IFSH High-Throughput Sequencing (HTS) Initiative

Behzad Imanian
IFSH HTS Initiative, leader
Research Assistant Professor, FSN
Illinois Tech

September 4, 2024

ILLINOIS TECH

IFSH INSTITUTE FOR FOOD SAFETY AND HEALTH ILLINOIS TECH

Innovation Through Collaboration

IFSH HTS Initiative

Industry Advisory Committee

33 members
20 food companies

Industry-Governmental Agencies Council

Proposal & Charter — *Apr 2015*

Funding from FDA — *Sept 2015*

HTS Initiative — *Mar 2016*

Food companies → WGS of pathogens → GenomeTrakr

Promote HTS technology

FDA | CDC | FSIS | BioTech | Industry

Infrastructure

- HTS Laboratory
- HTS Bioinformatics

Activities

- HTS Services
- Collaborative Research
- Outreach

ILLINOIS TECH

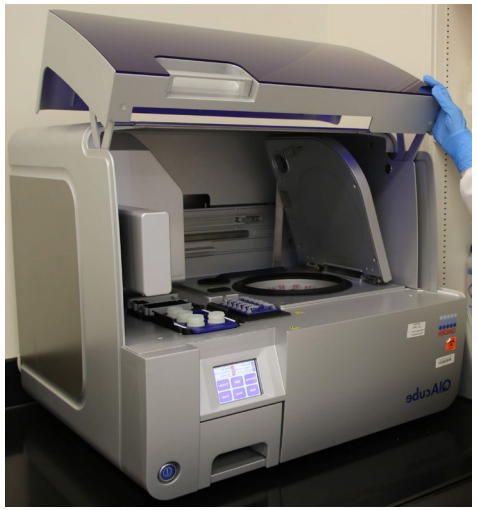
IFSH INSTITUTE FOR FOOD SAFETY AND HEALTH ILLINOIS TECH

Innovation Through Collaboration

Laboratory

TapeStation 4200

QIAcube



Quality Control & Automation

MinION

MiSeq

15 GB 50 x 10^6 reads

NextSeq 2000

