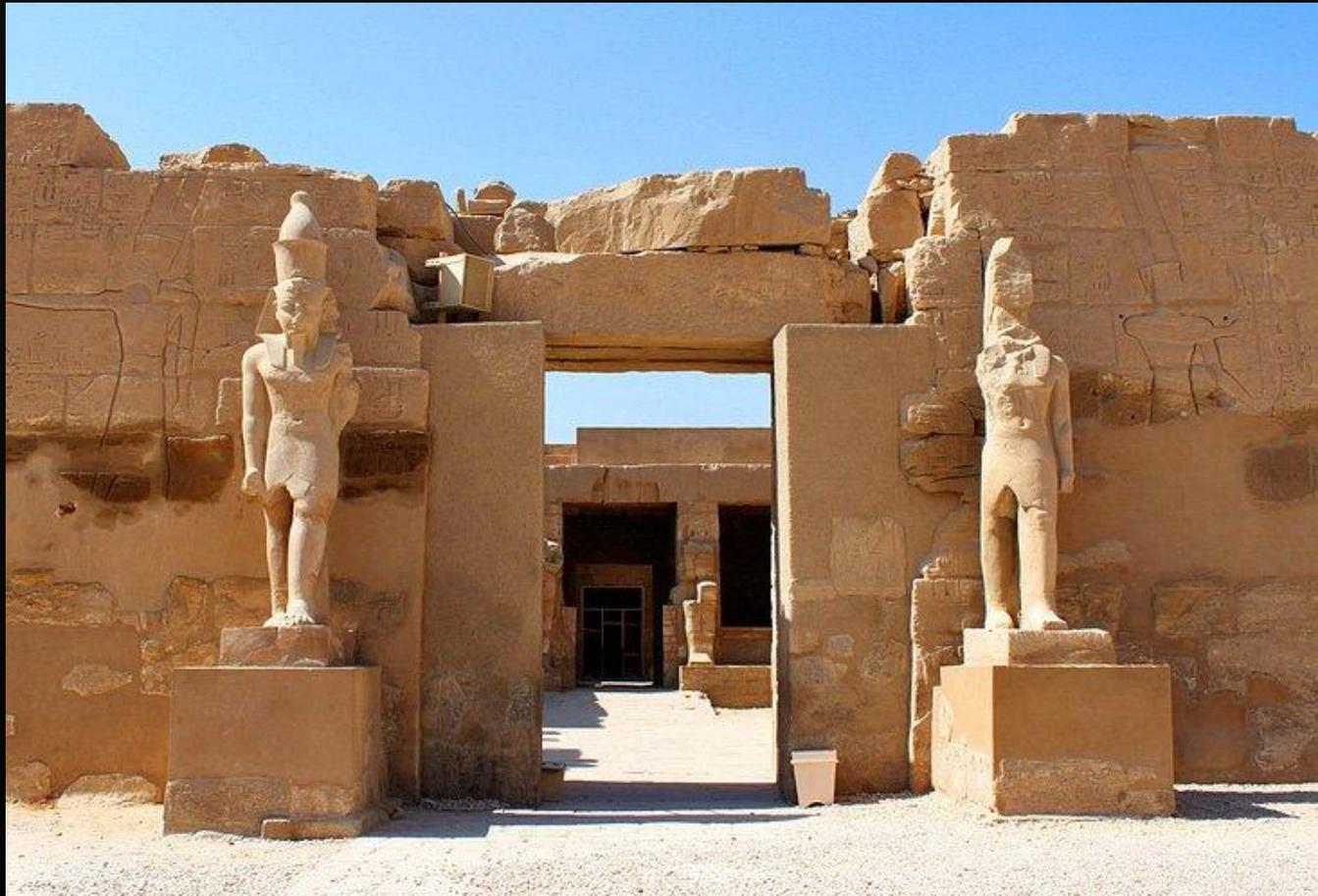
A photograph of the Great Pyramids of Giza in Egypt at night. The pyramids are silhouetted against a dark, starry sky. The Milky Way galaxy is visible, stretching across the sky from the bottom left towards the top right. The foreground is a sandy desert landscape.

Pyramids aligned with Polaris (the North Star)



Alignment with Sky

Temple Amun-Re at Karnak has a passage that is only illuminated by the mid-winter's rising sun.



