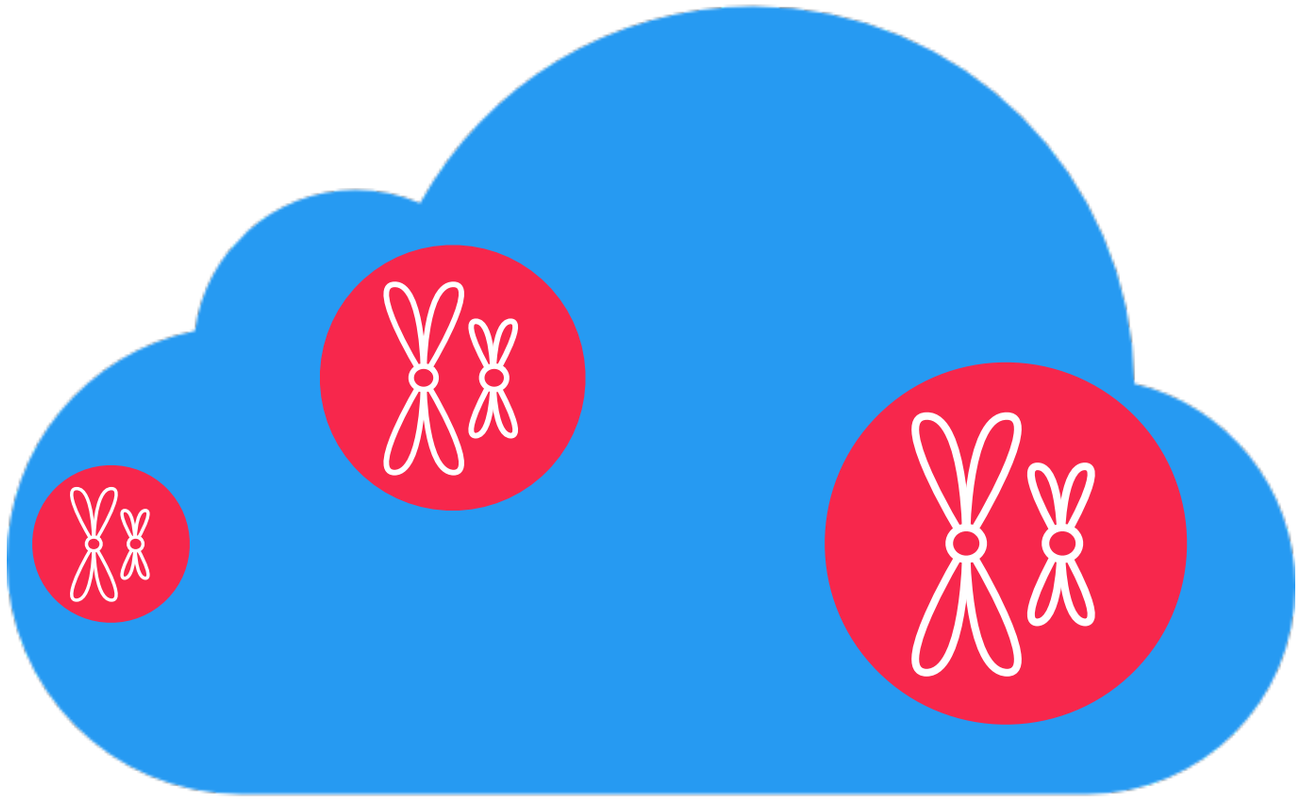


LISA WU WILLS, DUKE UNIVERSITY

GENESIS: A COMPOSABLE HARDWARE ACCELERATION FRAMEWORK FOR GENOME ANALYSIS


My Research Goal #1: **Design and deploy highly efficient domain-specific hardware accelerators to advance state-of-the-art emerging applications.**

My Research Goal #2: **Democratize end-to-end accelerated system development and deployment while leveraging hardware acceleration to advance emerging application domains in the interdisciplinary area of computer architecture and healthcare.**

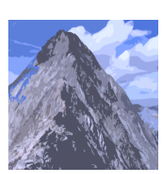
FPGA ACCELERATED INDEL REALIGNMENT IN THE CLOUD [HPCA 2019]

LISA WU, DAVID BRUNS-SMITH, FRANK NOTHAFT, QIJING HUANG, SAGAR KARANDIKAR, HOWARD MAO, BRENDAN SWEENEY, KRSTÉ ASANOVIC, DAVID PATTERSON, AND ANTHONY JOSEPH

