Sequence-Based Pangenomic Core Detection

(Work in progress...)

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Faculty of Technology, Bielefeld University

February 11, 2021

Pangenomic Diversity

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What defines a (bacterial) species on a genomic level?

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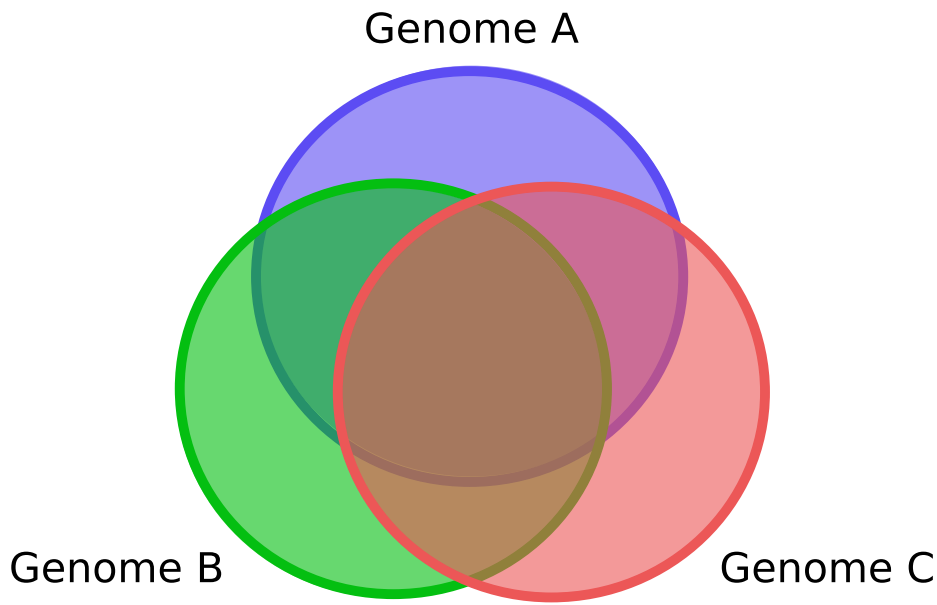

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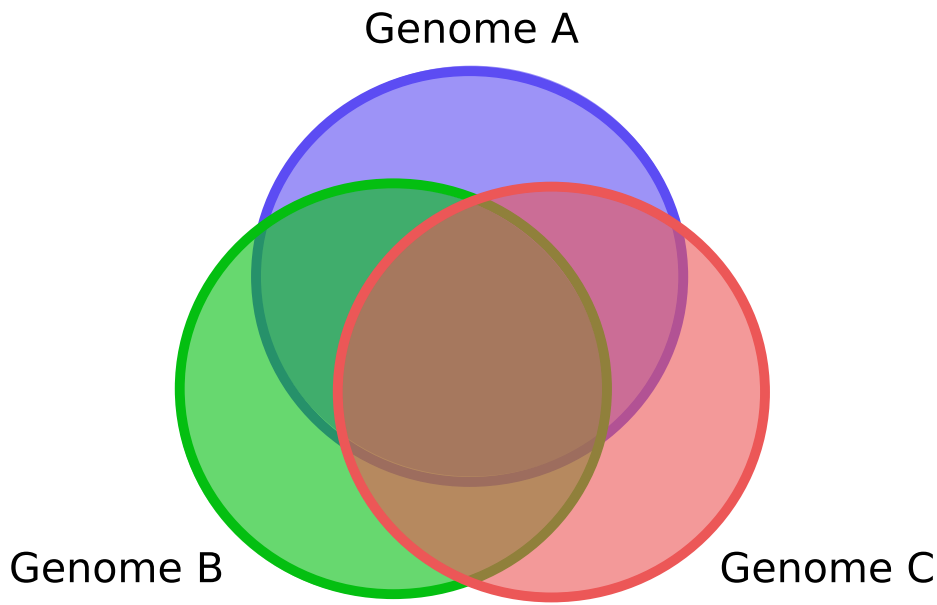