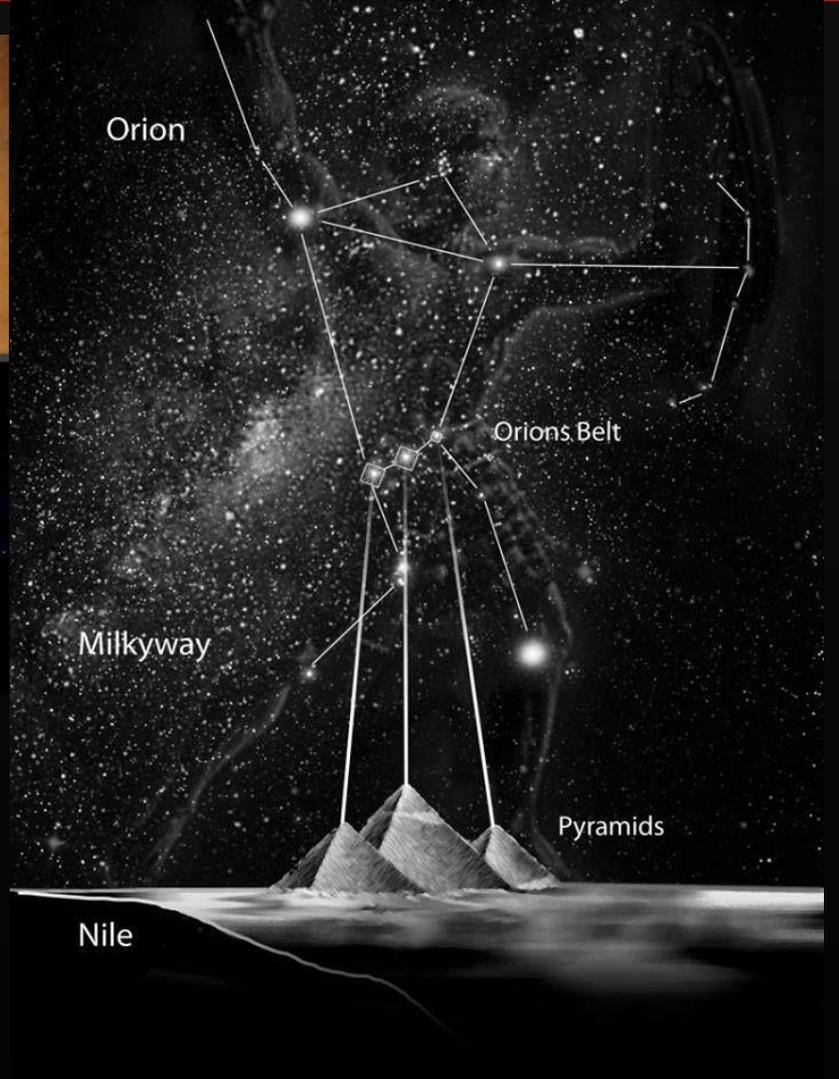
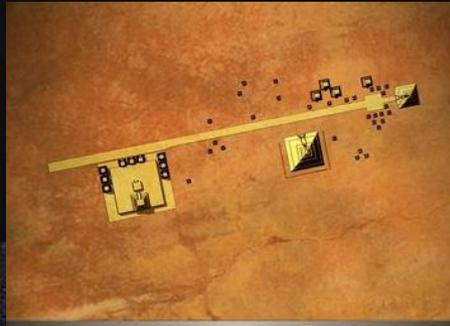


Alignment with Sky

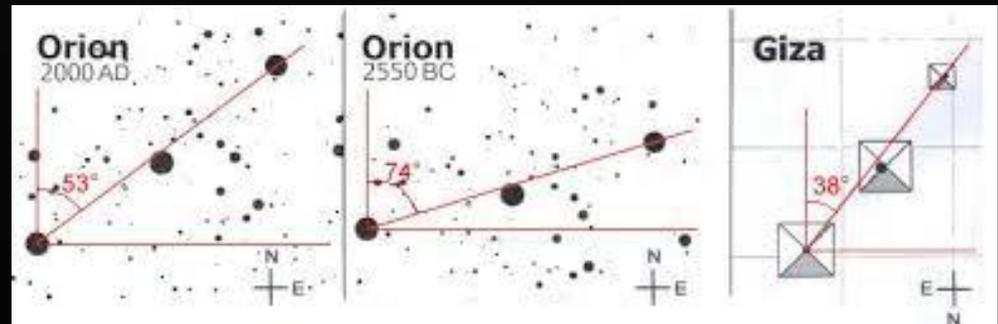
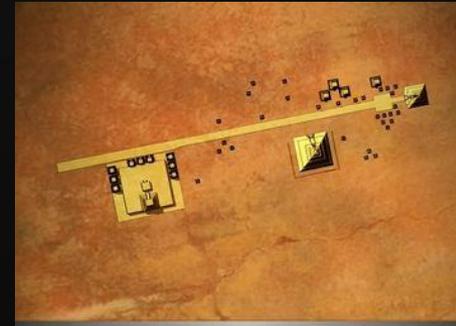
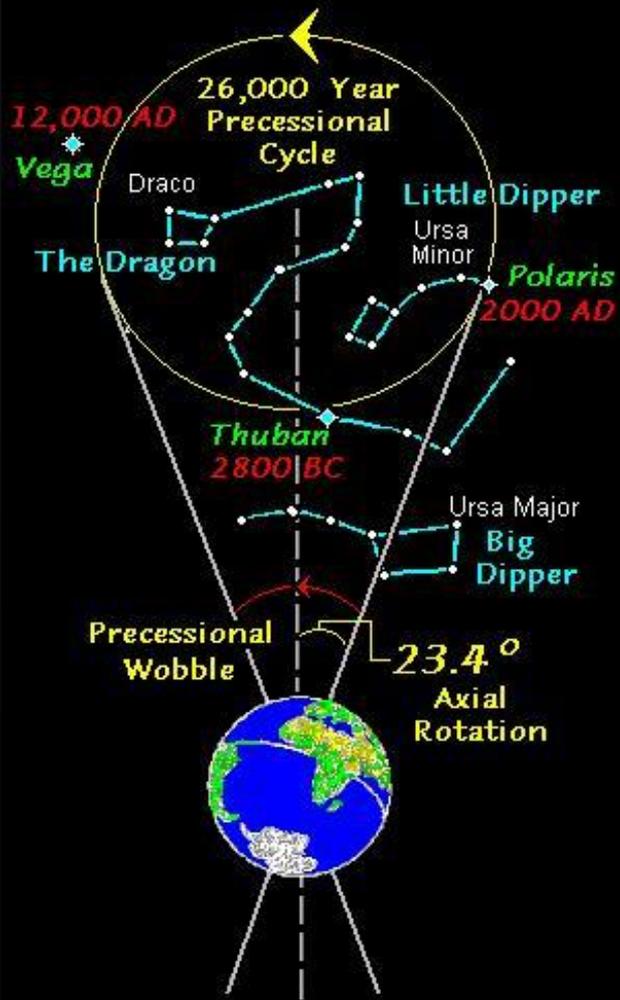
The Pyramid of Kukulcan twice a year creates a shadow that looks like a snake. It happens twice in a year when the length of night is the same as length of daylight.



