INTO THE ZOONIVERSE

2019

THE ZOONIVERSE TEAM

2019

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THE ZOONIVERSE TEAM

THANK YOU!

Over the past decade, Zooniverse projects have led to many unexpected and scientifically significant discoveries, from the detection of a solar system containing exoplanets and four suns to the uncovering of a 17th-century Pop Tart recipe.

These discoveries and others would have been impossible if it weren't for you, part of our global community of nearly 2 million people who work alongside hundreds of professional researchers. The projects have produced over 160 peer-reviewed publications (see zooniverse.org/publications) and many open source data sets.

Since the launch of Galaxy Zoo in 2007, we've been determined to show that you don't need any specialized background, training, or expertise to participate in Zooniverse projects. Our goal is to make it easy for anyone to contribute in a valuable and meaningful way to real academic research.

This book highlights 40 Zooniverse projects selected from the more than 150 launched to date. We were keen to include a diverse range of projects, representing the variety of disciplines (astronomy, biomedical research, climate science, ecology, humanities, physics), organizations (colleges and universities, research institutes, government organizations), and projects which show images, video, and audio, and ask for tagging, marking, or transcribing. There are many fascinating

projects we weren't able to include this year. We hope to continue creating these books annually, highlighting a whole new set of projects and discoveries each year.

Four volunteers (Mark Benson, Caitlyn Buongiorno, Leslie Grove, and Andrew Salata) wrote text, vetted it with research teams, and designed the book in collaboration with Zooniverse designer Becky Rother. We're so thankful to them for their time and efforts in assembling this lovely homage to the Zooniverse Year of 2019.

We're also thankful to the Zooniverse's host institutions: the University of Oxford, the Adler Planetarium, and the University of Minnesota — Twin Cities. This special mix of expertise in research, public engagement, and modern web development supports an amazing community of volunteers and dedicated research teams using the Zooniverse platform. These collaborations are the true strength of Zooniverse: the *people* in people-powered research.

Laura, Becky, Helen, and the Zooniverse Team

Becky Rother
Zooniverse Designer,
The Adler Planetarium

Dr. Helen Spiers
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VP of Citizen Science,
The Adler Planetarium

2019 FEATURED PROJECTS

A selection of projects from the more than 150 beta-tested, launch-approved projects available to Zooniverse volunteers in 2019
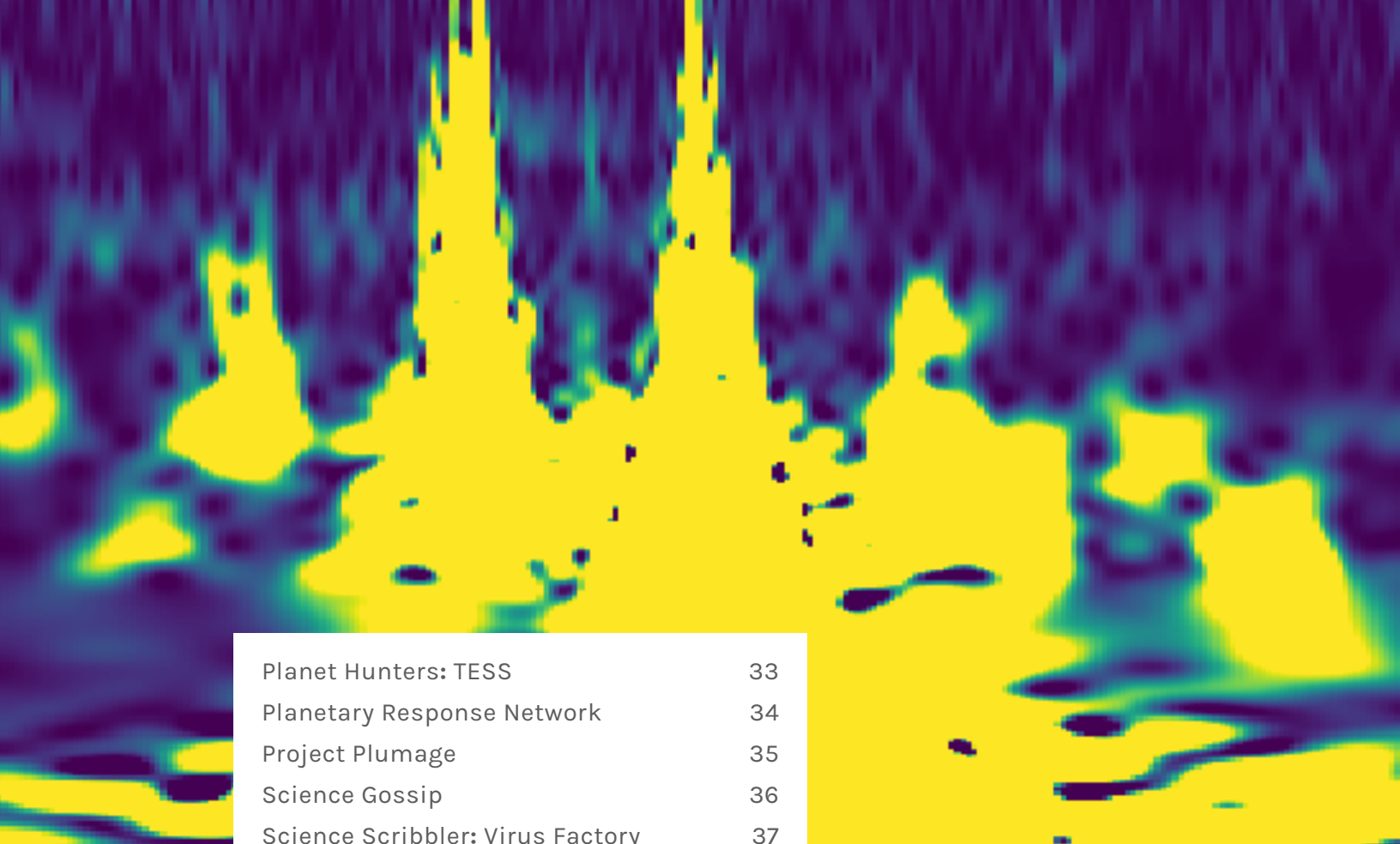

ABOVE, SNAPSHOT SERENGETI, P. 41

BELOW, SCRIBES OF THE CAIRO GENIZA, P. 39

GRAVITY SPY, P. 24

ZOONIVERSE CHALLENGE!

Look for the square at the bottom of each project page. We invite you to **classify on each project and keep track of your progress by checking each box.** Experience first hand all the different types of research that are happening on Zooniverse.

A quick way to find each project is to go to zooniverse.org/projects *and type the project name in the search bar. It's possible that some projects may be complete or close to completion by the time this book is published, so just skip them if that's the case.*

1961 CENSUS

The "Swinging Sixties" were a period of change in the U.K. Unbridled by conscription or a looming world war, the rising generation of young adults had the freedom to challenge cultural and political norms and to push the boundaries of musical and artistic expression.

YEAR LAUNCHED
2018

SUBJECTS
2,107,600

CLASSIFICATIONS
5,678,981

Ideally, data from population censuses conducted in the U.K. at either end of the decade in 1961 and 1971 would be used to research these dramatic societal changes across the decade. However, while census data from 1971 has been digitally accessible for years, 1961 census data has remained sequestered in outdated print and image formats, barring historians today from using modern digital analysis techniques to study the demographics of this dynamic decade.

Advanced Optical Character Recognition (OCR) and quality assurance techniques were initially used to process over 140,000 digital images of aggregate data produced for small areas in England and Wales from the 1961 census collection.

Zooniverse volunteers then stepped in to correct errors identified in a small proportion (approximately 3%) of the data by providing 5.5 million classifications over the 11 months in which the project was active. Through the contributions of citizen scientists via Zooniverse, this crucial dataset is now accessible to researchers in a convenient and searchable digital format.

1961 Census is a collaborative project between the University of Salford's Pattern Recognition and Image Analysis Research Lab (PRImA) and the Office for National Statistics (ONS). It is anticipated that the digital version of the small area data will be released for open use by the ONS by the end of 2019.

CHALLENGE!

AFRICAN AMERICAN CIVIL WAR SOLDIERS

African Americans serving in the military are part of a celebrated legacy. From Crispus Attucks, one of the first casualties of the Revolutionary War, to the legendary Tuskegee Airmen, African Americans have fought for America's independence and democratic ideals. African American Civil War Soldiers aids in memorializing the history of military service by transcribing the United States Colored Troops (USCT) records.

YEAR LAUNCHED
2018

SUBJECTS
63,726

CLASSIFICATIONS
193,032

The goal is to increase the historical database and to provide ancestral information for descendants researching their genealogical trees. According to the project's principal researcher, John Clegg, "By visiting our project and transcribing these men's records, you can help preserve their memory and build an invaluable database for African American genealogists and historians."

The information volunteers transcribe gives insight into the lives of the African American veterans during and after the Civil War. The project is comprised of records from the Compiled Military Service Records and the Pension Records in the National Archives in Washington, D.C. These records were photographed to preserve them and later digitally stored. These records are part of the Zooniverse project to aid in filling in the details of almost 200,000 African American Civil War soldiers. The project's end result is to add the transcribed records to the searchable database for historical and personal genealogical research. Researchers can access the database hosted by the African American Civil War Museum.

Last year, 40,000 records were transcribed. Not only is America's historical record enhanced, but the project will allow today's descendants to learn how an ancestor played a role in shaping our nation during a turbulent time in its short history.

ANNOTATE

When gazing at a piece of art, some may wonder at the inspiration behind it. AnnoTate is looking to answer that question and more. With the help of AnnoTate's transcription tool, volunteers are able to read and transcribe the personal papers, such as diaries and letters, that artists left behind along with their art.

The Tate Archive, the world's largest archive of British art, is the first fine arts organization to collaborate with Zooniverse. Together with thousands of volunteers, the project provides full text transcriptions of more than 50,000 handwritten documents, revealing the inspiration and stories behind some of the greatest British artworks of the last century. These works include those of Josef Herman, Barbara Hepworth, and Kurt Schwitters.

Much of what we know about the daily lives of people who lived over a hundred years ago comes from writings they left behind. AnnoTate volunteers encounter such insights through letters, notebooks, and sketches that provide a window into the lives, artistic methods and the creation of renowned works of art.