GENESIS: A HARDWARE ACCELERATION FRAMEWORK FOR GENOMIC DATA ANALYSIS [ISCA 2020, IEEE MICRO TOP PICK 2021]

TAE JUN HAM, DAVID BRUNS-SMITH, BRENDAN SWEENEY, YEJIN LEE, SEONG HOON SEO, U GYEONG SONG, YOUNG H OH, KRSTÉ ASANOVIC, JAE W LEE, AND LISA WU WILLS

Berkeley Architecture Research

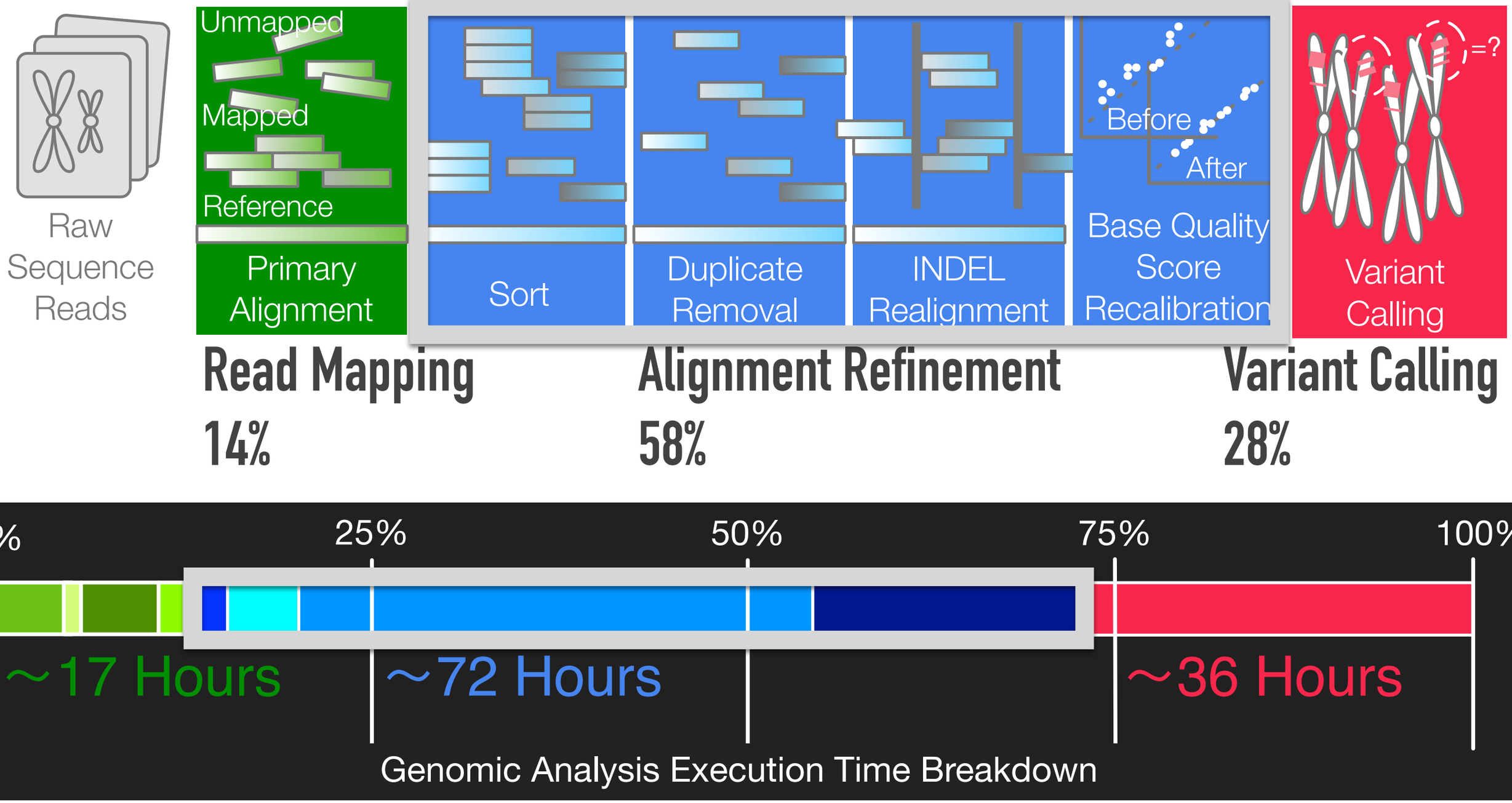


APEX Lab @ Duke

GOAL OF GENOMIC ANALYSIS:

Identify the **nucleotide differences (or variants** between an individual genome and the reference genome at a given position, with **acceptable accuracy**.