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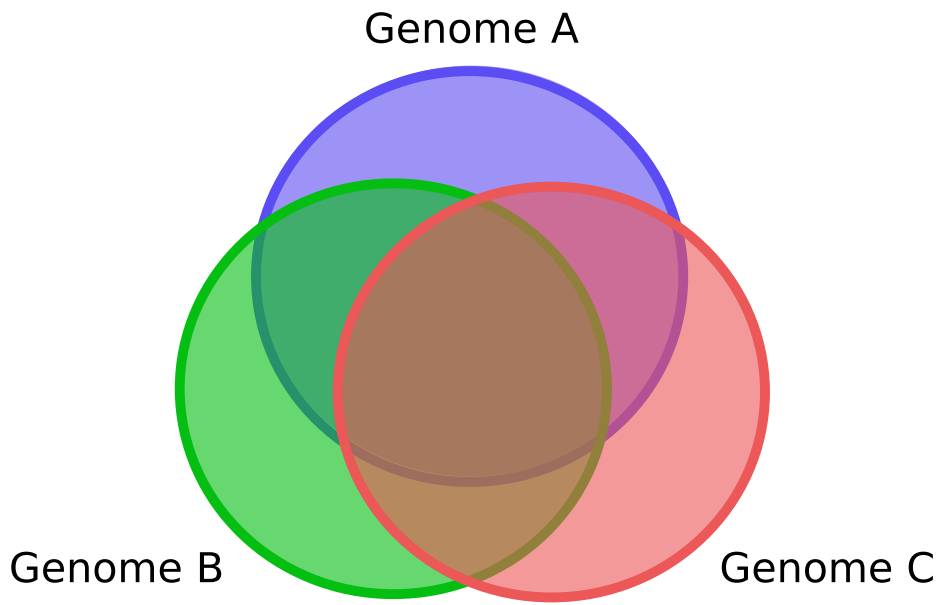

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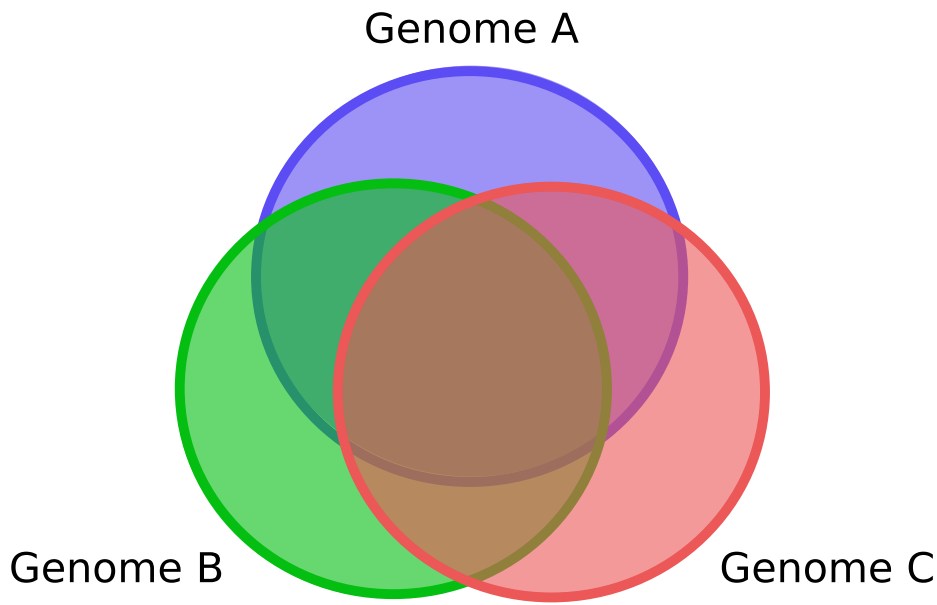