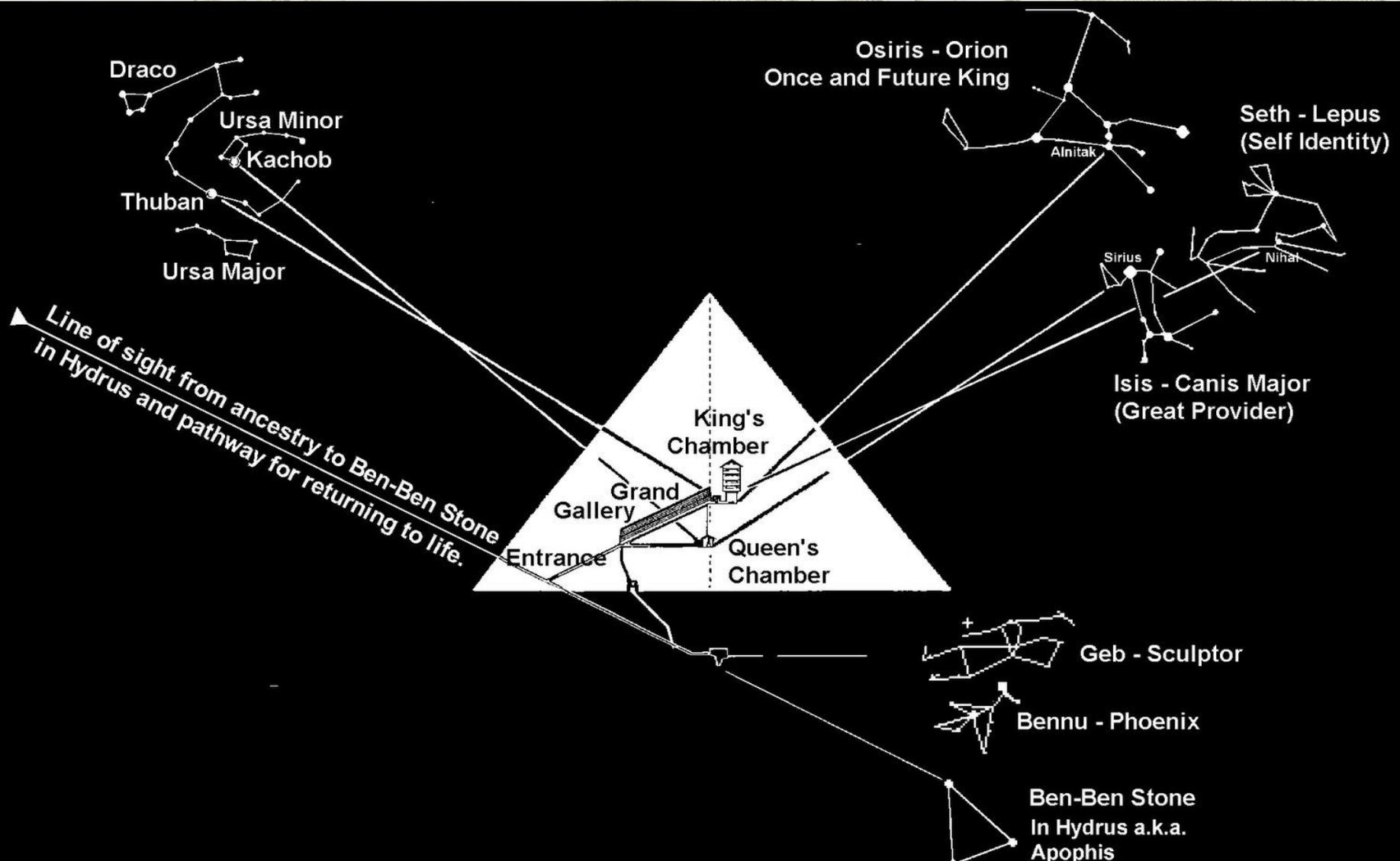
Alignment with Sky



Alignment with Sky

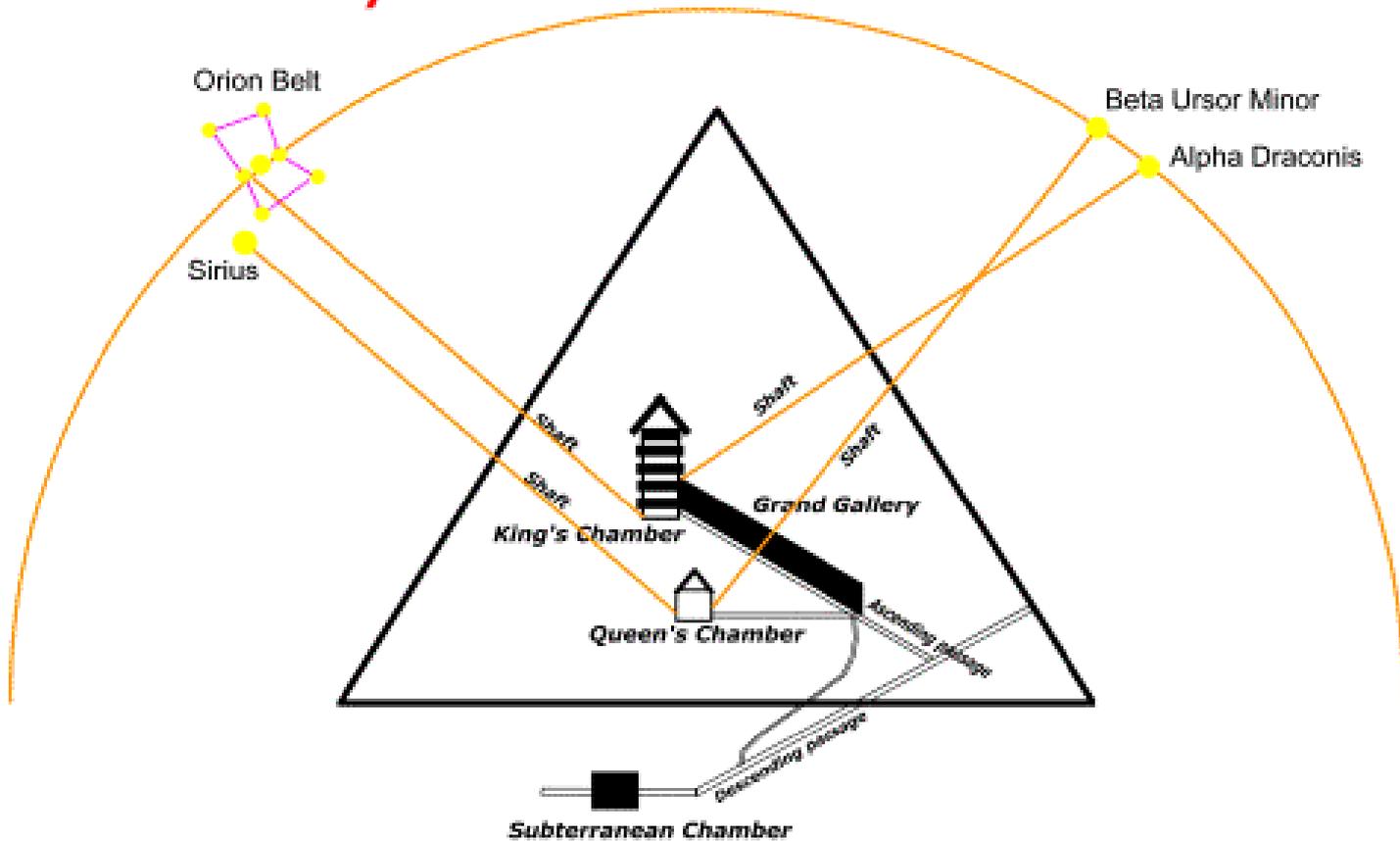


Alignment with Sky



Alignment with Sky

Sky over Giza 2500 BC