YEAR LAUNCHED
2015

SUBJECTS
29,098

CLASSIFICATIONS
255,144
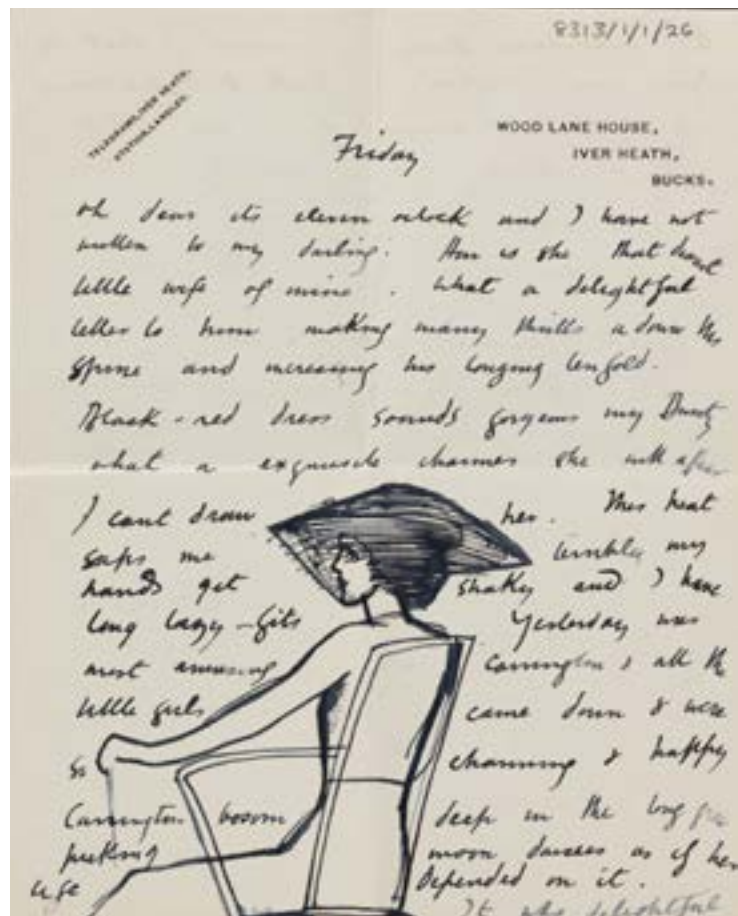
CREDIT: THE TATE ARCHIVES
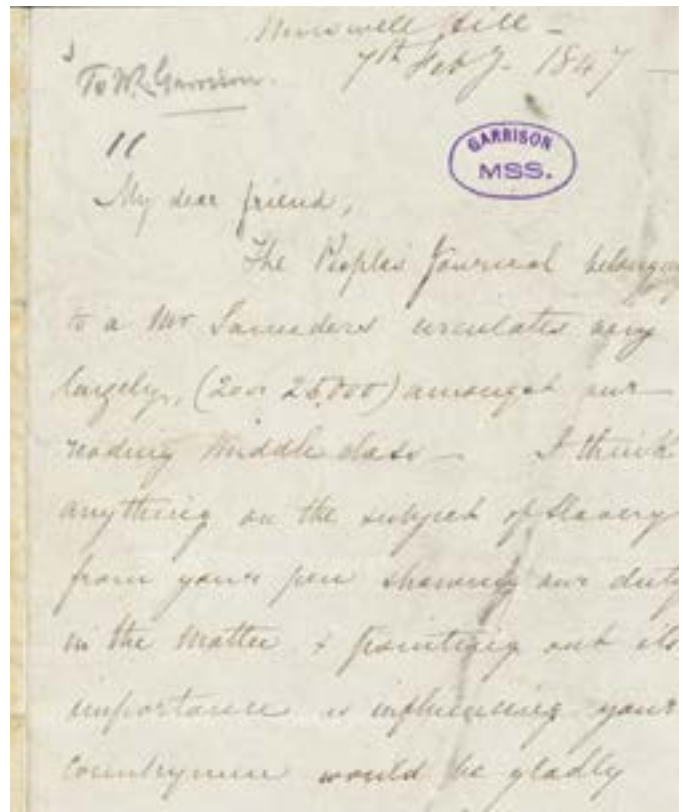
ANTI-SLAVERY MANUSCRIPTS

YEAR LAUNCHED
2018

SUBJECTS
4,801

CLASSIFICATIONS
80,660

The Anti-Slavery Collection at the Boston Public Library is one of the world's largest and most comprehensive collections of its kind. The collection contains approximately 40,000 documents and 35 years' worth of abolitionist literature including newspapers, pamphlets, books, and written correspondence between leaders of the anti-slavery movements in the United States, Great Britain, and Ireland.

Much of the collection, dating from the 1830s to the 1870s, was donated by descendants of prominent figures in the movement. The materials provide insight into the minds and lives of the forerunners of 19th century Abolitionism, while also touching on the rising women's rights movement.

Developed with funding from a National Leadership Grant from the Institute of Museum and Library Services, the project asks volunteers to transcribe scans of original letters from the library's expansive collection using a digital magnifying lens and a guide to calligraphy style and notation characteristic of the time period. The resulting transcriptions will allow the documents to be fully searchable by members of the public for the first time and provide invaluable material for digital humanities research methods like large-scale text analysis and natural language processing.

Through these efforts, the Boston Public Library is engaging the public with primary source material and providing increased access to cultural heritage materials, consistent with their motto: "Free to All."

ANTI-SLAVERY MANUSCRIPTS

CHALLENGE!
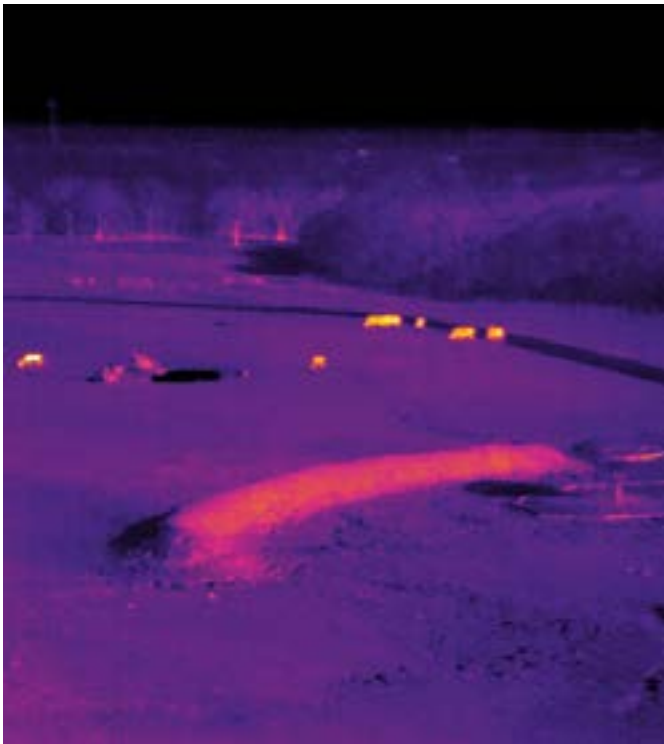
ASTRO-ECOLOGY

Astro-Ecology is a unique collaboration between astronomers and ecologists to help save endangered animals using drone imaging. By observing infrared light, ecologists gather data on animals that would otherwise be challenging to monitor.

YEAR LAUNCHED
2019

SUBJECTS
27,518

CLASSIFICATIONS
277,426

Astronomers can image the Universe in wavelengths beyond those the human eye can see, which allows them to gather data that would otherwise be invisible. In infrared or thermal images, the body heat of animals make them glow brightly, standing out from their surroundings and making it easy to identify them in a way their natural camouflage normally prevents. Using thermal drones, scientists hope to develop a program that can not only identify body heat signatures but differentiate between different species and potential poachers.

Poachers present one of the biggest threats to wildlife. With Astro-Ecology, it can be possible to find and catch poachers in real time, even at night when animals are more susceptible to the practice.

Beyond stopping poachers, Astro-Ecology also stands to advance scientists' understanding of these species by giving us a glimpse into their world. This glimpse will inform conservationists on the best ways to protect these vulnerable species.

It will eventually be possible for a computer algorithm to identify the different species and alert scientists to potential poachers. Before that can happen, the algorithm needs to be trained using a dataset created by Zooniverse volunteers. Together, astrophysicists, conservationists, volunteers, computer scientists, and engineers are ushering in a new tool for ecologists and conservationists that stands to revolutionize the way we understand and protect endangered species.
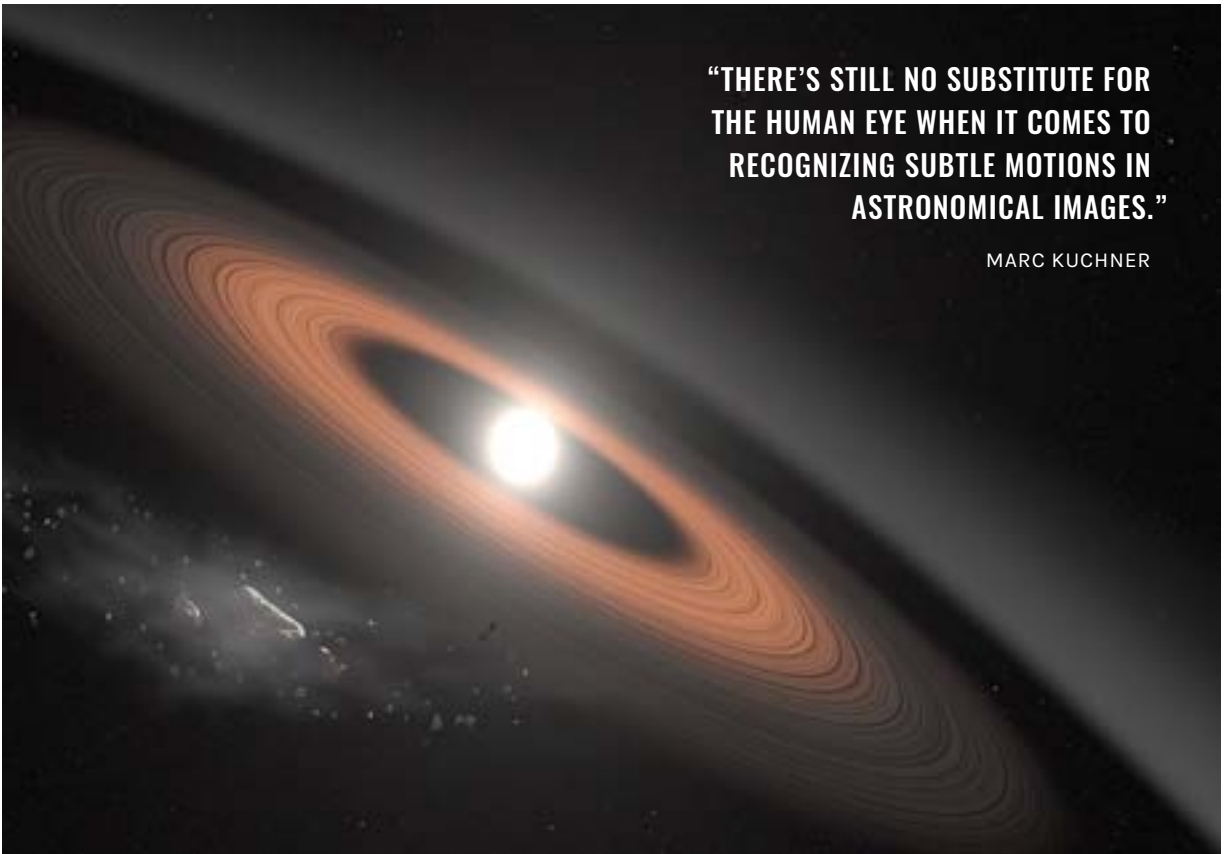
"THERE'S STILL NO SUBSTITUTE FOR THE HUMAN EYE WHEN IT COMES TO RECOGNIZING SUBTLE MOTIONS IN ASTRONOMICAL IMAGES."

MARC KUCHNER

BACKYARD WORLDS

What objects exist beyond the edge of our Solar System? We know very little about what lies beyond the orbit of Pluto, though astronomers have inferred that a population of cold balls of gas called brown dwarfs — some of them very much like the planet Jupiter — drifts through our Sun's backyard.

YEAR LAUNCHED
2017

SUBJECTS
1,137,093

CLASSIFICATIONS
6,243,397

Backyard Worlds: Planet 9 is searching for these brown dwarfs and for new planets that orbit the Sun, like the hypothesized ninth planet, by examining infrared images from NASA's Wide-field Infrared Survey Explorer (WISE) telescope. Even cold brown dwarfs and planets radiate some heat, and they also moved from image to image as WISE scanned the sky over several years. Volunteers watch a sequence of images to flag glowing, moving objects, finding objects for astronomers to study.