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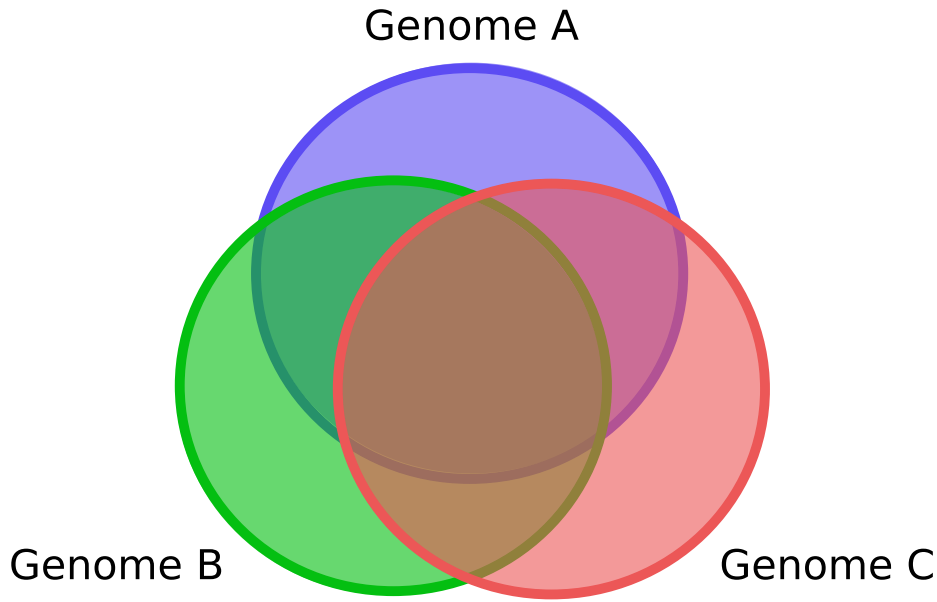

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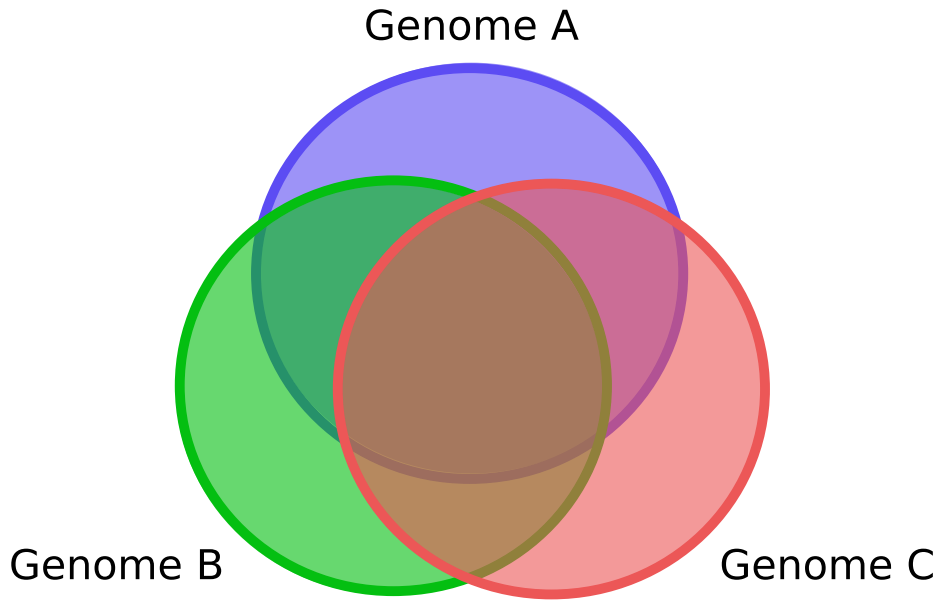