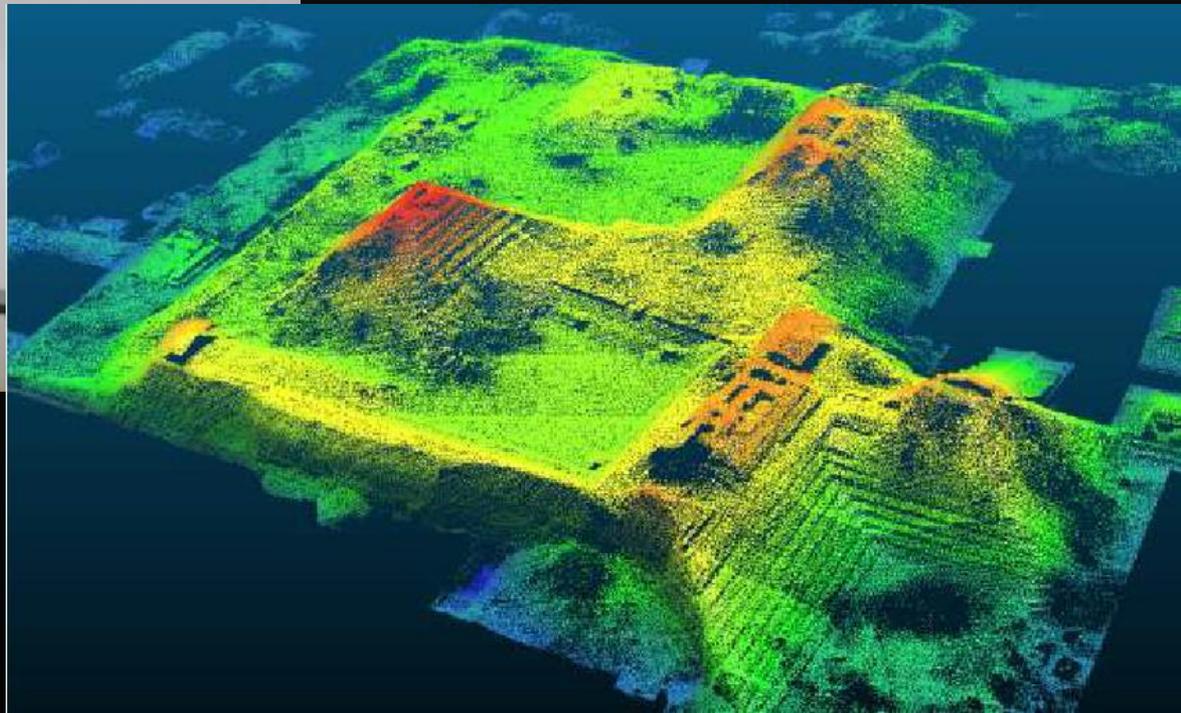


Data Visualization

Visualization allows us to feel, directly, how the people of early civilization perceive their environments and how they might develop their concepts of the “World”.