The project launched in 2017, and since then, volunteers and researchers have discovered more than 1,000 brown dwarf candidates and other surprises in our galactic backyard. Most recently, a volunteer found a record-breaking "crystal ball" white dwarf with a dust disk: an analog for the future of our Solar System. The oldest and coldest white dwarf with a dust disk — likely a remnant of an ancient, dead planetary system — it will help astronomers learn more about the life cycle of a planetary system like our own.
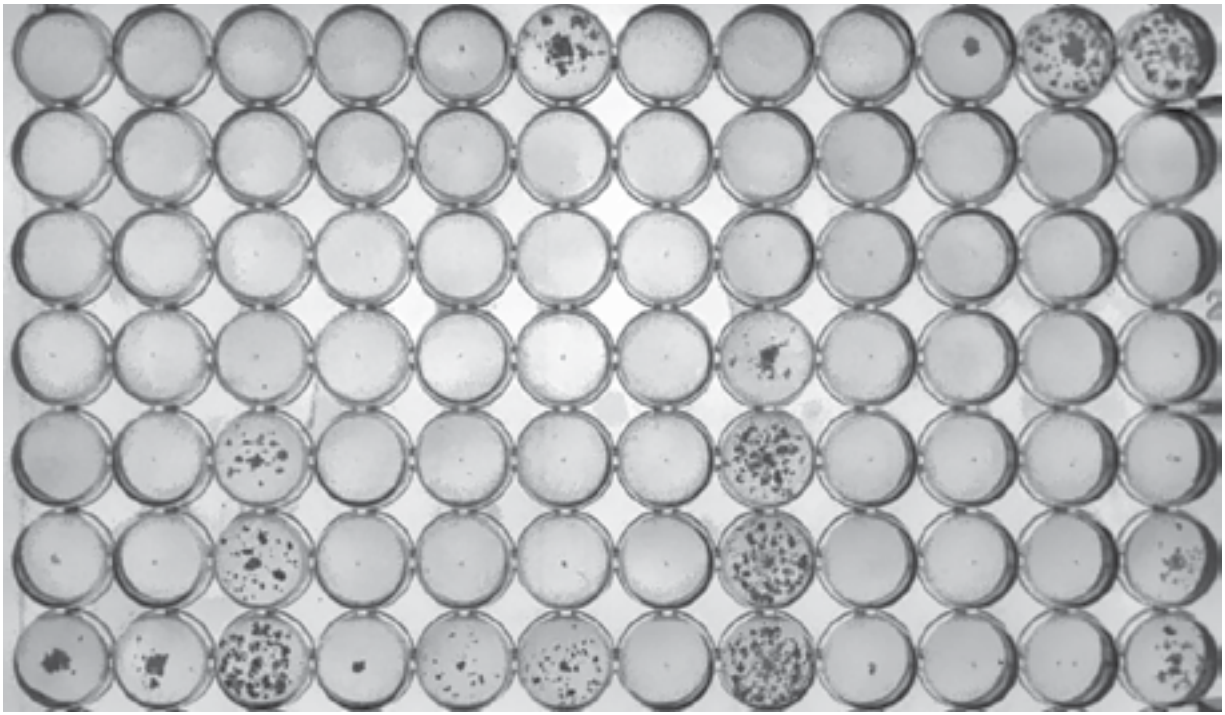
BASH THE BUG

The first true antibiotic, penicillin, was discovered in 1928 by Alexander Fleming, ushering in the age of antibiotics. But today, our usage has resulted in antibiotic-resistant bacteria. Doctors need to know which antibiotic or combination of antibiotics will be effective against every infection, particularly tuberculosis (TB), which, according to the World Health Organization (WHO), kills more people than any other infectious disease worldwide.

The bacteria that causes tuberculosis was discovered in 1882 and in 1993 TB was declared a global health emergency by the WHO. The system for determining the operative antibiotic to use in each case of TB involves taking a sample of the bacteria from the patient and testing different antibiotics to find the most effective one. This process can take up to a month, which severely limits recovery speed. Scientists are working to improve this process by instead sequencing the whole genome of the bacteria responsible for each infection and then, by looking up the effect of individual genetic variants in a published catalogue, rapidly predicting which antibiotics will be effective.

The aim of the Comprehensive Resistance Prediction

YEAR LAUNCHED
2017

SUBJECTS
113,591

CLASSIFICATIONS
1,575,083

for Tuberculosis: an International Consortium, or CRyPTIC, is to map all the genetic variants that confer resistance to a wide range of anti-TB drugs. Over 20,000 clinical samples are being screened using a 96-well plate containing 13 antibiotics, each present at a range of concentrations. Reading these plates is difficult; in 40% of cases the measurements are different between multiple experts and/or between experts and computer algorithms. To resolve these challenging cases, scientists have reached out to the public via Bash the Bug.

This project brings together volunteers from all around the world to help fight TB and ultimately decrease the chances of bacteria developing resistance to antibiotics.

> "YOU'LL HELP US UNDERSTAND HOW LEARNING AND OUTCOMES CHANGE WHEN PARTICIPANTS AND COMMUNITIES ARE INVOLVED IN MORE THAN THE DATA COLLECTION PHASE OF A RESEARCH PROJECT."
>
> CHARLES ELDERMIRE

BATTLING BIRDS

Do you enjoy watching birds? If so, Zooniverse invites you to join an exciting ongoing research project: Battling Birds from the Bird Cams Lab at Cornell University's Laboratory of Ornithology.

Whether you're new to bird watching or have enjoyed birds for a lifetime, Battling Birds welcomes you! Your task is to document bird behaviors recorded from the 24/7 livestream of the Cornell Lab FeederWatch Cam. As the name suggests, Battling Birds focuses on aggressive interactions between bird feeder visitors with specific attention to "displacements," or when one bird takes over the location of another bird at the feeder. Talk about angry birds!

When observing interactions from the recordings of the FeederWatch Cam, volunteers record the number of individuals from each species present and incidents where one bird intentionally ousts (or "displaces") another from its spot. In studying the datasets generated by Zooniverse volunteers, Battling Birds researchers can better understand the relationships between the diversity and abundance of species and the resulting behaviors between individuals while accounting for other factors such as rain and snow.

Battling Birds is funded by the National Science Foundation as part of the Bird Cams Lab which brings together cam viewers and scientists to co-create investigations that reveal new insights about birds.

YEAR LAUNCHED
2018

SUBJECTS
54,630

CLASSIFICATIONS
176,561

CHICAGO WILDLIFE WATCH

Living in a large urban environment can make one yearn for parks and other green spaces to enjoy nature. These areas are not only prime places for human residents to visit, but are also a beacon for wildlife sharing our urban areas.

YEAR LAUNCHED
2010

SUBJECTS
247,688

CLASSIFICATIONS
1,339,288

The diversity of wildlife coexisting in our urban spaces can surprise city residents. The goal of Chicago Wildlife Watch is to understand how urban populations can coexist with this wildlife. As urban areas continue to spread, these answers can help in conservation efforts.

The project has over 100 sites across Cook, Lake, DuPage, and Will counties and deploys motion-triggered cameras four times per year. Green urban spaces like city parks, forest preserves, golf courses, and cemeteries are selected. To attract the diverse wildlife, a scented pouch is placed in the location and a camera is set to photograph when any motion is sensed near the lure.

Once an image is taken, the process to identify the animal begins. Zooniverse volunteers help classify the wildlife in these images.

The Lincoln Park Zoo's Urban Wildlife Institute uses the monitoring stations to understand where Chicago's urban wildlife is located. The data from the images will provide a context for what habitats attract animals, how populations are changing, and how human population is affecting the areas animals visit.

In addition to understanding how human activity may affect wildlife populations and habits, the predator/prey dynamics of an urban environment versus a natural setting can also be analyzed. The data from this project will allow researchers to better understand the impact of urban areas on food and habitat sources for wildlife.

CHALLENGE!

CHIMP&SEE

It is thought that a major leap in the mental, physical, and cultural development of *Homo sapiens* was associated with increases in hunting, meat eating, and the use of tools. According to the fossil record, early hominids first used stone tools about 2.6 million years ago. Over time, the fossil record shows that stone tools evolved and, it is assumed, so did their use.

YEAR LAUNCHED
2015

SUBJECTS
269,273

CLASSIFICATIONS
262,721

The fossil record is not the only means available to study human evolution. Humans are primates and share similar abilities with one of our closest living relatives, chimpanzees: bipedal motion, tool use, social group living, language, and symbol use. Because of the close evolutionary relationship between our two species, researchers look to chimpanzees to study how we may have developed tool use and other behaviors.

Chimp&See is part of the Pan African Programme: The Cultured Chimpanzee (PanAf), based out of the Max Planck Institute for Evolutionary Anthropology. The goal of the project is to understand how evolutionary changes have contributed to the behavior and cultural diversity of chimpanzees.

Volunteers for Chimp&See watch videos from camera traps located in 40 different chimpanzee habitats and annotate the species and behaviors they observe. The resulting data will help researchers understand how chimpanzee behavior varies in different environments. These findings will help scientists understand what is driving chimpanzee evolution, and possibly provide a glimpse into how early human behavior evolved based on tool use and ecological changes.

CRIMINAL CHARACTERS

First colonized as an open-air prison for transported British criminals in the late 18th century, Australia has a complex history. Some of the transported convicts continued to commit crimes upon arrival, escaping into the bush and surviving by robbing passers-by — the start of a uniquely Australian crime known as bushranging.

YEAR LAUNCHED
2019

SUBJECTS
41,938

CLASSIFICATIONS
44,691

For years, the figure of the criminal was a divisive one for Australians. To some, convict ancestors were a shameful secret and bushrangers violent ruffians; to others, convicts were victims of an oppressive system who overcame tremendous hardships to become founders of a nation and bushrangers were heroic resistance leaders and symbols of Australia's anti-authoritarian spirit.

With the help of modern analytical methods and the University of Technology Sydney, Criminal Characters is shedding new light on who Australia's "criminal" predecessors actually were.

Criminal Characters is transcribing tens of thousands of booking records of individuals imprisoned in Australia from the 1850s to the 1940s. This period marked the transition from the end of the convict era through the beginning of World War II and oversaw dramatic political, economic, and social events.

Yet little is known about how this affected the lives of those brought before the justice system in Australia.

Criminal Characters aims to take a hard look at these records and to consider the socio-historical factors at play when these individuals entered the prison system in the midst of social change, economic depression, and all-out global war.

What type of person committed offenses during this period, and why? Criminal Characters is asking these questions to challenge the very definition of "criminal" while also offering an opportunity for citizen scientists to contribute to cutting-edge research in criminal justice and sociology.

CHALLENGE!

DECODING THE CIVIL WAR

After 150 years, the U.S. Civil War still captures the imagination. There are reenactments, national landmarks, and large tracts of research and books devoted to this seminal period in American history.

YEAR LAUNCHED
2016

SUBJECTS
12,970

CLASSIFICATIONS
131,965

With so much available material, familiar stories can be retold and new ones uncovered. Decoding the Civil War sought to engage experts and amateurs alike to transcribe telegrams from the Thomas T. Eckert papers and provide fresh insights into those stories.

A two-year federal grant from the National Historical Publications and Records Commission enabled The Huntington Library, Art Museum and Botanical Gardens, along with the Zooniverse and North Carolina State University's Digital History and Pedagogy Project to launch Decoding the Civil War. In under 17 months, Zooniverse volunteers transcribed a collection of 12,970 subjects comprising 15,971 messages from ledgers that recorded the telegrams sent and received by the War Department during the American Civil War. About one-third of the recorded messages in the ledgers were written in code, and more than 100 were from Abraham Lincoln himself.

This extraordinarily rare collection is a near-complete archive belonging to Thomas T. Eckert, the Head of the United States Military Telegraph Office of the War Department under President Lincoln.

Zooniverse volunteers were encouraged to participate in both transcribing telegrams and in discussing wartime history with fellow volunteers. They did so with vigor, posting over 7,000 comments in more than 4,800 discussion threads on the project's Talk boards.

The resulting transcriptions can be found on the Huntington Digital Library in the Thomas T. Eckert Papers.
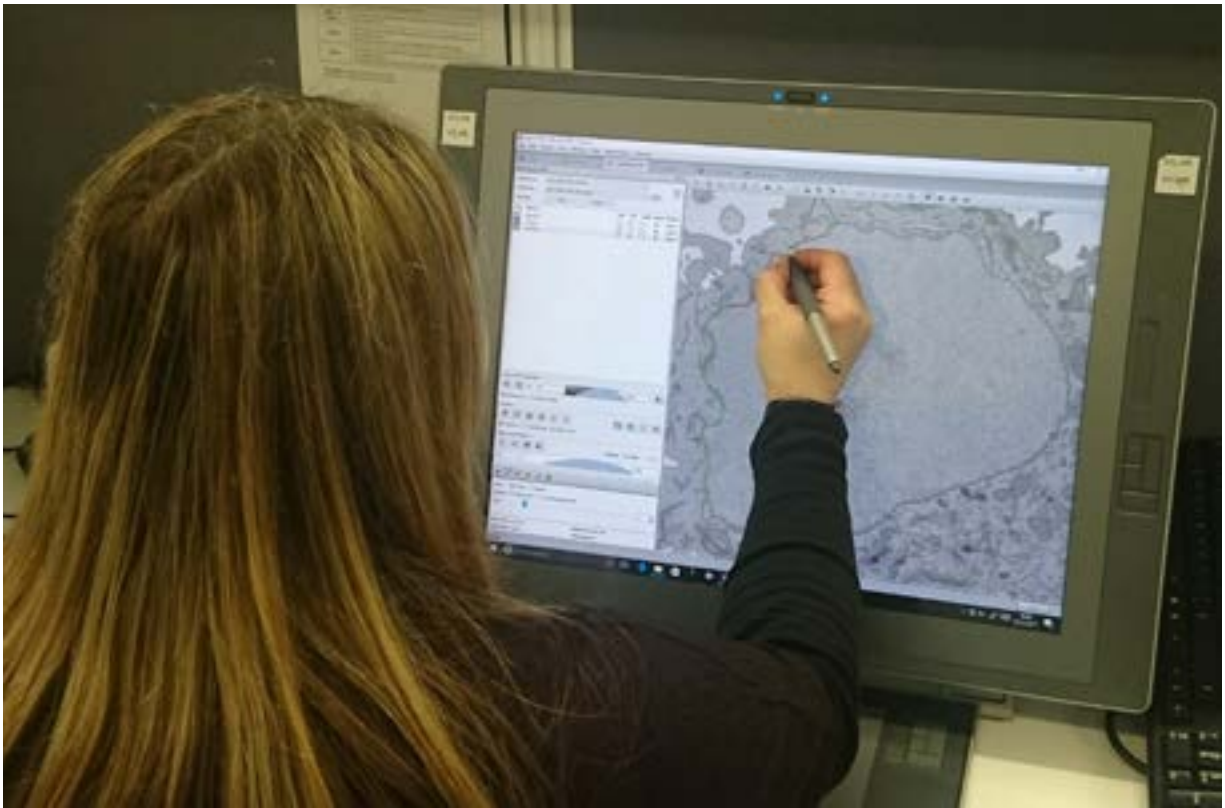
ETCH A CELL

Microscopes magnify a world we normally cannot see. Our bodies are composed of cells invisible to the unaided eye. Electron microscopes allow scientists to peer into these cells to learn more about our biology and health.