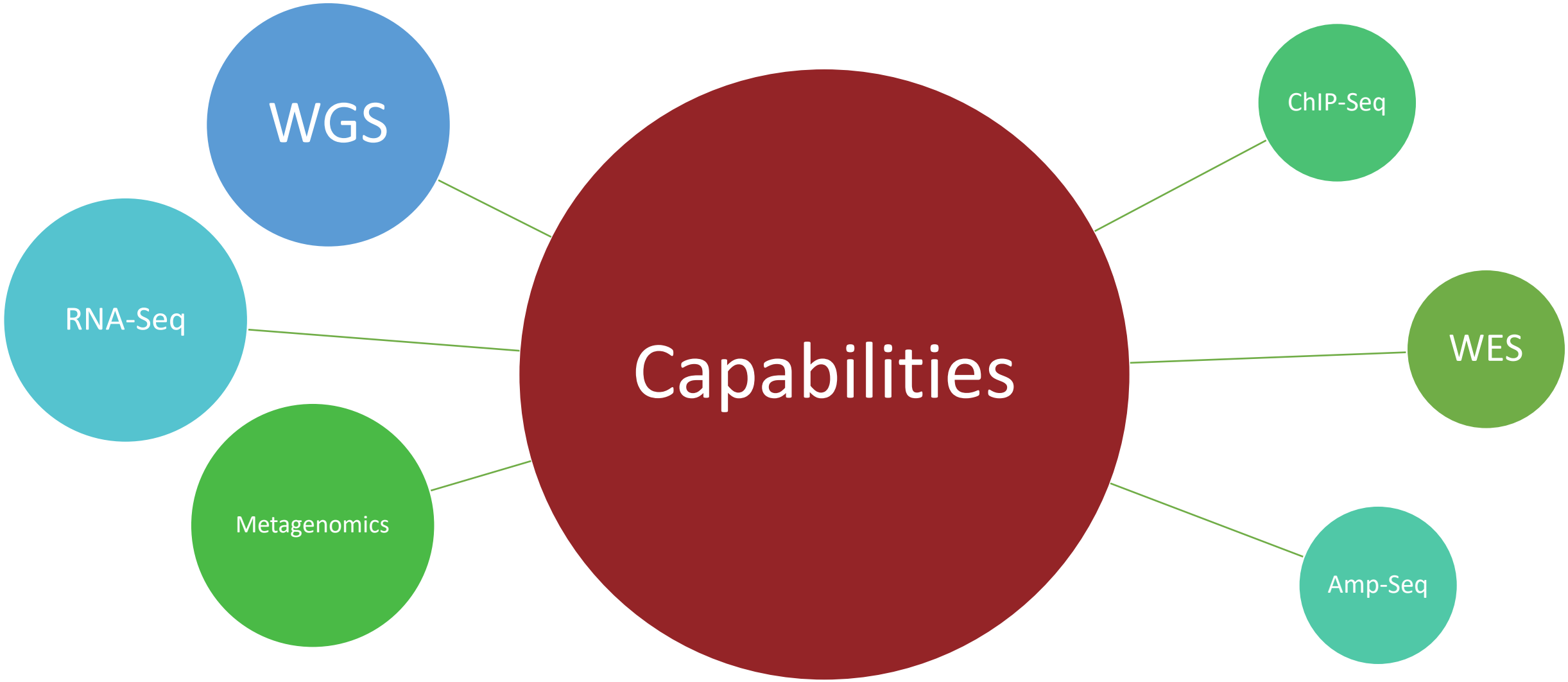
540 GB **3.6 x 10^9 reads**

ILLINOIS TECH

IFSH INSTITUTE FOR FOOD SAFETY AND HEALTH ILLINOIS TECH

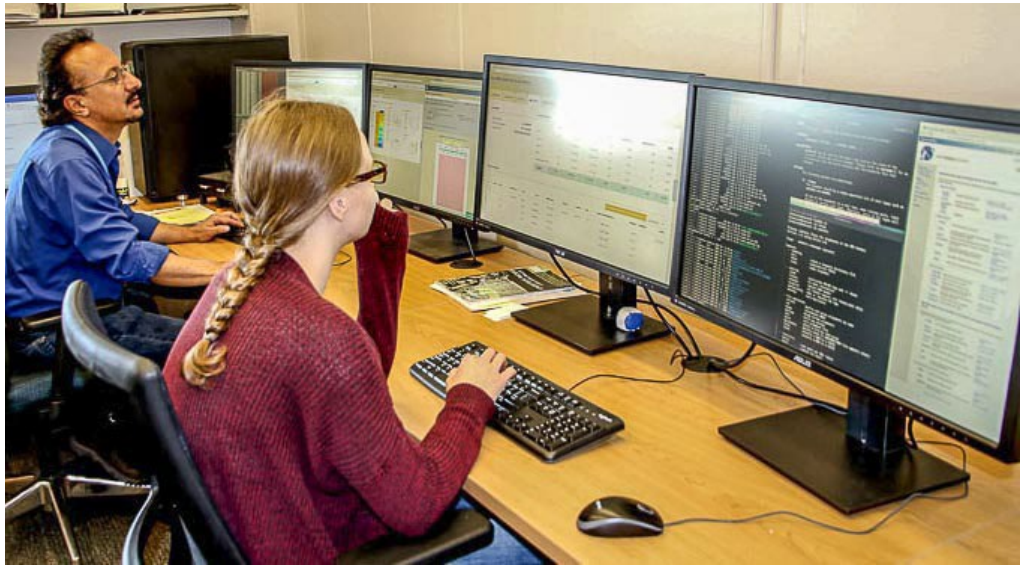
Innovation Through Collaboration

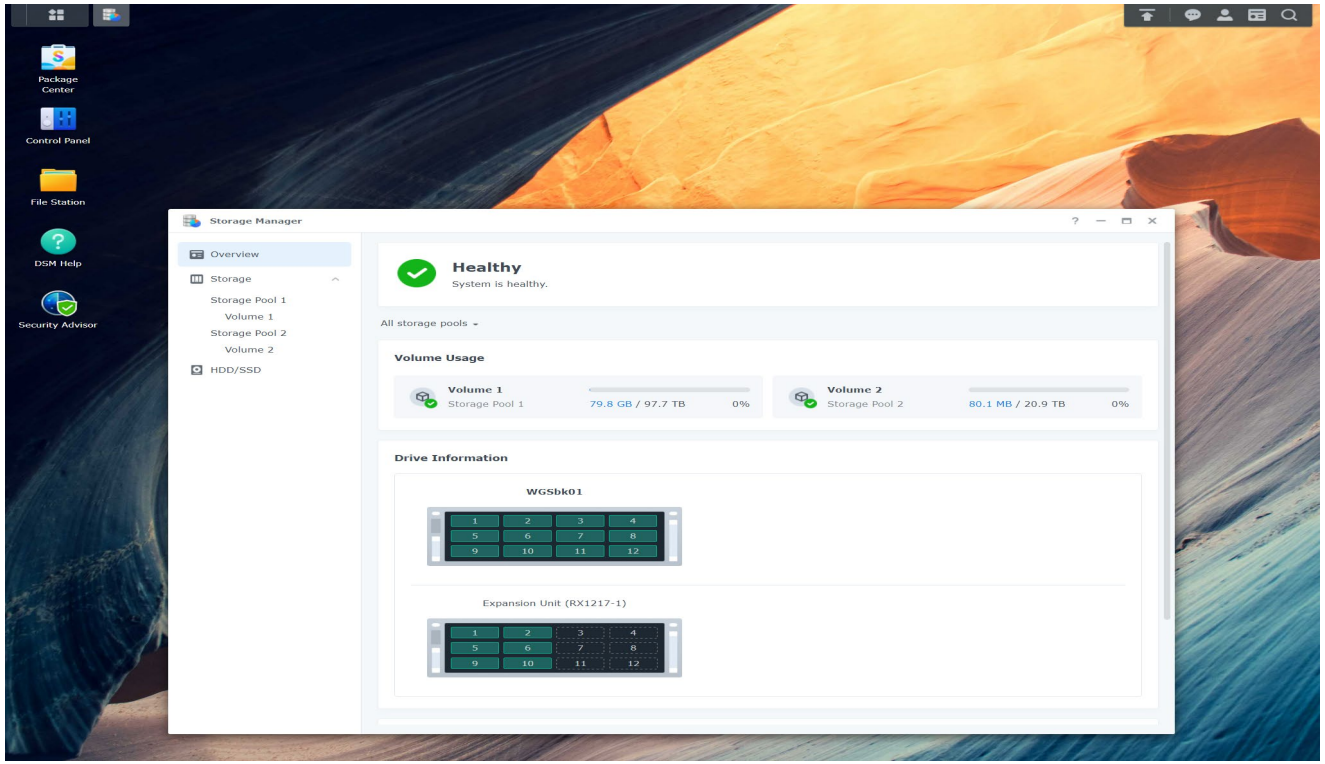
HTS Laboratory

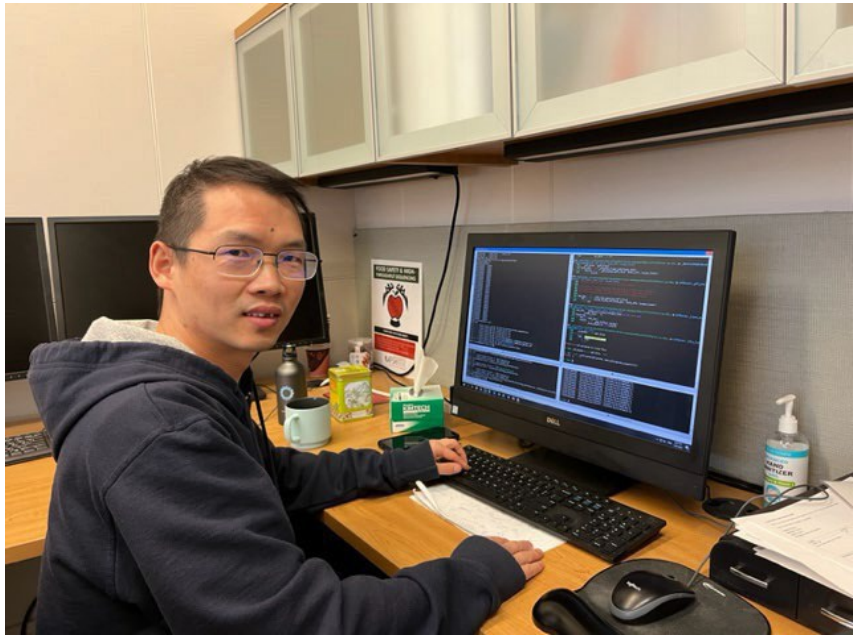


Bioinformatics Facility

- Four HPCs (512 GB - 1 TB RAM; up to 128 CPUs)
- A back-up system (> 140 TB current capacity – expandable)
- Learning and training (e.g. ML and AI)