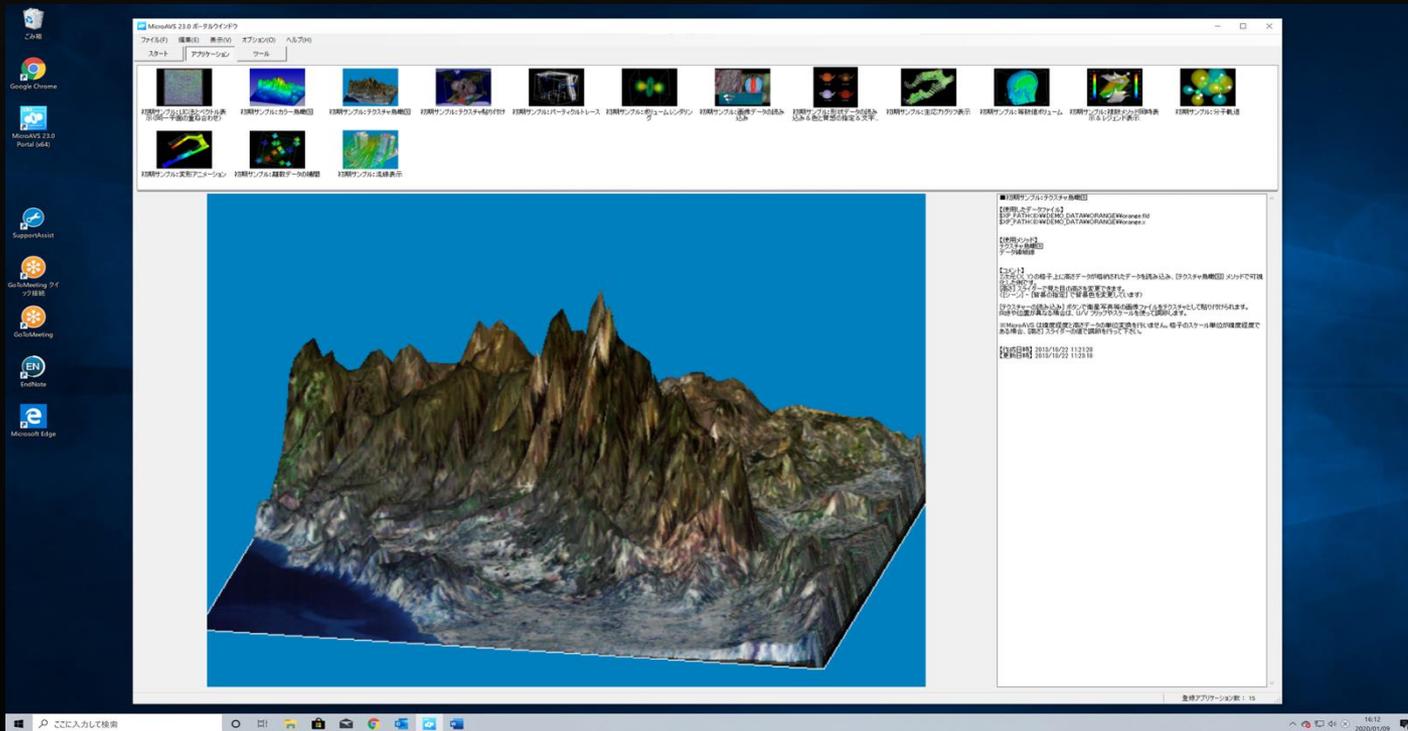
3D archeological data
Astronomical data projection



Positional data of the observer
Background topographic data

Data Visualization

We use MicroAVS for the de-fact visualization software of our three-dimensional (3D) archeological data with the astronomical objects. MicroAVS can combine different data types such as CAD data (archeological structure data) and computational results (precession calculations of astronomical objects) and display it on a single screen.

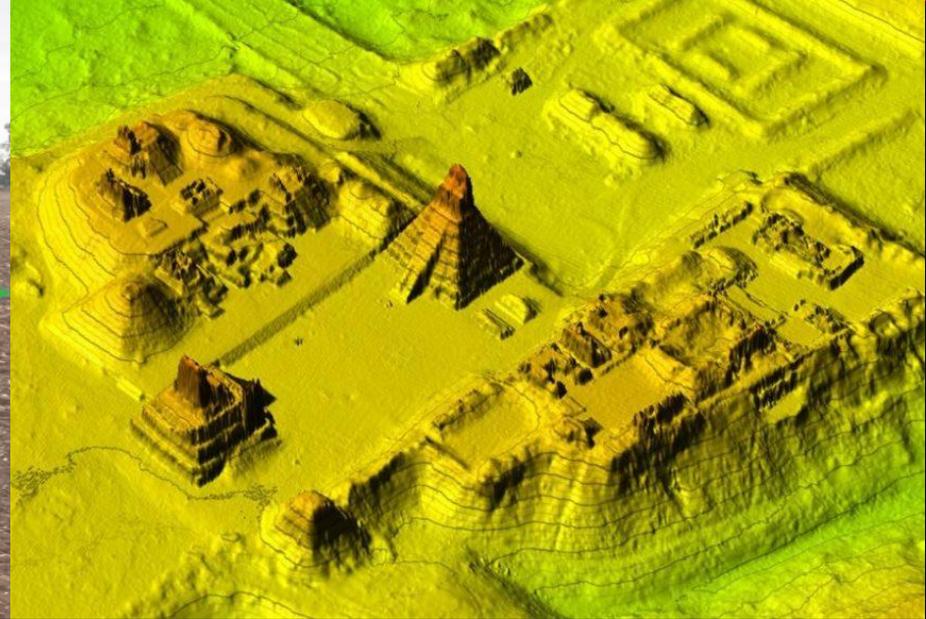
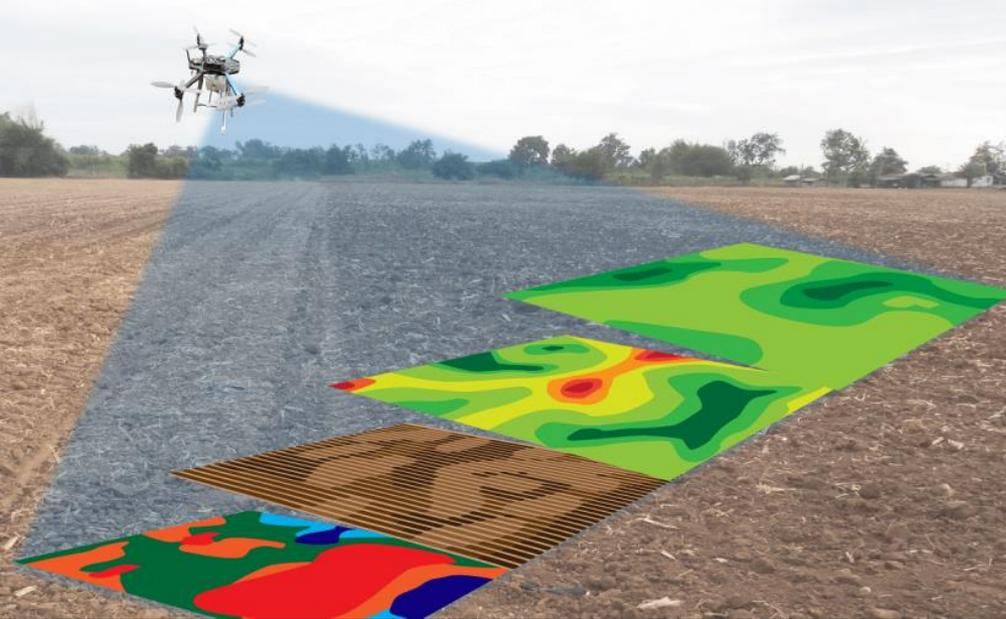