YEAR LAUNCHED
2017

SUBJECTS
6,777

CLASSIFICATIONS
152,132

Etch a Cell uses images from an electron microscope to peer into a cell and analyze its nuclear envelope, which contains the cell's genetic information. Analyzing this nuclear envelope can help differentiate between healthy DNA and cells with DNA affected by diseases like cancer.

Each microscopic image consists of a 2D segment of the cell. For researchers to better identify what a healthy nuclear envelope looks like compared to one with cancer or a rare disease, each segment is analyzed to create a 3D model.

Segmenting the cells and identifying their nuclear envelope can take days for a single researcher to complete. In addition, the variations of nuclear

envelopes can create other problems: Currently, variations in the shapes of the envelopes do not allow computer automation to create these 3D images. So the researchers turned to Zooniverse to refine the computer model.

To create a robust automated routine, thousands of nuclear envelope segments must first be analyzed. This is where Zooniverse comes in! Etch a Cell volunteers have annotated thousands of cell slices since the project began in early 2017.

With the help of Zooniverse, Etch a Cell is helping to improve our understanding of cell biology, essential for working towards finding new treatments and cures for diseases.

> **"A GIANT KELP FOREST CAN DISAPPEAR IN A SINGLE STORM, REMAIN ABSENT FOR MONTHS OR YEARS AND THEN FULLY REAPPEAR IN A FEW MONTHS OF EXPLOSIVE GROWTH."**
>
> DR. ANDREW RASSWEILER

FLOATING FORESTS

Have you ever seen seaweed floating in the water at the beach? How about an entire forest of seaweed?

Large masses of seaweed, known as giant kelp forests, exist off of 25% of shorelines worldwide. The forests can grow up to one foot per day. These underwater gardens take root in the rocky sea floors of cool, shallow waters and provide food and shelter for organisms of all shapes and sizes, from the sea floor to the surface. In supporting these high levels of biodiversity, giant kelp forests constitute one of the most dynamic habitats on Earth. Humans are drawn to kelp forests, too, and harvest kelp to create alginate, an ingredient in shampoo and ice cream.

In addition to sheltering marine fauna from predators, giant kelp can serve as a buffer between powerful ocean waves and sandy beaches, minimizing destruction of fragile coastline ecosystems. However, increasing ocean temperatures and a rise in the severity of storms threaten kelp forests and their inhabitants. Closely monitoring the health and growth of giant kelp forests across the globe helps us to predict and prevent ecosystem loss.

While Zooniverse volunteers can't SCUBA dive to collect data on kelp, they can monitor changes in giant kelp abundance on photographs from NASA Landsat satellites. These satellites have photographed the ocean surface since 1984, but computers still struggle with distinguishing kelp patches from shadows, sediment plumes, and other nearshore features. Luckily, the human eye can easily identify and outline giant kelp forests, which is exactly what citizen scientists do!

Together, the project has analyzed more than 7,000 images of giant kelp in an effort to preserve these floating forests.
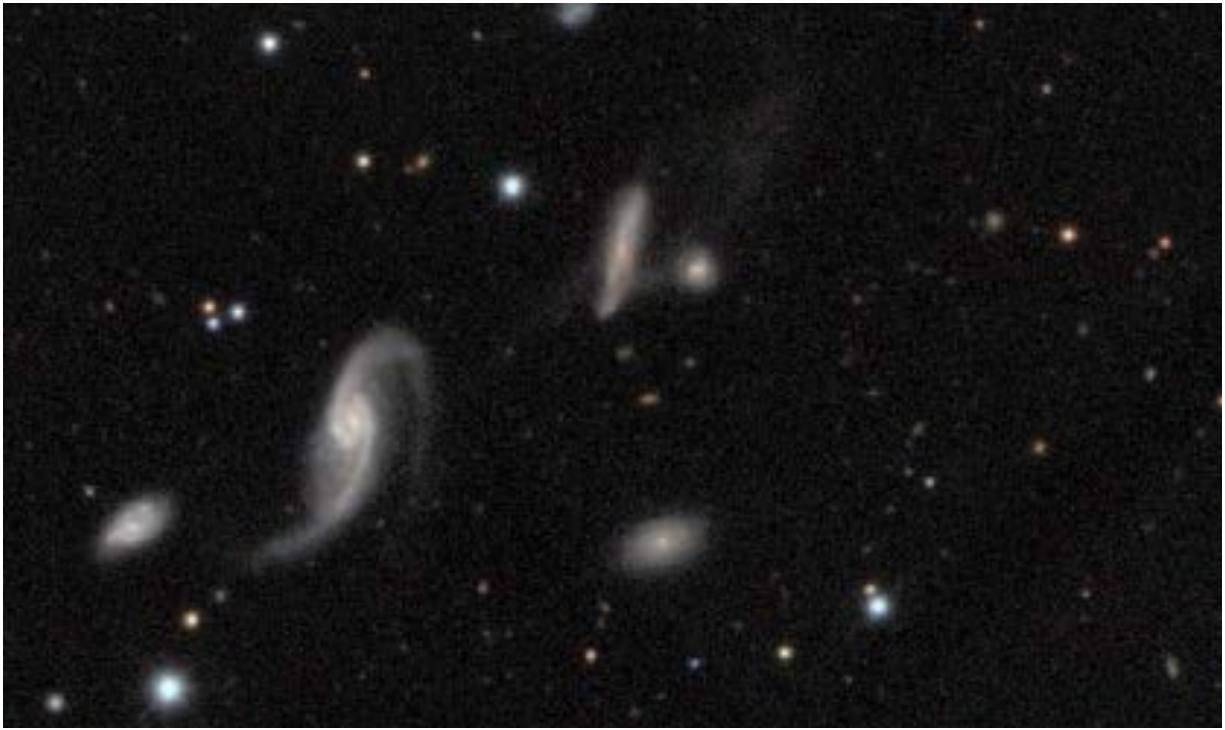
YEAR LAUNCHED
2014

SUBJECTS
109,997

CLASSIFICATIONS
381,859

CHALLENGE!

GALAXY ZOO

To understand the past, present and future of our own Milky Way galaxy, astronomers look outwards, studying millions of galaxies that inhabit our cosmic neighborhood.
We better understand our galaxy's history by studying their stories. Galaxy Zoo has helped us understand our place in this cosmic narrative — and given us a new understanding of how our Universe came to be the way it is.

YEAR LAUNCHED
2007

SUBJECTS
**1,507,172**

CLASSIFICATIONS
98,774,267

The shape of a galaxy encodes its history, giving us clues to what it has gone through during the 13.8 billion years of cosmic history. With technological improvements in telescopes and their instruments in recent years, deep sky surveys now provide images of millions of galaxies. Researchers using Galaxy Zoo images examine how galaxies form, how the supermassive black holes that lurk in their centers play a role, and how mergers contribute to galaxy evolution.

Galaxy Zoo launched in 2007 when astronomers realized they would need volunteers' help to cope with the large volume of available data. The project was an instant success: Within the project's first day, volunteers were contributing 70,000 classifications per hour. During the first year, more than 150,000 volunteers completed more than 50 million galaxy classifications.

Since then, Galaxy Zoo volunteers have classified millions of galaxies using deep surveys conducted by the Hubble Space Telescope and from telescopes in Chile surveying the southern sky. Beyond classifying galaxy samples, volunteers have made exciting serendipitous discoveries: finding a new class of galaxies as well as evidence of past activity from a supermassive black hole. The work of Galaxy Zoo continues as volunteers view never-before-seen galaxies — what discoveries will Galaxy Zoo volunteers make next?

CHALLENGE!

Livingston - O2a

Hanford

Livingston - ER13
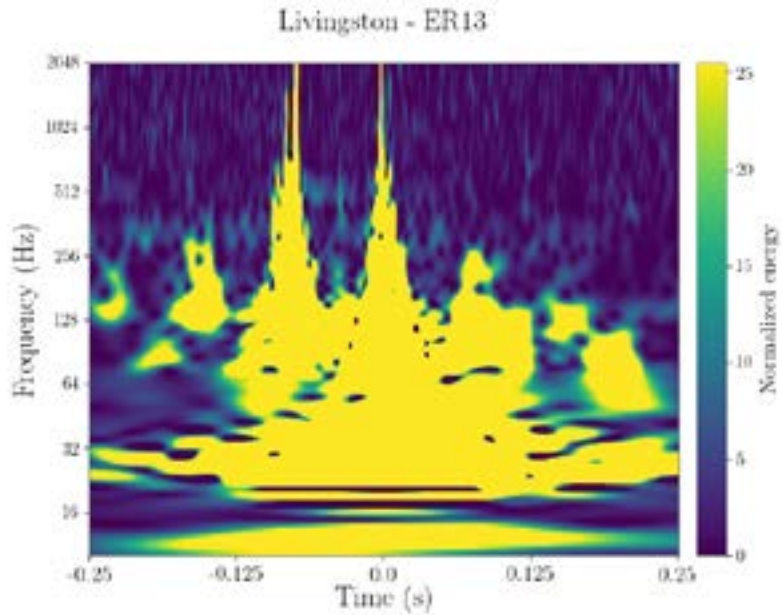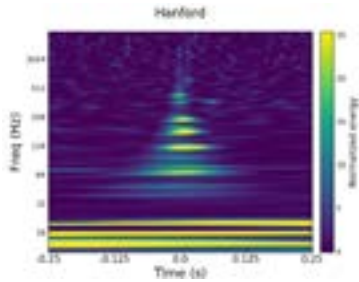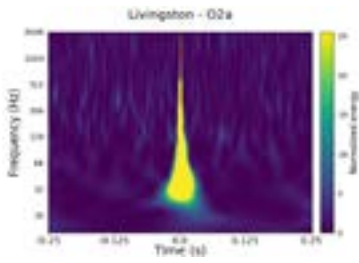
GRAVITY SPY

Albert Einstein predicted the existence of gravitational waves from his theory of general relativity in 1916. Nearly 100 years later, the Laser Interferometer Gravitational-wave Observatory (LIGO) proved his prediction correct, a feat Einstein himself didn't believe would ever be possible.

LIGO uses laser light, combined with interferometry, to detect the minuscule way gravitational waves cause space to shrink and stretch. Since the first detection of a black hole merger in 2015, LIGO has provided a new sense for physicists to use to explore astronomical bodies.

However, these gravitational wave signals from astronomical events are very weak and difficult to detect. In order to help recognize these events, LIGO utilizes machine learning to recognize and classify the instrumental and environmental noise, or "glitches," bombarding the instruments. Glitches can mimic true signals, making LIGO less sensitive to gravitational waves. While machine learning algorithms are fast, people are far better at flagging and categorizing rare or unusual signals. Gravity Spy brings together more than 14,000 volunteers to train the computers to recognize dozens of glitches.