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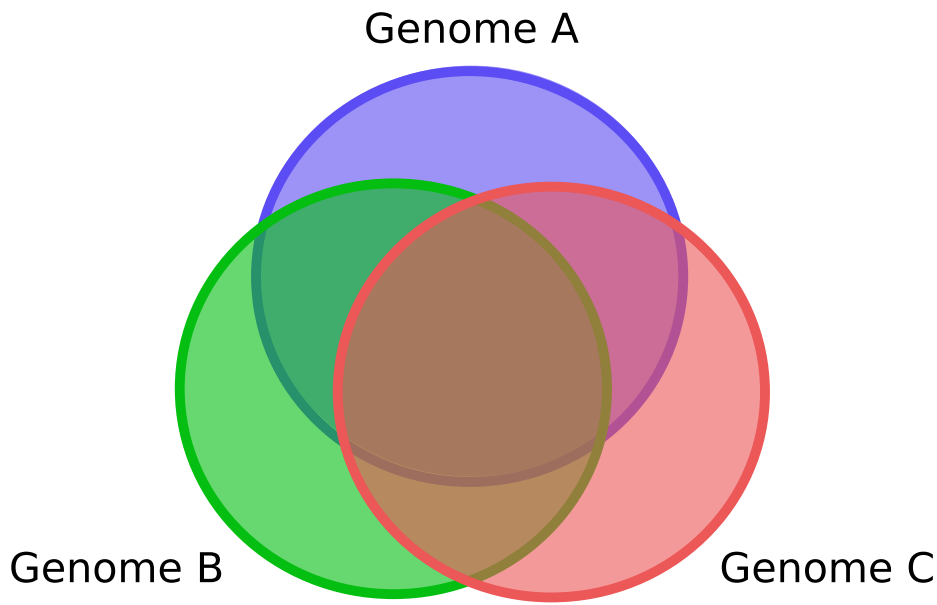

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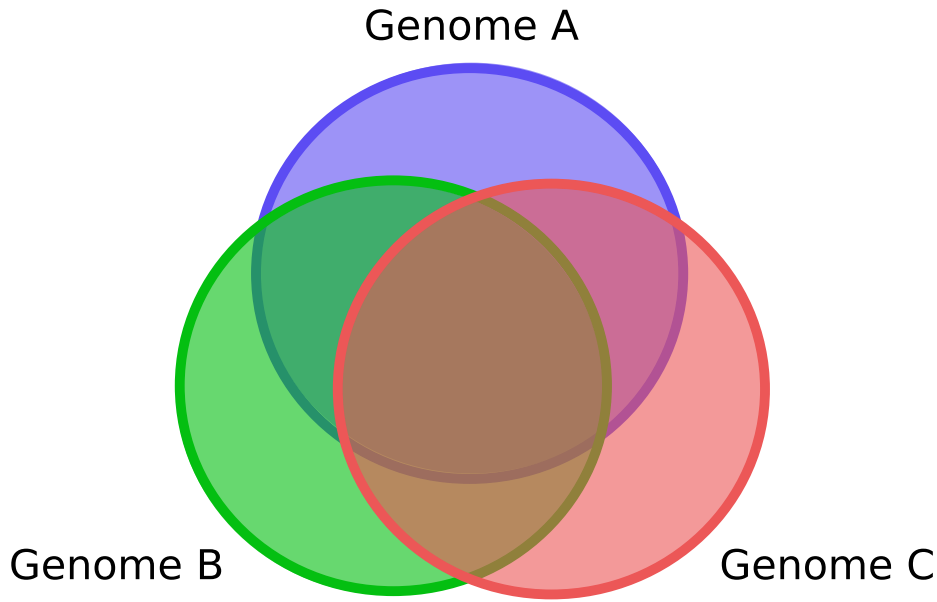