Data Driven Discovery

Measured data are the source of
archeological discovery
and
knowledge!



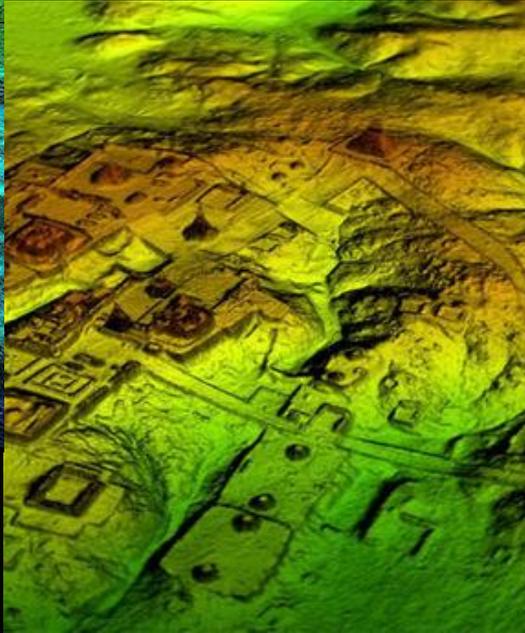
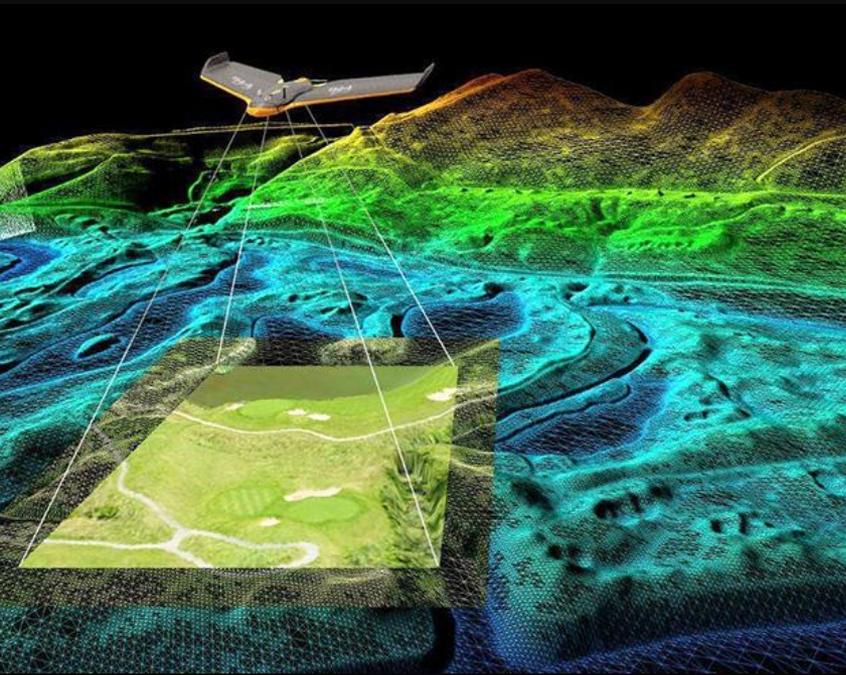
Data Driven Discovery



The tools of anthropology and archeology continue to change and evolve as new questions need to be answered, bringing with those changes a number of technological challenges. In response to those challenges, the toolkit of the archeology is also changing.

Data Driven Discovery

Anthropology and archeology are now entering the era of “Big Data” science!