Volunteers have helped classify over one million of LIGO's glitches. In October 2018, data from the Virgo detector in Pisa, Italy, was added to the Gravity Spy project and brought with it a new set of glitches to be classified. Ultimately, these classifications have helped LIGO scientists to better understand the noise inherent in the detectors, allowing them to filter out the noise and identify astronomical events, continuing to expand their view through this new window into the Universe.
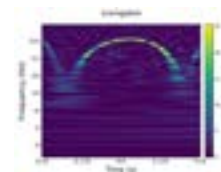
YEAR LAUNCHED
2016

SUBJECTS
593,987

CLASSIFICATIONS
4,303,477

LOCAL GROUP CLUSTER SEARCH

Astronomers study star clusters to learn about the lives of stars and the history of the galaxies in which the stars reside. Star clusters provide an avenue to better understand the life cycle of individual stars, to look back into the past and learn about dramatic galaxy collisions, and to uncover the details of star formation and stellar birth.

YEAR LAUNCHED
2019

SUBJECTS
21,095

CLASSIFICATIONS
865,048

Astronomers seek out star clusters to accomplish these goals, and Zooniverse volunteers play an important role in finding and assembling collections of these valuable objects.

The Local Group Cluster Search focuses its efforts on three galaxies in our Local Group of galaxies: the Triangulum Galaxy, the Large Magellanic Cloud, and the Small Magellanic Cloud. These targets are three of our Milky Way's closest neighbors and serve as valuable targets for star cluster studies, allowing astronomers to capture detailed images crucial to their investigations. Specifically, the project uses Hubble Space Telescope's Advanced Camera for Surveys and Wide Field Camera 3 to image the Triangulum galaxy, while the Dark Energy Camera on the Blanco 4-m telescope at Cerro Tololo Inter-American Observatory in northern Chile is used to image the Magellanic Clouds.

The Local Group Cluster Search is making contributions to our knowledge of cluster formation, and the history of Local Group galaxies. While algorithmic analysis continues to improve, people-powered efforts to identify star clusters, picking out these gravitationally-bound families out of the sea of surrounding stars, continues to produce valuable results. Zooniverse volunteers join a long tradition of peering into images of outer space in search of a better understanding of our Universe.

MILKY WAY PROJECT

Stars live and die on a scale vastly different to that of people. The Sun, for example, is currently about 4.6 billion years old, just under half of its expected lifetime. At that scale, it's impossible for astronomers to observe any individual star from its birth to death.

Instead, scientists rely on observing as many stars as possible throughout the Universe at light wavelengths beyond the visible to get a grasp of the different stellar milestones.

In the Milky Way Project, scientists look for signs indicating where star births have impacted massive clouds of dust and gas throughout our home galaxy. To build this comprehensive view of the Milky Way galaxy, the project has used images taken at infrared wavelengths from the Spitzer Space Telescope and combined them with the keen eyes of volunteers to identify hidden features. The space between the stars and planets in our galaxy is permeated by interstellar dust particles. This dust, each particle one-tenth the

YEAR LAUNCHED
2010

SUBJECTS
94,806

CLASSIFICATIONS
1,774,372

size of a grain of sand, is mixed with cold gas that coalesces into massive clouds that eventually collapse to form stars.

Unexpectedly, dust can survive around hot, massive stars. Heated by starlight, the dust glows in infrared, giving astronomers bright beacons revealing star birth within the Milky Way and even across the Universe. Two features in particular, known as "bubbles" and "bow shocks," mark locations around developing and newly formed stars.

Beyond newly formed stars, there are other objects potentially hidden within these images of the Milky Way galaxy such as star clusters and never-before-seen galaxies.

MONKEY HEALTH EXPLORER

When we feel sick, we often prefer to stay in bed and avoid social interactions. Are we alone in this behavior? Do other animals behave similarly? For answers to these questions, we can study one of our close relatives, the rhesus macaque monkey, with whom we share 93% of our DNA.

The close genetic similarity between humans and the rhesus macaque makes this monkey an ideal candidate for studying the impact of genetics and health on behavior, particularly as these monkeys are highly social, like us.

This project seeks to study the connections between social behavior, health, and genetic variation by closely studying the monkeys.

Zooniverse volunteers contribute to Monkey Health Explorer through carefully counting the number and type of white blood cells present on a microscope slide of blood. If a given monkey's count falls outside of the normal range for one or more of the five types of white blood cells, this signals to scientists that the monkey may be sick.

This information about the monkey's health, coupled with its genetic history and behavioral observations (i.e., time spent eating, grooming, or in solitude) can help can help us to better understand how health affects behavior while also learning more about ourselves as primates.

YEAR LAUNCHED
2018

SUBJECTS
15,204

CLASSIFICATIONS
153,683

NOTES FROM NATURE

Welcome to Notes from Nature, your window to the world's collections of plants, bugs, and butterflies! Through the Notes from Nature organization, Zooniverse volunteers partner with professional botanists and entomologists to digitize an incredible collection of 10 billion specimens from natural history museums and research institutions across the globe.

YEAR LAUNCHED
2013

SUBJECTS
577,829

CLASSIFICATIONS
1,335,071

The goal of the project is to provide the public and researchers alike with complete access to this unique digital archive.

Scientists use primary data from specimens, such as when and where a specimen was collected, to study the changes in species distributions and populations. While much of this data is stored in museum archives, specimen labels have historically been handwritten. To make the information contained in these labels more accessible, they need to be digitized.

The label transcription process requires time and resources many institutions do not have, which is why the volunteer work by Zooniverse volunteers is essential. By means of a robust digitized specimen library, scientists will have ready access to spatial and temporal data, which can then be used to model biodiversity fluctuations and to assess impact on ecosystems and human health.

For transcription beginners, Notes from Nature offers transcription keys to aid with interpreting commonly used abbreviations, notations, and references to prominent research biologists.

One of the latest projects in the organization is called "Labs." In this project, volunteers not only study a certain type of regional plant species over a period of time, they also document the presence of flowers, which can be used to study variations in flowering cycles over time.

OLD WEATHER

The year is 1914. You have just begun another long, cold watch aboard the *Revenue Cutter Bear*, searching for the survivors of a lost Arctic expedition in the icy waters around Wrangell Island. Like every officer, you dutifully note your observations of weather and sea ice during your watch, both to help keep the ship safe and to better understand seasonal patterns that govern all aspects of life in the Arctic.

YEAR LAUNCHED
2010

HOURLY WEATHER RECORDS
4,000,000

However, your handwritten observations are not of interest solely to navigators of your time. In fact, Arctic ship logs like yours are being meticulously digitized by volunteers with the Old Weather Arctic project, for use by climate scientists and historians in the present day.

Old Weather: Arctic was created to tap into the wealth of knowledge stored in ship logbooks from military and whaling vessels traversing the Arctic Ocean in the 19th and 20th centuries. Volunteers are responsible for the extraction and transcription of data from the logs, after which the data becomes accessible to scientists and the public through the International Comprehensive Ocean-Atmosphere Data Set and advanced retrospective analysis (reanalysis) products.

Old Weather: Arctic primarily focuses on the dynamics of sea ice and Arctic weather as documented in vessel logbooks for nearly two centuries. With the assistance of computer models, climate scientists can use these unveiled datasets to better understand the past, present, and future of Arctic and global climate conditions. Similarly, historians can use observations from these logs to more accurately interpret and analyze the historical events that unfolded during the course of a Arctic voyages more than 200 years ago.

PELICAMS

On a remote northern part of the Great Salt Lake in Utah sits Gunnison Island, one of the world's largest breeding grounds for American white pelicans. But recently, the Great Salt Lake's water level has been low, creating land bridges to the island and exposing this once-safe place to people and predators.

YEAR LAUNCHED
2018

SUBJECTS
29,907

CLASSIFICATIONS
88,773

Pelicans are highly susceptible to disturbances from humans and ground-based predators, making these environmental changes and their effects of great interest to environmental scientists. Together, the Great Salt Lake Institute at Westminster College, University of Utah's MesoWest, the Utah Division of Wildlife Resources, and the Tracy Aviary have placed 15 cameras, nicknamed PELIcams, on those secluded breeding grounds.

The Project in Education and Longitudinal Investigation of American White Pelicans, or PELI Project, seeks to use those cameras and the eyes of citizens scientists around the world to answer questions such as: How do the environmental changes impact pelicans' migration patterns? Are predators impacting the colony? How does nesting unfold? How do the sub-colonies formed on the island change throughout the year?

With the help of Zooniverse volunteers, PELI Project can analyze thousands of images of the pelicans and their nesting ground to gain a better grasp of both the pelicans' nesting behaviors and changes within the Great Salt Lake itself.

PENGUIN WATCH

Using high resolution images from 140 colonies around Antarctica, Penguin Watch scientists and volunteers are able to study penguins in unprecedented detail.

YEAR LAUNCHED
2014

SUBJECTS
58,959

CLASSIFICATIONS
372,627

Each April, the world celebrates World Penguin Day and, in 2019, Penguin Watch partnered with the World Wildlife Foundation, the British Antarctic Survey and the public to count penguins along the Antarctic Peninsula.

Despite having one of the world's most extreme climates, Antarctica is home to an exceptional range of species, including penguins. These species have evolved specifically to live in this harsh environment, but climate change, fisheries, and direct human disturbance is potentially putting them all at risk. The Antarctic Peninsula is rapidly warming, resulting in the collapse of ice shelves and significantly less sea ice.

With the help of volunteers, Penguin Watch seeks to determine the size of the colonies changes over time and

how penguins may change the use of their habitat. Penguins are particularly important to study because they are an easy species to monitor and any changes in a species higher on the food chain will likely reflect back on them. All this information serves to advise scientists on how to best approach conservation strategies.

Ultimately, the project hopes to use this research to positively impact policy around the world to protect penguins and other Antarctic species.

CHALLENGE!

PLANET FOUR: TERRAINS

As observatories with increasingly larger telescopes were being built, observations turned to mapping our neighboring terrestrial planets like Mars.

YEAR LAUNCHED
2015

SUBJECTS
118,202

CLASSIFICATIONS
2,077,832

In 1877, Italian astronomer Giovanni V. Schiaparelli began mapping regions on Mars, and named a network of features "canali," which means channels. It was misinterpreted to mean canals, and later U.S. astronomer Percival Lowell made his observations of the "canal system" on Mars.

These early sightings are a result of human tendency to see patterns in what we observe. Although the canals never actually existed, there are many real geological features that planetary scientists are interested in studying.

Planet Four: Terrains asks volunteers to apply their pattern recognition abilities to identify features on the surface of Mars that have been imaged by the Context Camera (CTX). The cameras are part of the scientific instruments on the Mars Reconnaissance Orbiter, which is

currently orbiting Mars.

Volunteers use images from the CTX to identify features from the polar areas and formations created by the springtime thawing of the seasonal carbon dioxide ice sheets on the South Pole of Mars.

The researchers informally named these visual structures "spiders," "baby spiders," "channel networks," and "Swiss cheese." Researchers examine the distribution of these features and, for interesting cases, obtain higher resolution images to study using HiRISE (High Resolution Imaging Science Experiment).