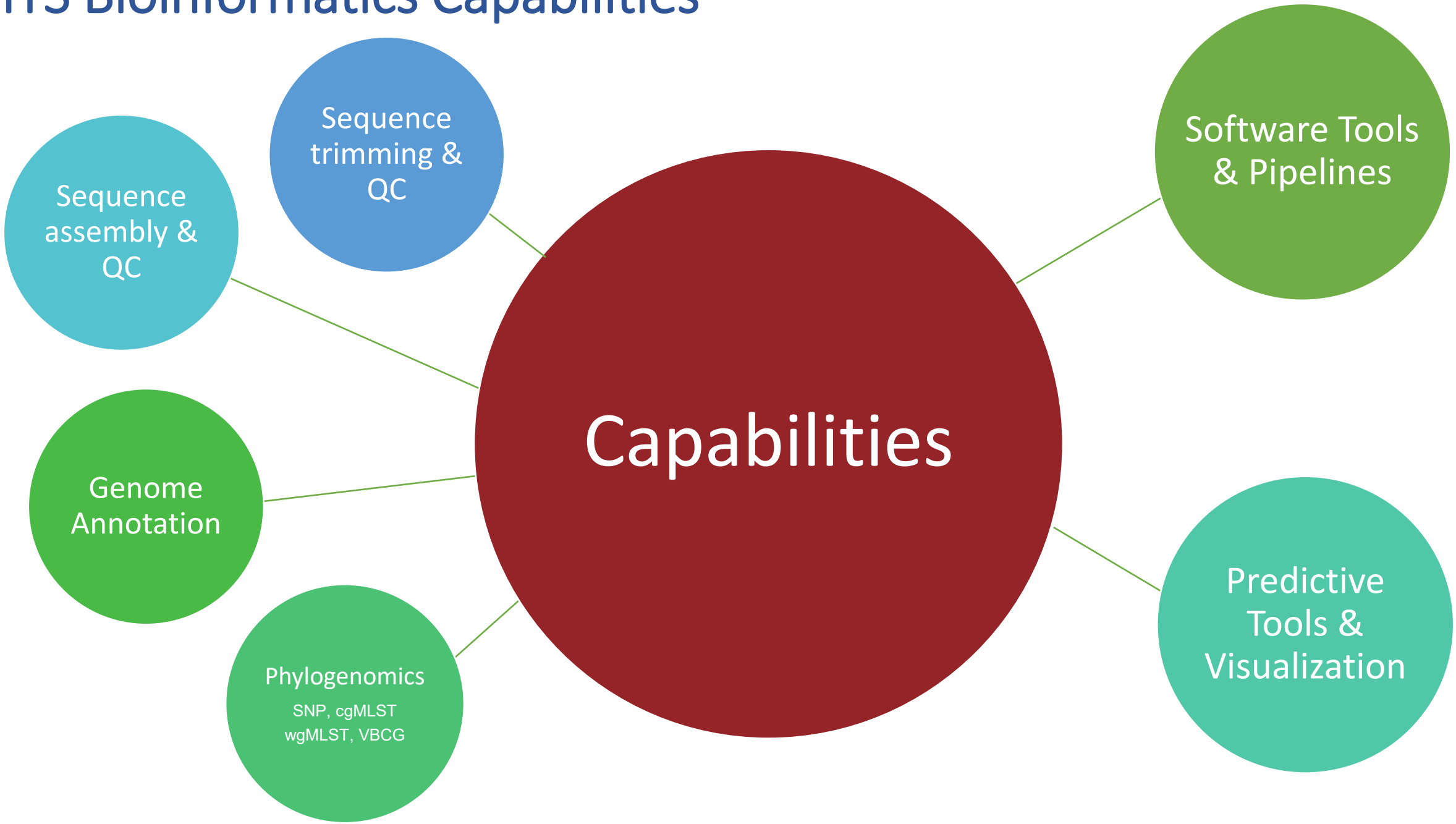


ILLINOIS TECH

IFSH INSTITUTE FOR FOOD SAFETY AND HEALTH ILLINOIS TECH

Innovation Through Collaboration

HTS Bioinformatics Capabilities



New Software & Tools

Phylogenomic Analysis - VBCG

BCG

Amplicon Sequence Analysis Pipeline - ASAP2

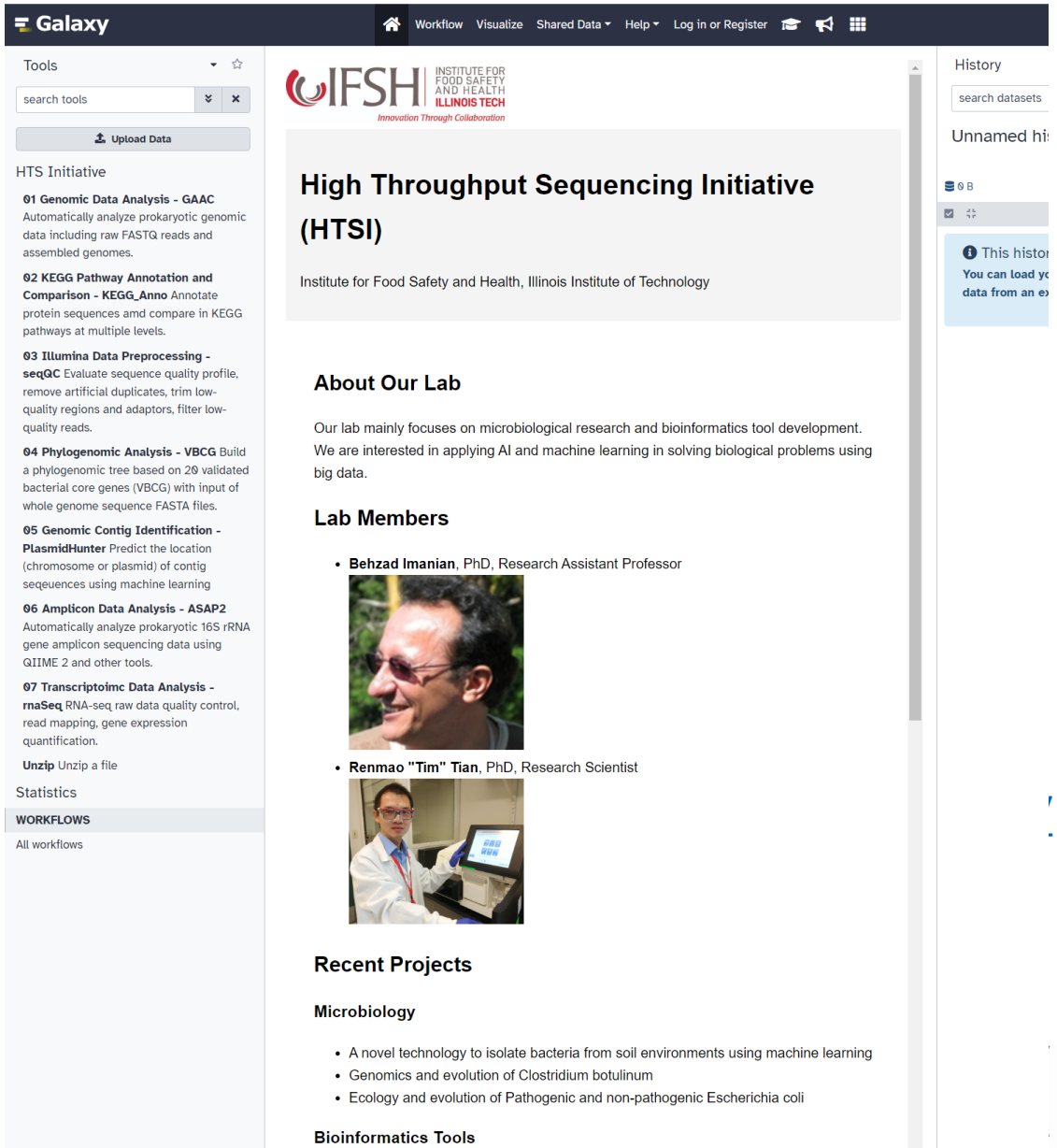
Amplicon Sequence Analysis Pipeline

ASAP 2

PlasmidHunter

PlasmidHunter

ILLINOIS TECH

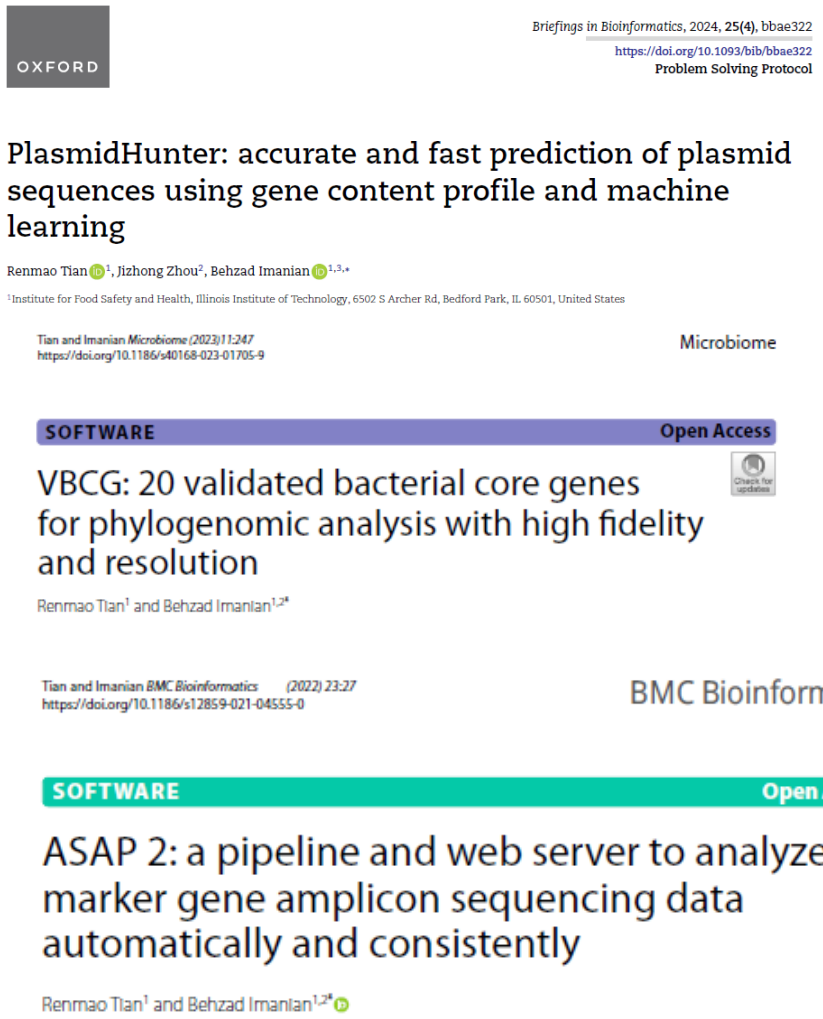


Galaxy Server

FSH INSTITUTE FOR FOOD SAFETY AND HEALTH ILLINOIS TECH

Innovation Through Collaboration

Recent Publications