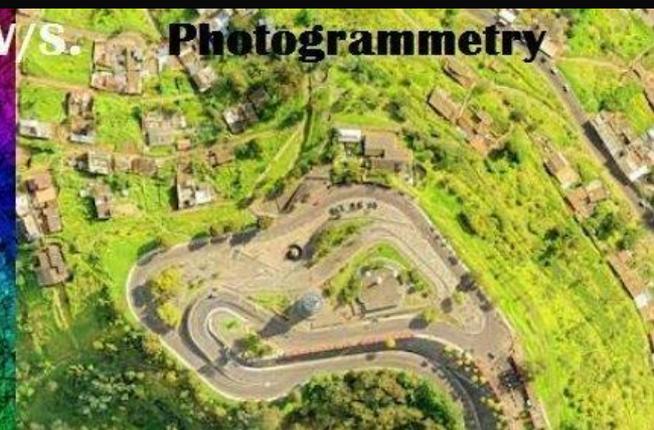
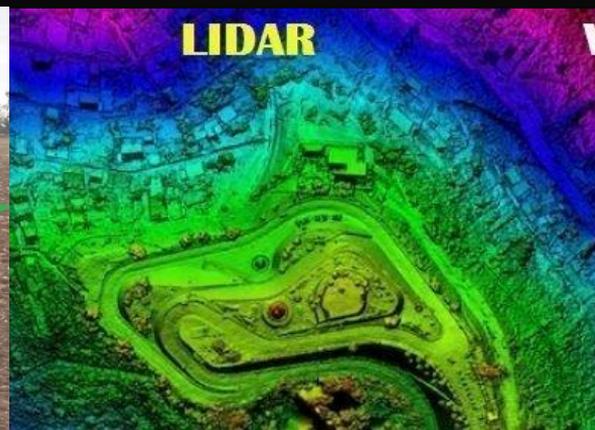
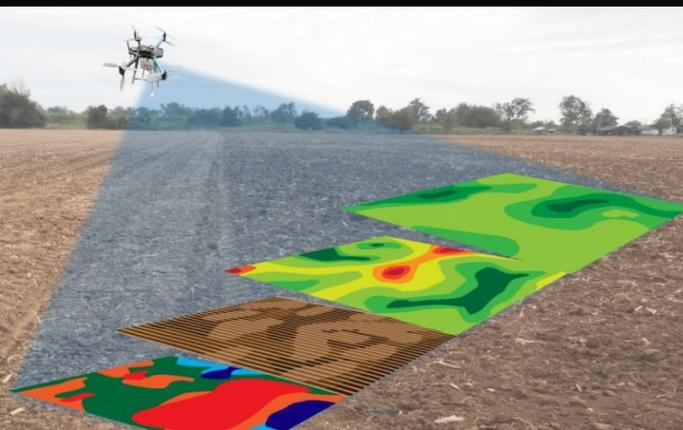


Data Driven Discovery

How do we explore our data in modern archeology?

How can we leverage the technologies that lie untapped at our fingertips?

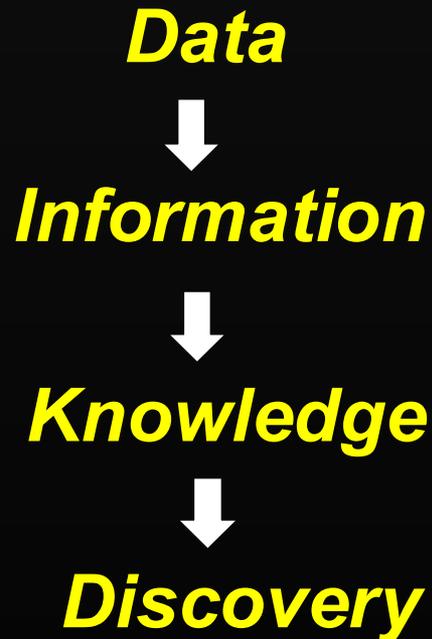
What discoveries lie dormant, waiting to be found in new parameter spaces of existing data?





Data-Information-Knowledge-Understanding Abstraction Hierarchy

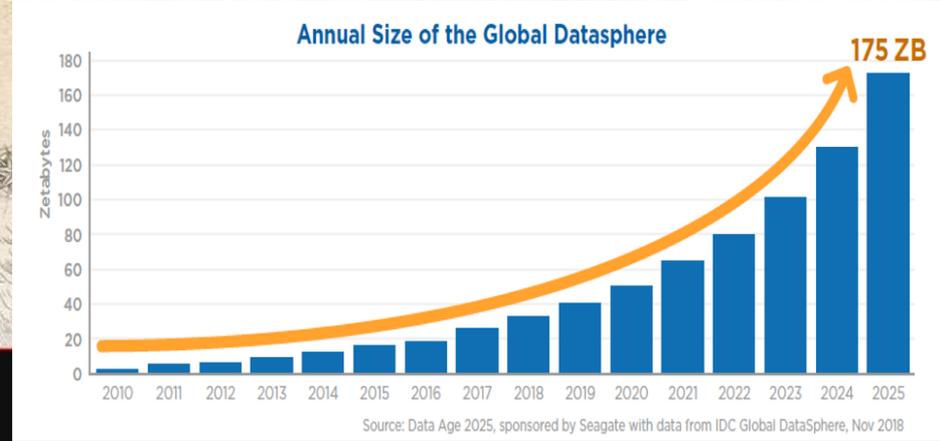
Knowing how to mine, analyze, visualize, and derive scientific knowledge from large complex data collections are essential skills for future archeological research.





data-information-knowledge-understanding abstraction hierarchy

At the highest level of **data abstraction** is the *scientific understanding* that scientists derive from *data*, *information*, and *knowledge*. Among the four levels of **data abstraction**, *scientific understanding* is the hardest to capture in a structured, searchable form. But it is *scientific understanding* that all scientists aim to achieve and to make fundamental contributions to.



What is Fundamentally New Here?

The information volumes and rates grow exponentially

Most data will never be seen by humans

A great increase in the data information content

Data driven vs. hypothesis driven science

A great increase in the information complexity



There are patterns in the data that cannot be comprehended by humans directly.