This project allows researchers and volunteers to see patterns on Mars' polar regions, which can help us understand the erosive processes in these areas.
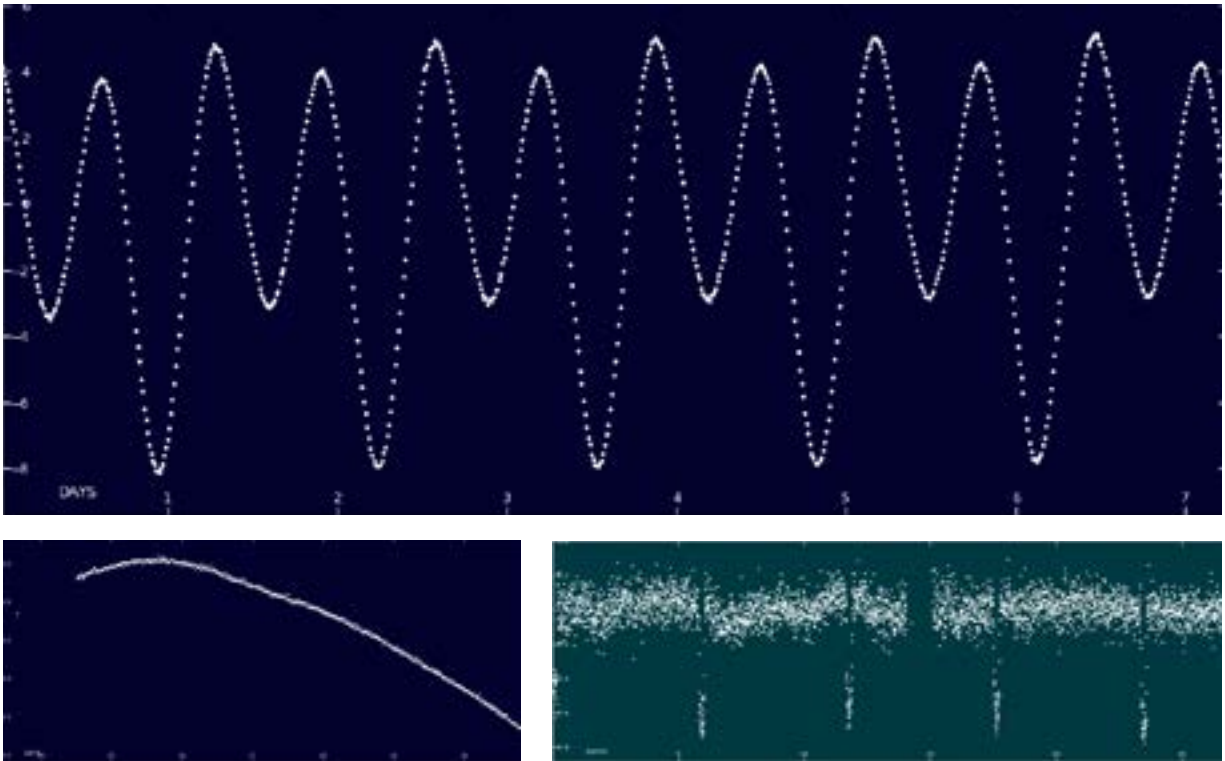
PLANET HUNTERS: TESS

For generations, humans have imagined the kinds of worlds that might exist outside of our solar system. Planet Hunters: TESS is making it possible for people around the world to join the search for these worlds.

YEAR LAUNCHED
2018

SUBJECTS
876,606

**CLASSIFICATIONS**
10,788,945

Since the launch of the first Zooniverse Planet Hunters project in 2009, volunteers have used satellite data to find potential planets around stars outside of our system. With the launch of the Transiting Exoplanet Survey Satellite (TESS) in 2018, Planet Hunters: TESS was launched to take up the search.

Stars are by far the brightest objects within their respective solar systems, which makes directly viewing a planet with a telescope next to impossible because any light from a planet would be drowned out by its star. Instead, scientists look at the variation of a star's brightness to locate potential planets around it. The larger the planet, the better this method works: a Jupiter-sized planet will reduce the visible brightness of a star by about

1% when it transits in front of a star. A planet the size of Earth, on the other hand, would only be one-hundredth of that. By looking at the light curve data from TESS, volunteers can help identify potential planet transits.

Both humans and computers are good at identifying the specific patterns in the data that can show a potential planet, but for different reasons. While a computer can quickly sort through the data and spot standard transits, people are better at spotting patterns even if they aren't what we might expect. Based on the unusual systems that the original Planet Hunters project uncovered, like Boyajian's star and a quadruple star system, Planet Hunters: TESS volunteers stand to identify even more planetary transits.
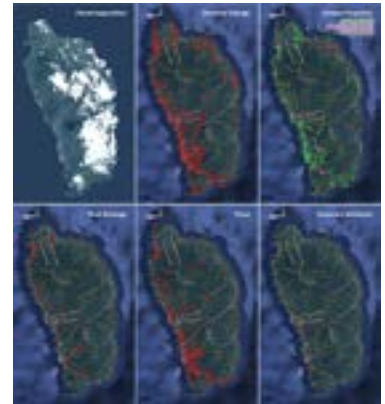
PLANETARY RESPONSE NETWORK

When natural disasters strike, relief response groups spring to action to assist in recovery. But where should the groups concentrate their recovery efforts? Zooniverse volunteers look at satellite imagery to help narrow down a starting point.

YEAR LAUNCHED
2017

SUBJECTS
**67,680**

CLASSIFICATIONS
727,564

Planetary Response Network is the result of collaboration between Rescue Global, Oxford's Machine Learning Research Group, and Zooniverse. The project analyzes satellite imagery taken before and after an event to identify areas of need. The analyzed images create a heat map to identify areas of priority for relief efforts.

After Hurricanes Irma and Maria devastated the Caribbean in 2017, the Planetary Response Network set forth to create damage heat maps of affected islands. The project identified damaged buildings, flooding, and blocked roads in Antigua, Barbuda, Dominica, Guadeloupe, Puerto Rico, Turks and Caicos, and the U.S. and British Virgin Islands. From mid-September to early October that year, 5,000 volunteers completed nearly 650,000 classifications from satellite

imagery of the affected islands. The effort completed in a little over three weeks was equal to what one person working full time would need almost three years to complete.

The information generated by volunteers was used to help the recovery effort on location. The data generated were shared with other relief efforts in the Caribbean to enhance the humanitarian effort to provide relief to the devastated areas.

The ability to generate and share these heat maps among rescue and relief organizations increased the response time and led to swifter clearing of blocked roads and evacuation of unsafe structures, even in remote areas. With the help of the volunteer-generated heat maps, relief efforts knew where to go and where they could concentrate recovery efforts.
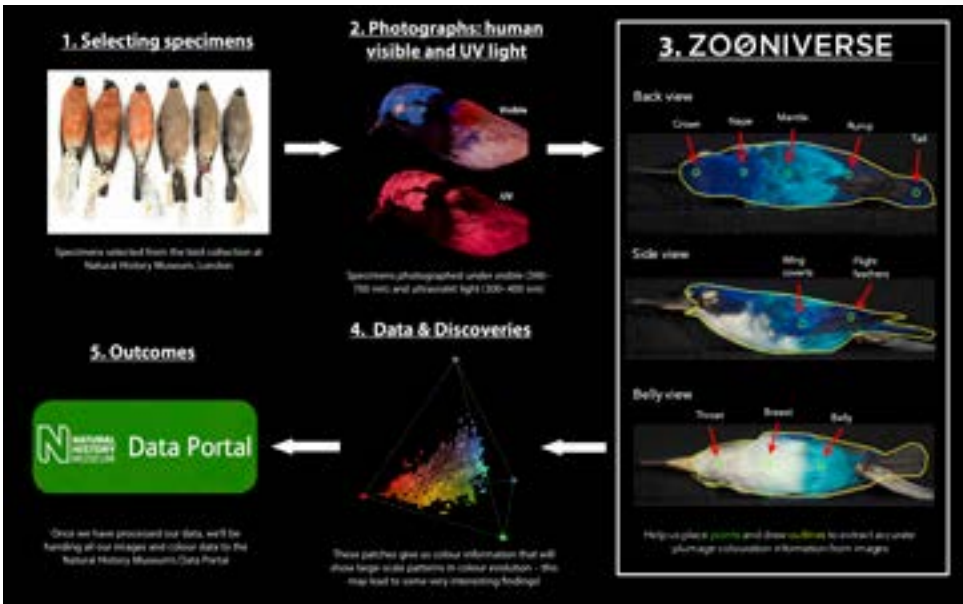
PROJECT PLUMAGE

Birds see a world of color that we can only imagine. While the human eye can capture light within the range of 400—700 nanometers on the electromagnetic spectrum, from violets and blues through to green, yellow, and red, birds can see all of these colors plus ultraviolet wavelengths.

Because of these added wavelengths, we as humans cannot fully perceive the diverse range of colors that birds' plumage can take on.

Project Plumage scientists are interested in studying color and pattern variation in bird plumage to better understand the conditions and causes of color-based evolutionary changes in birds. There are around 10,000 living species of birds around the world, and luckily for Project Plumage, the Natural History Museum of London has a collection housing specimens of 95% of these species.

YEAR LAUNCHED
2017

SUBJECTS
78,892

CLASSIFICATIONS
124,246

In this project, Zooniverse volunteers highlight key regions in plumage. Anatomical coloration varies from species to species, as does the function of the color or pattern: a red crown in one species could attract mates, whereas a red crown for another could serve as a warning to predators.

Once the specimens have been analyzed by volunteers, the research team applies camera calibrations to capture the vibrancy of the highlighted plumage areas.

Researchers use these data to answer important questions in evolutionary biology and ornithology, such as: How and why are birds so colorful? How have evolutionary changes in color driven the origin of new species? Help answer these questions and more by partaking in this exciting research venture with Project Plumage.

CHALLENGE!

SCIENCE GOSSIP

Prior to the 20th century, science was yet to be professionalized, so research and scientific inquiry was predominantly conducted by enthusiastic hobbyists, or "citizen scientists."

YEAR LAUNCHED
2015

SUBJECTS
161,000

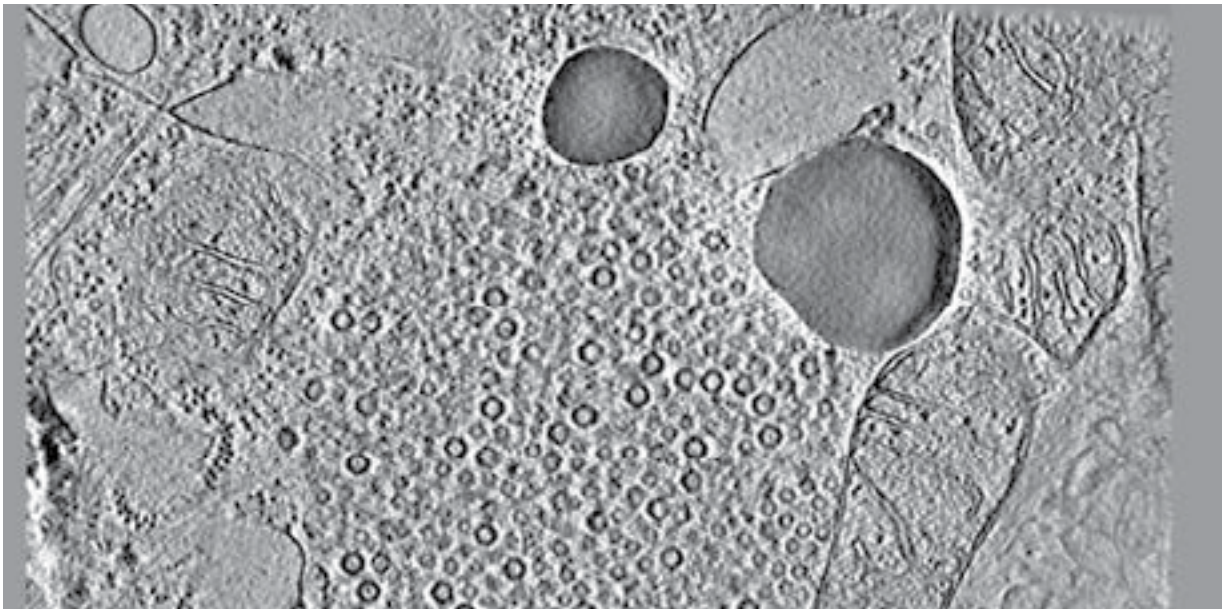**COMPLETED SUBJECTS**
585,000

During this period, the work of science was incredibly visual, from drawing plants and landscapes to taking photographs of solar eclipses. The resulting images, made by a wide range of people, were regularly published in scientific periodicals such as *Science Gossip*, *Recreative Science* and *The Intellectual Observer*.

Today, Science Gossip, a project developed by an Arts and Humanities Research Council project and the Missouri Botanical Garden, is determined to map out the origins of citizen science by classifying those images. They depict a wide range of natural sciences and historians want to know why they were created, how often, and by whom. By tagging illustrations and crediting artists and engravers information, volunteers create key data for historians to answer these questions.
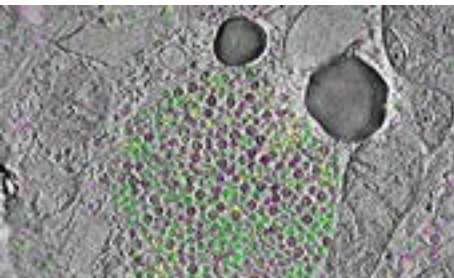

Better understanding the range of individuals who helped develop the field of science through their images will help ascertain what constituted 19th century scientists and citizen scientists. Together, volunteers and historians can uncover the vast history of naturalists and amateur science enthusiasts driving discovery and science communication from both the Victorian period and today.