OXFORD

Briefings in Bioinformatics, 2024, **25(4)**, bbae322
https://doi.org/10.1093/bib/bbae322
Problem Solving Protocol

PlasmidHunter: accurate and fast prediction of plasmid sequences using gene content profile and machine learning

Renmao Tian [1], Jizhong Zhou [2], Behzad Imanian [1,3,*]

[1]Institute for Food Safety and Health, Illinois Institute of Technology, 6502 S Archer Rd, Bedford Park, IL 60501, United States

Tian and Imanian *Microbiome* (2023)11:247
https://doi.org/10.1186/s40168-023-01705-9

Microbiome

SOFTWARE Open Access

VBCG: 20 validated bacterial core genes for phylogenomic analysis with high fidelity and resolution

Renmao Tian[1] and Behzad Imanian[1,2*]

Tian and Imanian *BMC Bioinformatics* (2022) 23:27
https://doi.org/10.1186/s12859-021-04555-0

BMC Bioinformatics

SOFTWARE Open Access

ASAP 2: a pipeline and web server to analyze marker gene amplicon sequencing data automatically and consistently

Renmao Tian[1] and Behzad Imanian[1,2*]

npj | science of food

www.nature.com/npjscifood

REVIEW ARTICLE OPEN

The power, potential, benefits, and challenges of implementing high-throughput sequencing in food safety systems