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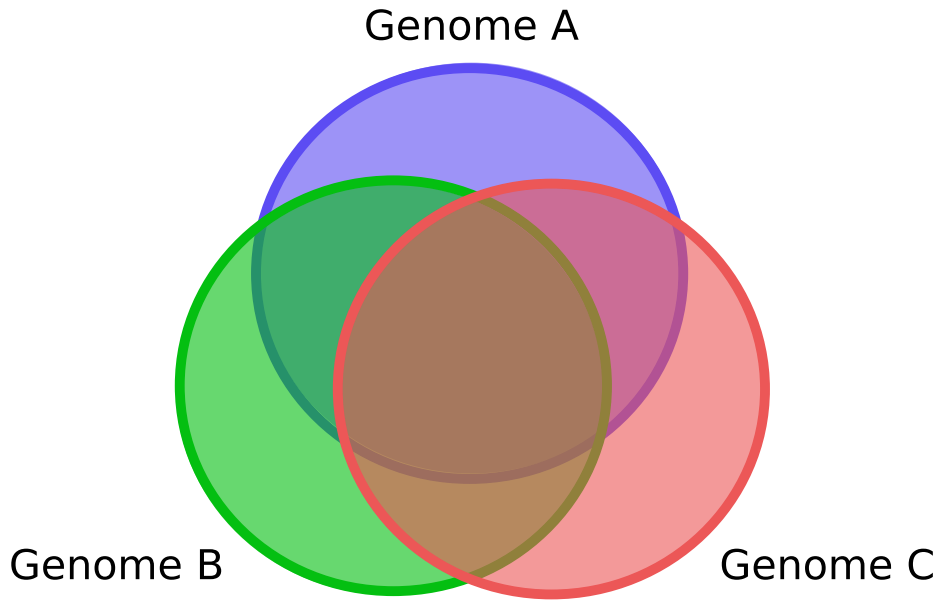

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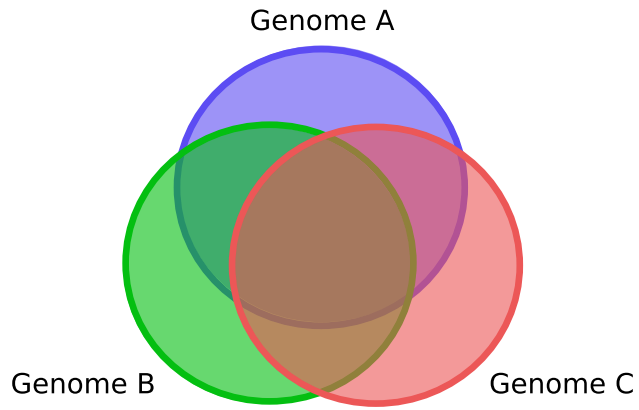
Limitations of Gene Based Approaches

Drawbacks of gene based pangenomic approaches:



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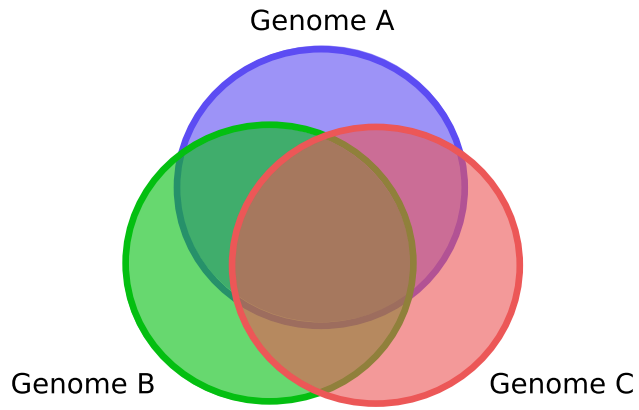

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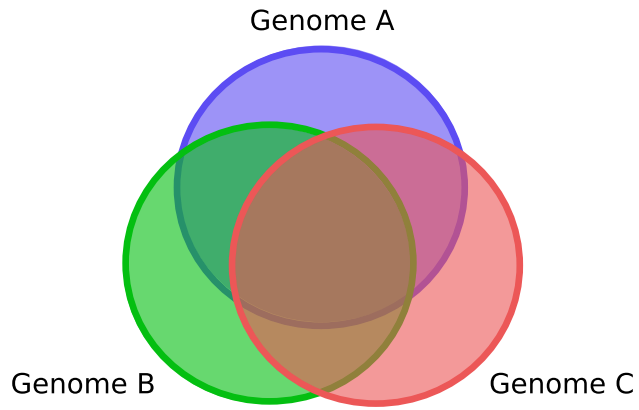