SCIENCE SCRIBBLER: VIRUS FACTORY

To survive, a virus takes over a cell's functions, causing it to reproduce more viruses until the host cell bursts. These newly created viruses then infect other cells.

YEAR LAUNCHED
2019

SUBJECTS
92,051

CLASSIFICATIONS
219,898

The process by which viruses hijack a cell is poorly understood in part due to the complexity of these parasites and how quickly they evolve.

Science Scribbler: Virus Factory hopes to improve automated data about a complex family of viruses known as Reovirus, enabling scientists to perform research faster than ever before.

The project uses electron tomography to collect images of a virus-infected cell from many different angles. The images are then stitched together to form a 3D picture of the cell and its contents. By capturing these images, scientists will be able to understand the full life cycle of a virus: how it enters a cell, replicates, and assembles copies of itself before it finally leaves the infected cell.

Even by virus standards, Reoviruses are complicated. Their size and layers of protein subunits, which enable the virus to assemble a reproduction factory within a newly infected cell in a matter of hours, make them prolific in animals and plants.

While in other species Reoviruses are responsible for serious gastroenteritis, they typically do not produce symptoms in humans. Unexpectedly, cancer cells are one of the places they replicate in, making them potential anti-cancer agents for humans.

With its volunteers, Science Scribbler: Virus Factory will further the ability of automated data analysis techniques to lead science into a new age of understanding viruses.

CHALLENGE!
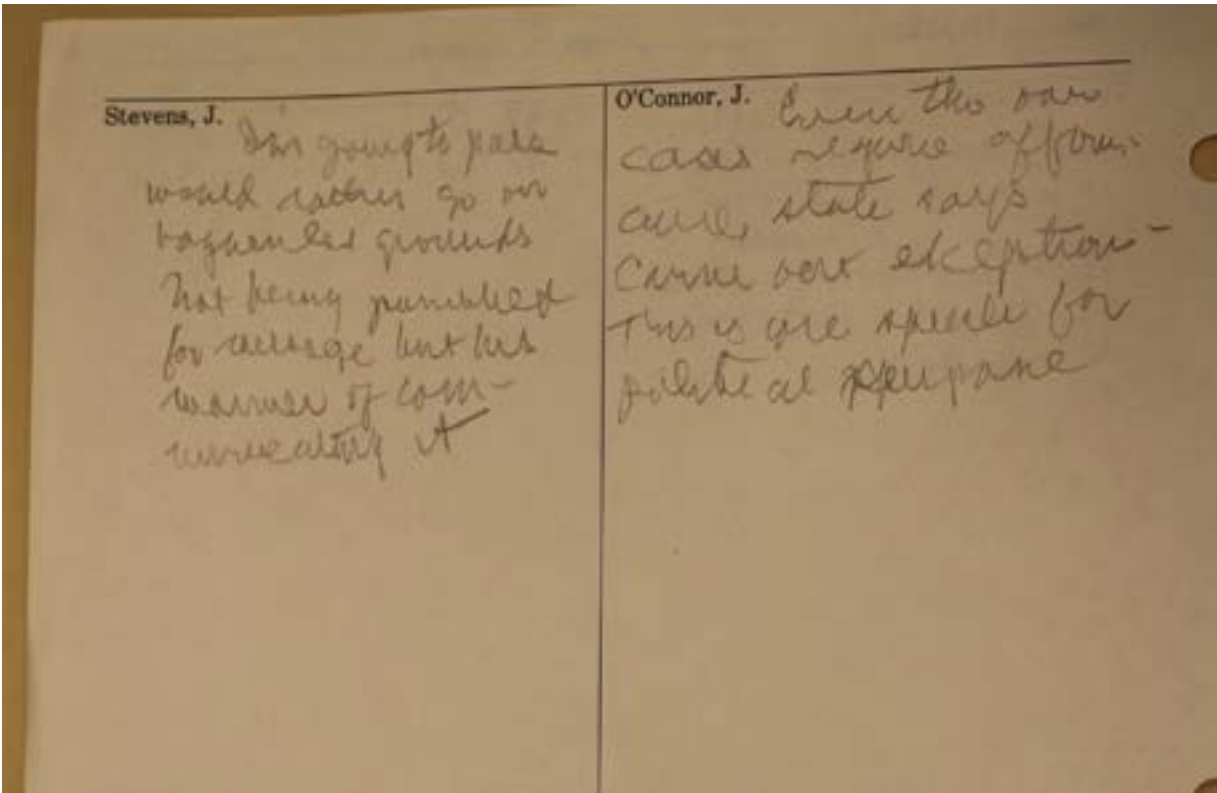
SCOTUS NOTES

The United States federal government is divided into three branches. Each branch is equal and plays an important role in shaping law and policy. Some parts of the decision making process take place publicly, but some do not.

YEAR LAUNCHED
2018

SUBJECTS
46,478

CLASSIFICATIONS
238,666

For instance, congressional debates and votes are broadcast on the U.S. cable television network C-SPAN, and its galleries are open to the public. Presidents are regularly on television for press conferences and to make speeches.

In contrast, the United States Supreme Court justices conduct almost all of their decision making in private, including conference deliberations in which they vote on how to decide cases. Therefore, any insights into how the justices arrive at decisions can give researchers and historians a wealth of knowledge about the least-known branch of government.

Sometimes former justices share insights into the Court's private conference discussions by opening their personal papers to the public after they leave the Court. These handwritten notes provide a valuable opportunity to understand how justices render decisions. SCOTUS Notes seeks to transcribe these notes.

Increased access to these records will lead to a better understanding of how Supreme Court decisions shape federal and state-level law and policy.

To create a digital, accessible repository of over 50,000 pages of records, SCOTUS Notes relies on volunteers to transcribe the records. The result of the project is that researchers, Court watchers, and citizens alike gain first-hand knowledge about how justices made some of the most important decisions about law in the nation's history.

SCRIBES OF THE CAIRO GENIZA

Scribes of the Cairo Geniza is responsible for the classification and transcription of medieval texts documenting daily life in the circa 10th–13th century Mediterranean basin.

Approximately 300,000 fragments of Hebrew and Arabic manuscripts were once stored in a geniza, or temporary storage area, within the attic of the Ben Ezra Synagogue in Cairo, Egypt. Today, they are available online for study by research institutions and Zooniverse volunteers alike.

Jewish tradition calls for the burial of written documents viewed as holy. These tattered manuscripts from the Middle Ages were placed in the Cairo geniza alongside day-to-day materials.

Fortunately for scholars, the texts were never buried and now serve as an incomparable record of medieval Jewish society, with literature ranging from sacred Hebrew poetry to court documents

to grocery lists. These fragments, once transcribed, can help researchers better understand the socioeconomic, political, and religious factors at play in pre-modern Middle Eastern history, such as trade in the Mediterranean Sea and Indian Ocean and the Jewish diaspora.

Zooniverse volunteers first filter the fragments based on script type and level of difficulty and then use key phrases and themes from simpler texts to piece together complex passages. For example, finding variations of the term kitābī ("I am writing") indicates to researchers that the text in question is likely a letter.

The project offers a unique opportunity for volunteers, even

those without a background in Arabic or Hebrew, to contribute to ongoing Geniza research. This project was funded by a National Leadership Grant from the Institute of Museum and Library Services. It represents a partnership between the University of Pennsylvania, Princeton University, the University of Haifa, the Jewish Theological Seminary, Cambridge University Libraries, the University of Manchester Library, Columbia University, and University of Oxford.

YEAR LAUNCHED
2017

SUBJECTS
73,196

CLASSIFICATIONS
283,580

CHALLENGE!
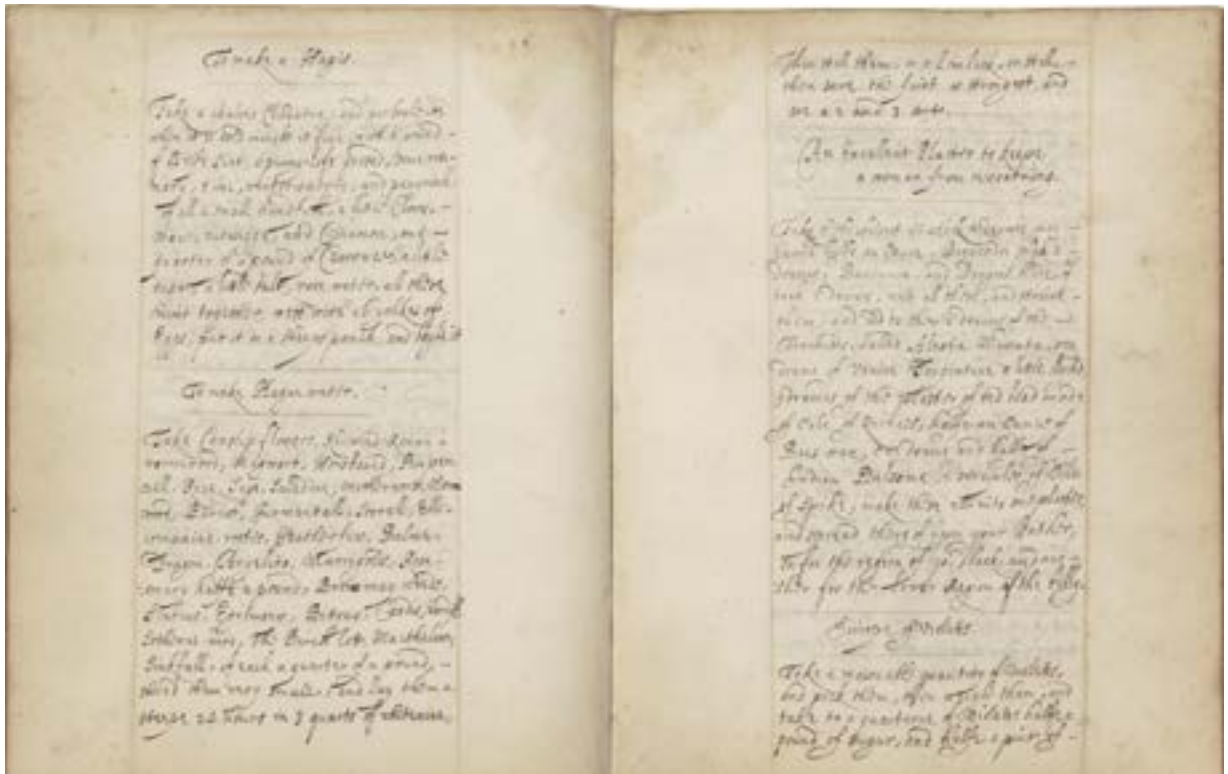
SHAKESPEARE'S WORLD

Shakespeare's works are studied by almost everyone at some point in their educational journey. Shakespeare died over 400 years ago, and although his literary works are well known, there is still much that may be learned about the time period in which he lived.

YEAR LAUNCHED
2015

SUBJECTS
14,339

CLASSIFICATIONS
203,390

Stepping back in time is one way to do this. Shakespeare's World allowed a sojourn into the early modern world by transcribing manuscripts created by Shakespeare's contemporaries.

In this project, volunteers transcribed early modern English manuscripts from the collection of the Folger Shakespeare Library in Washington, D.C., which has the world's largest collection of material relating to Shakespeare and his time period.

This project provided extensive glossaries and educational material that enabled volunteers to learn how to read "secretary hand," the most common script used in the period. Equipped with the basics in paleography, volunteers were virtually transported back to people's everyday interests and concerns in 16th- and 17th-century England.

As transcribers stepped back in time, they uncovered recipes for food and medicine, letters between family members and colleagues recounting domestic and political news, and handwritten newsletters reporting on international intrigues.

As a bonus, volunteers helped enrich definitions in the Oxford English Dictionary by providing early historic usages and contributed to the research of countless historians and literary scholars. New words or variants found while transcribing continue to be reviewed and added to the definitive dictionary of the English language.

SNAPSHOT SERENGETI

Is going on a safari on your bucket list? How about viewing wildlife in its natural habitat on the savanna? The Serengeti region of Tanzania has been featured numerous times in National Geographic and frequently comes to mind when considering planning a safari.

Safari photos are amazing, but are also difficult to capture based on animal migration and activity.

Snapshot Serengeti uses camera traps to track animal migration within the Serengeti. With over 200 cameras capturing millions of images of animals in their natural habitat, this project provides a safari experience as volunteers classify animal species.