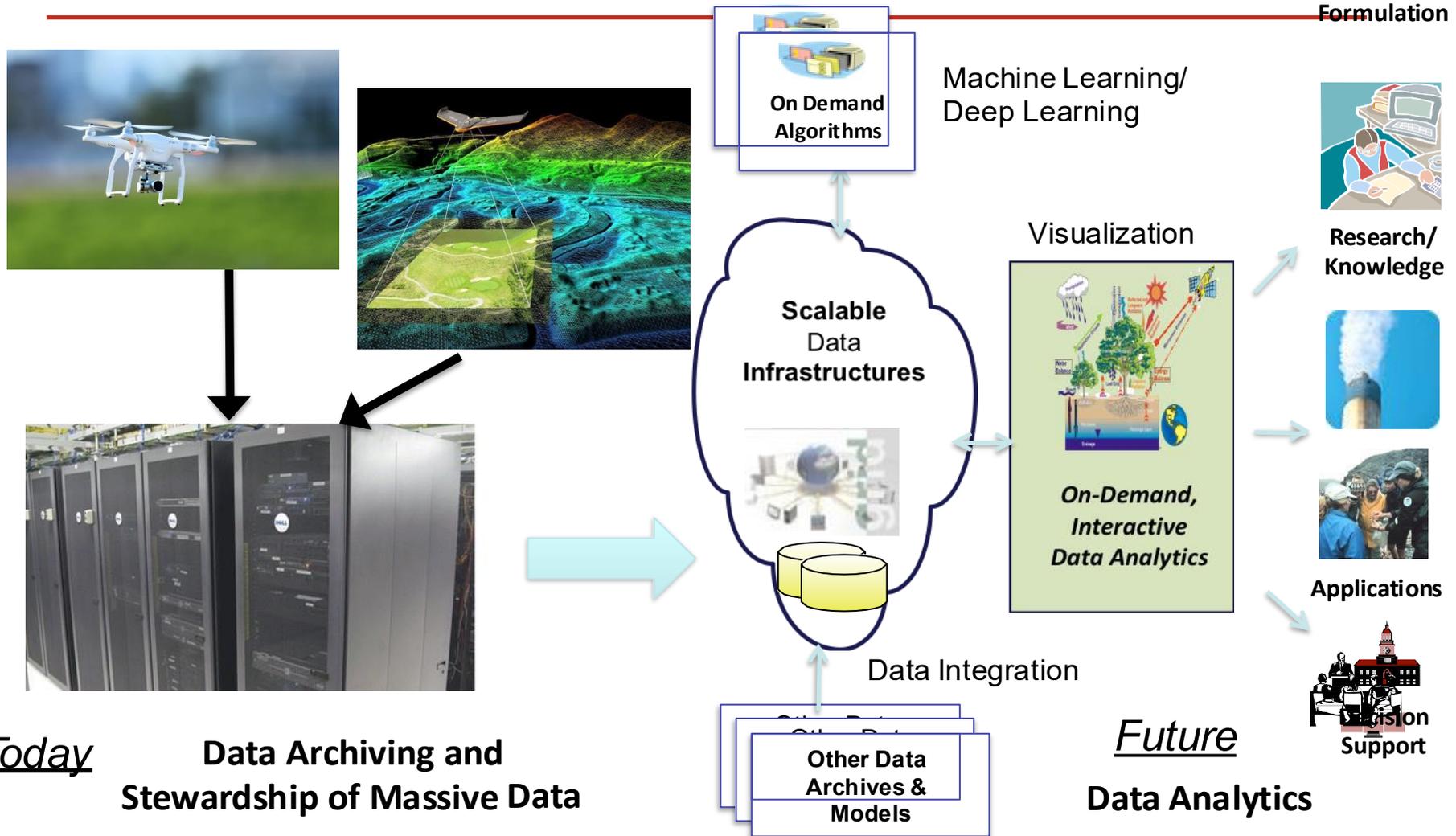


Big Data

**“Big Data is like teenage sex:
everyone talks about it,
nobody really knows how to do it,
everyone thinks everyone else is doing it,
so everyone claims they are doing it...”**

Dan Ariely

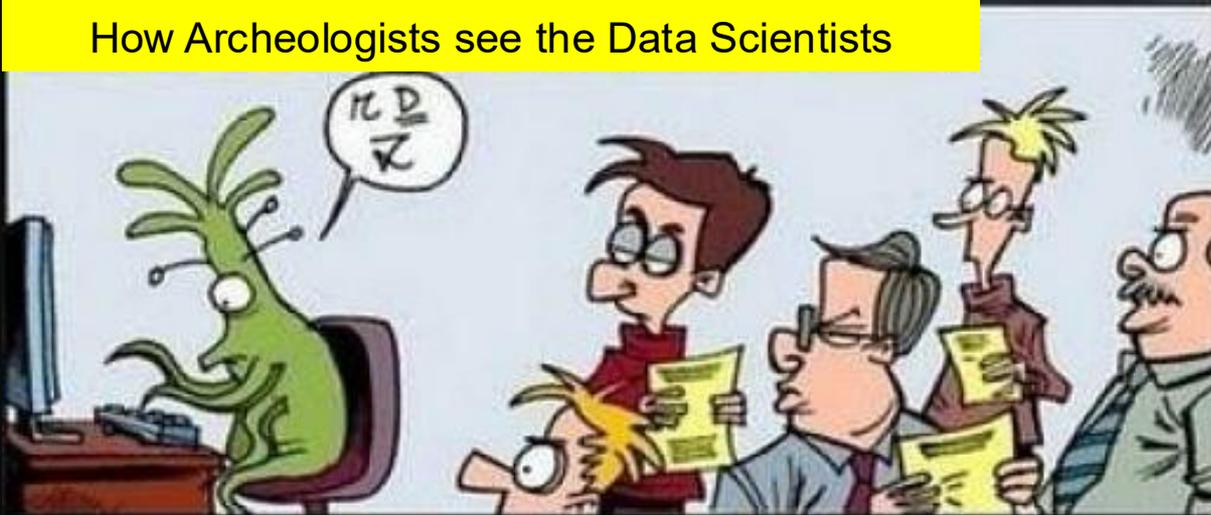
Expanding to Data-Driven Analytics to Enable Archeological Science



Reducing Data Wrangling: "There is a major need for the development of software components... that link high-level data analysis-specifications with low-level distributed systems architectures."
Frontiers in the Analysis of Massive Data, National Research Council, 2013.



How Archeologists see the Data Scientists



How Data Scientists see the Archeologists





At Mt. Wilson. One day in the last Century with Edwin, Albert and Kaz.