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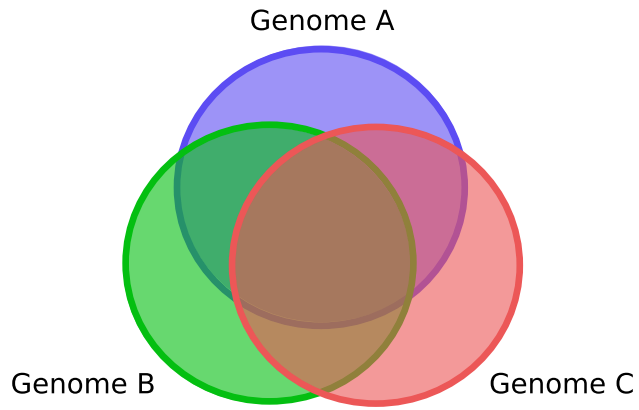
- expensive preprocessing needed (assembly, gene annotation)
- genes from different genomes need to be mapped
- core features below (and above) gene level remain undiscovered



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Realization: $\rightarrow$ e.g. colored de Bruijn graph (C-DBG)

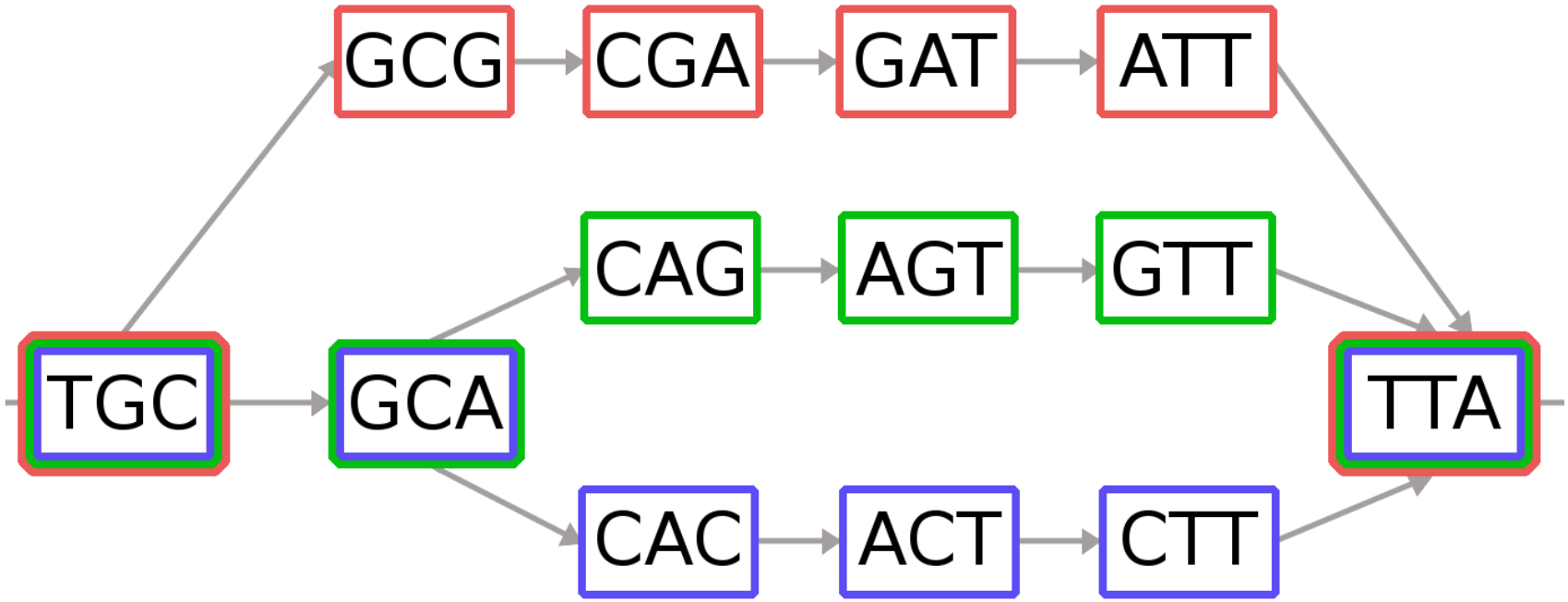

Image courtesy of Guillaume Holley

The Sequence Based Core

How to define the core of a sequence based, graphical pangenome?