Behzad Imanian[1,12], John Donaghy[2], Tim Jackson[3,14], Sanjay Gummalla[4], Balasubramanian Ganesan[5], Robert C. Baker[5], Matthew Henderson[6], Emily K. Butler[7], Yingying Hong[7], Brendan Ring[8], Clare Thorp[8,15], Ramin Khaksar[9], Mansour Samadpour[10], Kahlil A. Lawless[11], Iain MacLaren-Lee[12], Heather A. Carleton[13], Renmao Tian[1], Wei Zhang[1] and Jason Wan[1]

genes MDPI

Article

The Light Chain Domain and Especially the C-Terminus of Receptor-Binding Domain of the Botulinum Neurotoxin (BoNT) Are the Hotspots for Amino Acid Variability and Toxin Type Diversity

Renmao Tian [1], Melissa Widel [1] and Behzad Imanian [1,2,*]

[1] Institute for Food Safety and Health, Illinois Institute of Technology, Bedford Park, IL 60501, USA

toxins MDPI

Article

Integration of Complete Plasmids Containing *Bont* Genes into Chromosomes of *Clostridium parabotulinum*, *Clostridium sporogenes* and *Clostridium argentinense*

Theresa J. Smith [1,†], Renmao Tian [2,†], Behzad Imanian [2,3], Charles H. D. Williamson [1], Shannon L. Johnson [4], Hajnalka E. Daligault [4] and Kristin M. Schill [5,*,‡]

[1] Pathogen and Microbiome Institute, Northern Arizona University, Flagstaff, AZ 86011, USA; terrys2much@comcast.net (T.J.S.); chase.williamson@nau.edu (C.H.D.W.)

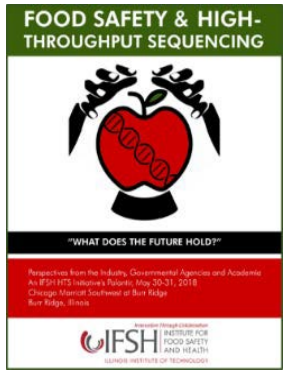
ILLINOIS TECH

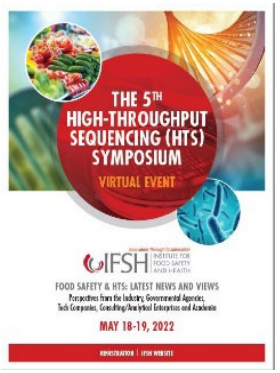
IFSH INSTITUTE FOR FOOD SAFETY AND HEALTH ILLINOIS TECH

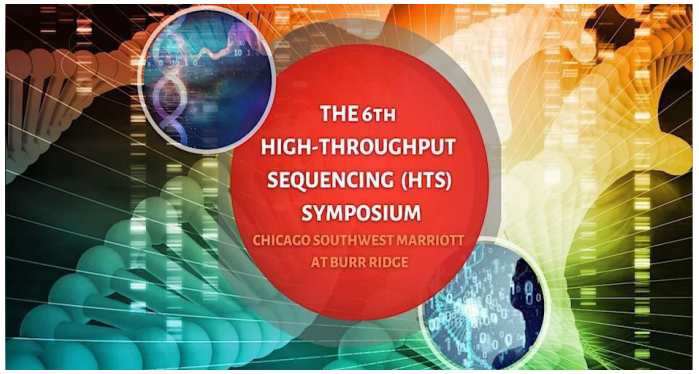
Innovation Through Collaboration

Symposiums Workshops Webinars Roundtables

2016 2017 2018 2019 2022 2023







ILLINOIS TECH

IFSH INSTITUTE FOR FOOD SAFETY AND HEALTH
ILLINOIS TECH
Innovation Through Collaboration

The 7th IFSH HTS Symposium

May 2025 - Chicago

ILLINOIS TECH

IFSH INSTITUTE FOR FOOD SAFETY AND HEALTH ILLINOIS TECH

Innovation Through Collaboration

Ongoing and Future Projects

Developing Analytical and Predictive Tools

Utilizing ML and AI

Evolution of Pathogenicity

Genomic distinctions between pathogens and non-pathogens (genes, genome content, kmers, …)
LLM (genome and protein language models)

Microbiomes Characterization

Characterization of microbial communities (composition, succession and links to events/traits in a longitudinal study in the State of Illinois)

Microbiomes Manipulation

Study the effects of manipulation of microbiomes in the environment by addition & removal of microbes/chemicals

Questions/Comments?