ALIGNMENT REFINEMENT IS THE SLOWEST PIPELINE

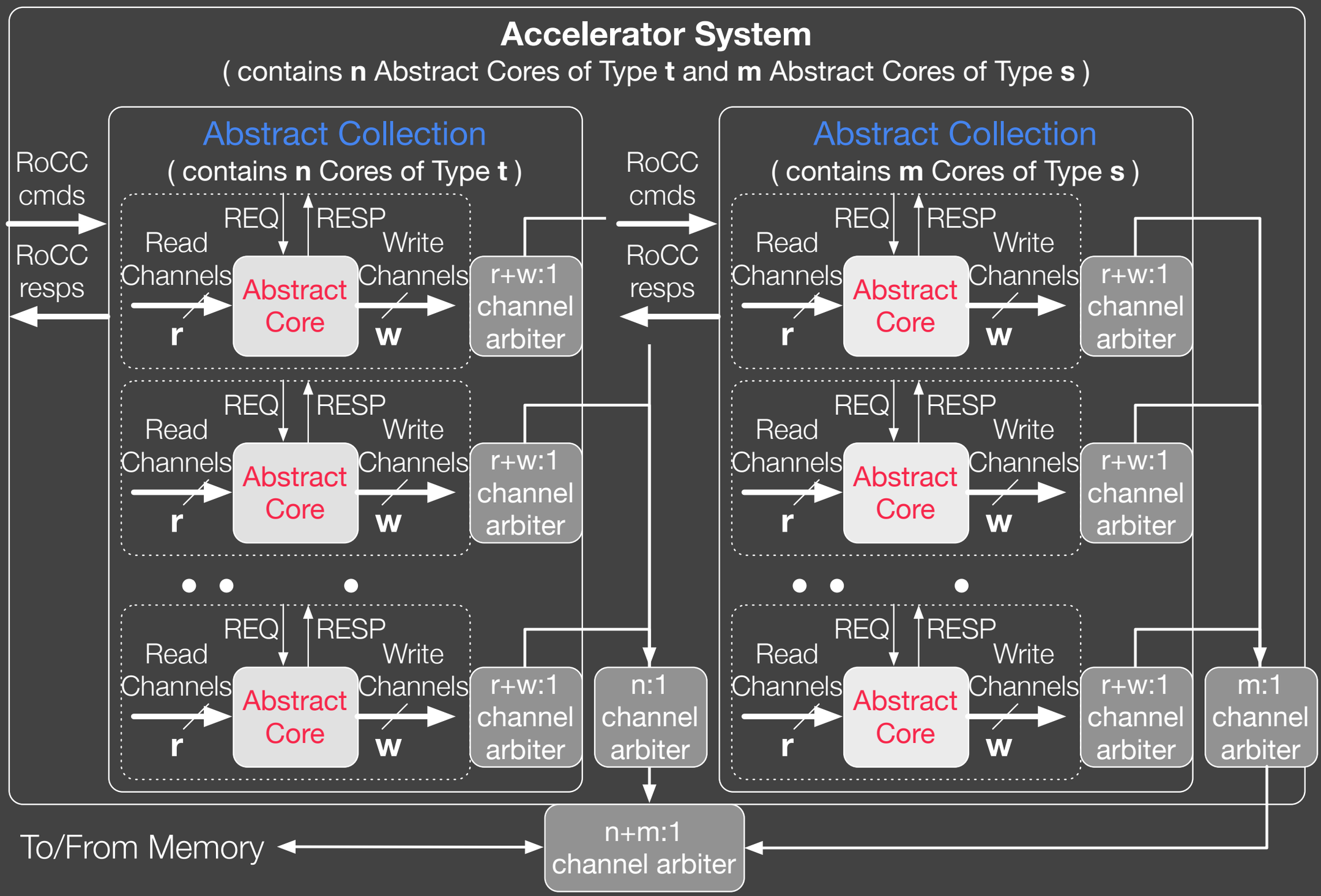


WHAT DOES DATABASE ANALYTICS AND GENOMIC ANALYSIS HAVE IN COMMON?