Snapshot Serengeti has several ways in which participants can interact with the camera trap data. Snapshot education materials within the project contain files to use in classroom settings to teach about African wildlife ecology and behavior. For example, the material titled "Activity Patterns" allows an instructor to download a PDF and use it with pictures and videos for students to identify and learn

YEAR LAUNCHED
2012

SUBJECTS
2.5 MILLION

CLASSIFICATIONS
13 MILLION

about specific animal behaviors based on daytime or nocturnal activity cycles.

The camera trap survey is part of the Serengeti Lion Project, which has been studying the lions in that part of Africa since the 1960s. The project monitors lions tagged with radio collars, while the camera traps are used to measure their prey's movements across the savanna. The project also provides researchers with data to illustrate how predators in the same natural habitats compete and coexist.

Furthermore, the cameras track all animal behavior on the African savanna so researchers can also identify how herbivores coexist within this environment. The volunteers' classifications help conservationists create programs that will continue to protect the animals of the Serengeti for future generations.

CHALLENGE!

SNAPSHOT WISCONSIN

The full spectrum of native wildlife in Wisconsin comprises 65 mammalian species, hundreds of other vertebrate species, and thousands of invertebrate species. There are myriad variables that impact Wisconsin wildlife, including hunter harvest, predator-prey dynamics, habitat quality, and severe weather.

YEAR LAUNCHED
**2016**

SUBJECTS
667,014

CLASSIFICATIONS
3,364,745

Managing these wildlife populations requires an understanding of population size and distribution: how many individuals exist and where they are.

The Snapshot Wisconsin program in the Wisconsin Department of Natural Resources (DNR) supports these efforts by offering citizen scientists the opportunity to gather data from the wildlife on their own land. These volunteers use agency-issued cameras to monitor their property, and the animals that they capture on camera are then classified by Zooniverse volunteers. Data collected from this project are used to support decision-making in wildlife management at the DNR. So far, the project has accrued more than 31 million photos.

Based on photos that have been classified, deer are the most common species to appear on Snapshot Wisconsin cameras, accounting for nearly two-thirds of the data set. Based on these data, researchers can examine the deer population by comparing fawn-to-doe ratios and tracking activity patterns through the seasons. Elk reintroduction sites like Black River Falls, Clam Lake, and Flambeau River State Forest are equipped with cameras as well, to monitor the success of the growing elk population.

Snapshot Wisconsin has also improved winter wolf-tracking efforts, and the University of Wisconsin-Madison uses data from the project to investigate how variables like winter severity or predation impact the state's deer population.
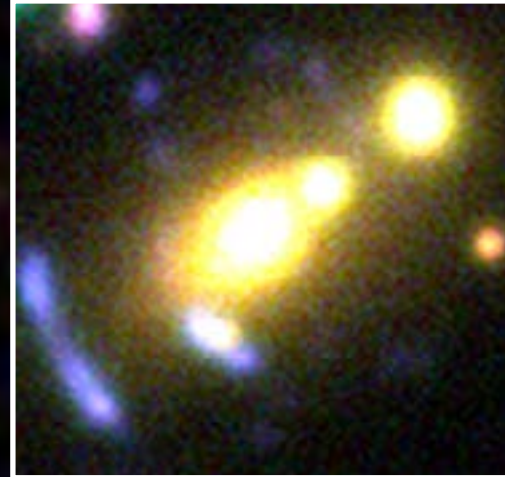
SPACE WARPS – HSC

During the 1919 total solar eclipse as the Sun passed in front of the Hyades cluster, astronomers found that the positions of the stars were slightly altered by an amount similar to that predicted by Einstein's theory of general relativity.

YEAR LAUNCHED
2018

SUBJECTS
307,957

CLASSIFICATIONS
3,313,651

Imagine spacetime — the four-dimensional combination of 3D space and time — as a rubber sheet and that you've placed a bowling ball at the center. The sheet would stretch down around it. Now replace that bowling ball with the Sun or a massive galaxy; the dip in spacetime around the galaxy can alter the apparent positions and shape of objects "behind" the dip. This makes it possible to see light from a distant galaxy (or galaxies) that would otherwise be hidden behind the massive one.

Astrophysicists can take advantage of this "lensing" phenomenon to locate and study new stars and galaxies hiding behind more massive stellar objects. For example, observing the curved light-rays from these otherwise hidden galaxies makes it possible

for scientists to precisely "weigh" galaxies, measure the expansion rate of the Universe, and determine how much of the total matter in the Universe can be attributed to dark matter.

In April 2018, Zooniverse, Space Warps — HSC, and "Science Friday," a radio show hosted by WNYC studios, partnered to issue a challenge to listeners and citizen scientists: classify one million potential lens galaxies. Within one hour of the segment's airing, 300,000 images were categorized and by the end of the week, the goal was met and dozens of galactic treasures were found. Space Warps — HSC volunteers have already discovered hundreds of gravitational lens candidates to date. Many more discoveries await!

CHALLENGE!

STELLER WATCH

There is a mystery unfolding in the western Aleutian Islands in Alaska: In the last 30 years, 94% of the endangered Steller sea lion population has vanished. Steller Watch is looking for answers that may take decades to discover.

YEAR LAUNCHED
2017

SUBJECTS
281,294

CLASSIFICATIONS
3,206,679

Zooniverse volunteers can help find answers by reviewing images that capture everyday activities of the sea lion population.

The western Aleutian Islands are very remote and field studies in this area only occur during the summer breeding season. This limitation means researchers may only conduct live observations once a year. Fortunately, there are now 24 remote cameras installed in seven sites to capture the everyday activity of sea lions in those habitats. With these cameras operating year-round and the help of Zooniverse volunteers, researchers were able to identify the highest-priority images that

can be used to solve this mystery.

The project was created by researchers from the National Oceanic and Atmospheric Administration Fisheries' Alaska Fisheries Science Center. The researchers use the data and field observations to track marked sea lions.

The sighting data are important because these data will provide information on survival, birth rates, and whether sea lions are moving out of this habitat instead of staying near their birthplace. Solving this mystery will take time, but with the help of volunteers, enormous amounts of images can be classified for biologists to review.

THE PLASTIC TIDE

You've probably heard over the last few years that plastic has become an increasing problem in the environment. One of the effects it has had is known as a "plastic tide." These "tides," sometimes as large as small islands, wreak havoc in the ocean and the plastic can end up inside the stomachs of marine life or washed up on beaches.

YEAR LAUNCHED
2017

SUBJECTS
196,350

CLASSIFICATIONS
3,968,770

Unlike normal tides, these plastic ones never recede. It takes a large piece of plastic 400 years to break down into micro-plastics, which often accumulate and form a kind of oceanic soup consisting of between an estimated 15—50 trillion pieces of plastic.

From 2017 to 2018, The Plastic Tide sought to document increases in plastic within our oceans in order to create valuable datasets for local and global researchers to understand this worldwide issue. Volunteers looked through images taken by drones or donated to the project and identified

both plastic and other litter. In doing so, they taught a computer algorithm to recognize the difference between natural debris such as driftwood and man-made trash.

The data provided by volunteers of The Plastic Tide will benefit many projects around the world that are investigating this issue. While no longer focused on identifying litter and plastic within drone-captured images, The Plastic Tide has shifted focus to community-based actions, which include coordinating beach cleanings and community outreach.

CHALLENGE!

WEATHER RESCUE

On October 26, 1859, the *Royal Charter* ship was wrecked by hurricane-force winds, sinking off the coast of Anglesey, Wales. With an estimated total of 450 lives lost, the *Royal Charter's* sinking marked the highest death toll for any wreck on the Welsh coast.

Soon after, Vice-admiral Robert FitzRoy, head of the new Meteorological Office for the United Kingdom, began the process of producing the first-ever weather forecasts. But in order to do that, and thereby save lives by warning ships of impending storms, FitzRoy needed data. So he established a network of monitoring sites around the United Kingdom, taking advantage of the development of the electrical telegraph to keep his information up to date. Beginning in September 1860, weather observations written first by FitzRoy and then by his successors were published in *The Times* newspaper. In February 1861, the first storm warning was issued to the shipping fleet, and starting August 1861 regular public weather forecasts were also included in *The Times*.

Today, FitzRoy's work stands to help current meteorologists and climate scientists, but it first needs to be digitized. There are millions of pieces of data, such as pressure, temperature, and rainfall, available from this period that can be used to inform the basis of how we understand climate change and risks of severe weather events. The sheer amount of data would take a single research team many years to complete, but with the help of Zooniverse volunteers from around the world, the task can be accomplished much faster.

YEAR LAUNCHED
2019

SUBJECTS
6,818

CLASSIFICATIONS
1,298,314

CREDIT: METEOROLOGICAL OFFICE

(IMAGE FROM JULY 31, 1861) CONTAINS THE FIRST PUBLIC WEATHER FORECAST IN FITZROY'S HANDWRITING AT THE BOTTOM OF THE PAGE. THIS FORECAST APPEARED IN *THE TIMES* NEWSPAPER THE NEXT MORNING.

WHALES AS INDIVIDUALS

For many, the image of a receding whale tail, glistening above the water at sunset along the coast, ushers in a sense of peace and awe. This has not always been the case, however: unfortunately, there once was a time when that telltale tail was a call to whalers to hunt.

YEAR LAUNCHED
2015

SUBJECTS
40,186

CLASSIFICATIONS
449,747

Whalers dominated the seas from the early 1900s to the 1970s, resulting in the loss of 3 million whales in the Southern Hemisphere alone. Dolphin populations were similarly decimated by hunters during that time, leaving current-day opportunities to witness a whale tail or dolphin dorsal fin few and far between.

Luckily, the tide eventually began to turn from whale hunting to whale watching. Whale watching, a term inclusive of all cetaceans (whales, dolphins, and porpoises), has become increasingly popular and is of great interest to both scientists and hobbyists. In collaboration with Zooniverse, Whales As Individuals welcomes whale watchers of all backgrounds to help identify individual whales and dolphins at sea.

Whales as Individuals also partners with HappyWhale, an online platform onto which whale watchers can upload photographs of whales and dolphins in real time. These images are then inspected by Zooniverse volunteers, who use a series of increasingly specific criteria (i.e., fin or tail shape, color, and pattern) to identify individuals within whale and dolphin populations. Through this method, research biologists are able to monitor those individuals and study population fluctuations, migrations, and behaviors.

CHALLENGE!

WILDWATCH KENYA

And now your (wild) watch begins. While not physically in Kenya with the Twiga Walinzi, you can join the cause to protect reticulated giraffes from your own home.

YEAR LAUNCHED
2017

SUBJECTS
1,262,477

CLASSIFICATIONS
12,203,232

Wildwatch Kenya is a conservation initiative that calls attention to giraffe conservation and research in Africa, the only continent native to the four known giraffe species.

Over the past 30 years, populations of one particular species, the reticulated giraffe (*Giraffa reticulata*), have dropped by a startling 50% due to loss of size and quality of habitats, climate chaos, and, in some areas, poaching.

On the ground in northern Kenya, conservation researchers from the local communities known as the Twiga Walinzi ("Giraffe Guards" in Swahili) work together to protect reticulated giraffes through education outreach, monitoring, removal of snares left by poachers, and by maintaining the 100 motion-activated cameras that monitor giraffe populations.

The cameras work around the clock and constantly require battery and memory card replacement. The 2 million photos captured by these cameras are then sent to the Zooniverse database, at which point Zooniverse volunteers can step in.

Volunteers sort through the images, determining if the animal that set off the motion sensor was indeed a reticulated giraffe or one of the other species that inhabit the area. By use of both pattern recognition software and the human eye, Wildwatch Kenya has been able to identify more than 4,000 images of reticulated giraffes so far!

The Twiga Walinzi can then use collected data to track giraffe migration patterns and habitat use and apply that information to improve conservation and protection efforts.
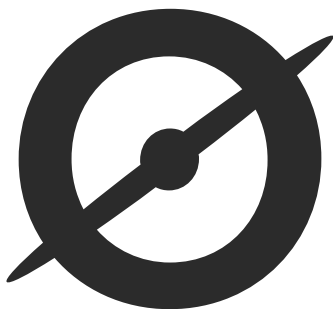
THANK YOU!

*EVERYTHING IN THIS BOOK
WAS MADE POSSIBLE BY YOU
THE ZOONIVERSE COMMUNITY*

INTO THE ZOONIVERSE
2019