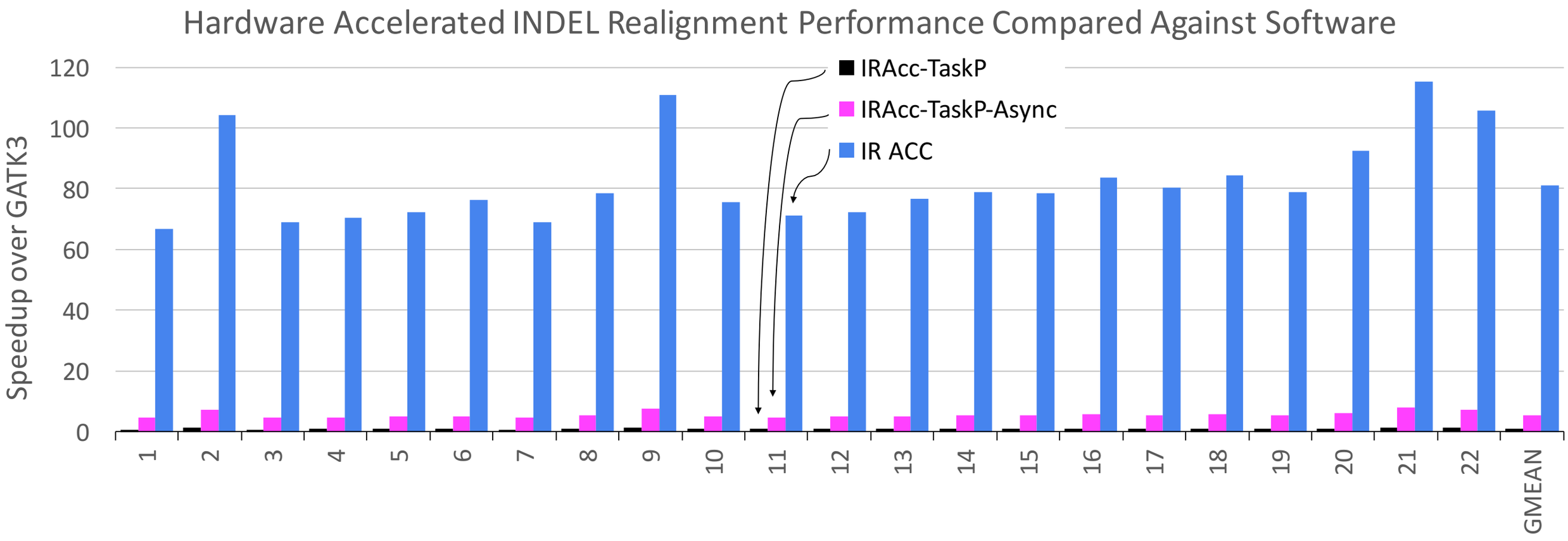
Generic Data Manipulations (i.e. aggregation, sorting)!

- Domain-Specific Language: SQL+
- Genomic Hardware Library
- Accelerator Composer

Accelerator Composer Design Templates



OUR ACCELERATED IR SYSTEM PERFORMS 81X BETTER THAN SOFTWARE RUNNING 8 THREADS



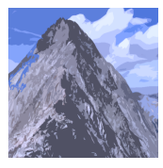
42 hours —> roughly 30 minutes

Berkeley Architecture Research | APEX Lab @ Duke

IMPACTS/SIGNIFICANCE

ACCELERATING COMMON PRIMITIVES ACROSS DOMAINS ALLOWS THE SHARING, REUSING, AND COMPOSITION OF ACCELERATED SYSTEMS ACROSS DOMAINS, LOWERING DEVELOPMENT EFFORT.

Berkeley Architecture Research

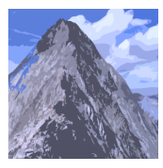


APEX Lab @ Duke

IMPACTS/SIGNIFICANCE

LEVERAGE AN ALREADY-STANDARDIZED LANGUAGE AS THE DSL AND CONSTRUCT PRIMITIVE OPERATORS THAT DIRECTLY MAP SOFTWARE PRIMITIVES TO HARDWARE BLOCKS PRODUCES EFFICIENT ACCELERATED SYSTEMS.

Berkeley Architecture Research



APEX Lab @ Duke

IMPACTS/SIGNIFICANCE

THIS DEVELOPMENT METHODOLOGY CAN BE ADOPTED FOR VARIOUS DOMAINS BEYOND DATABASE AND GENOMIC ANALYTICS.