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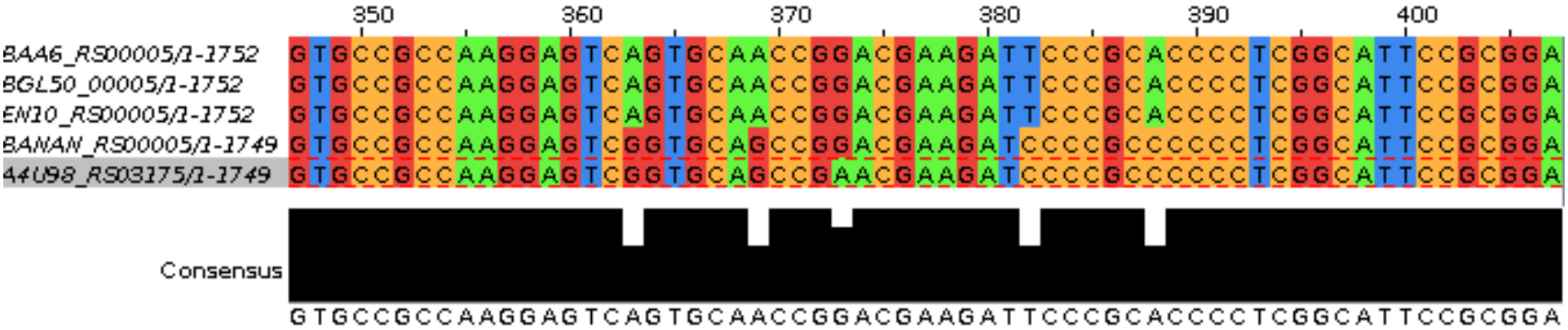

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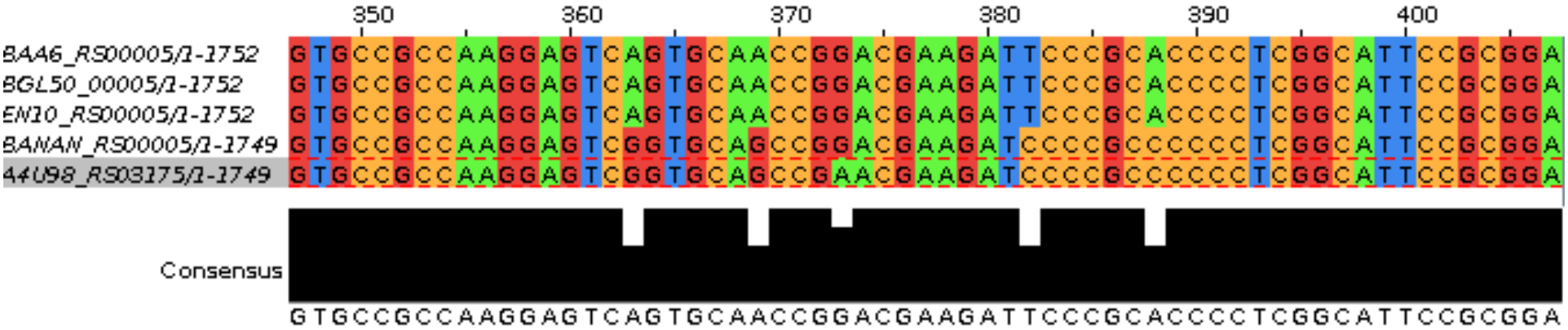
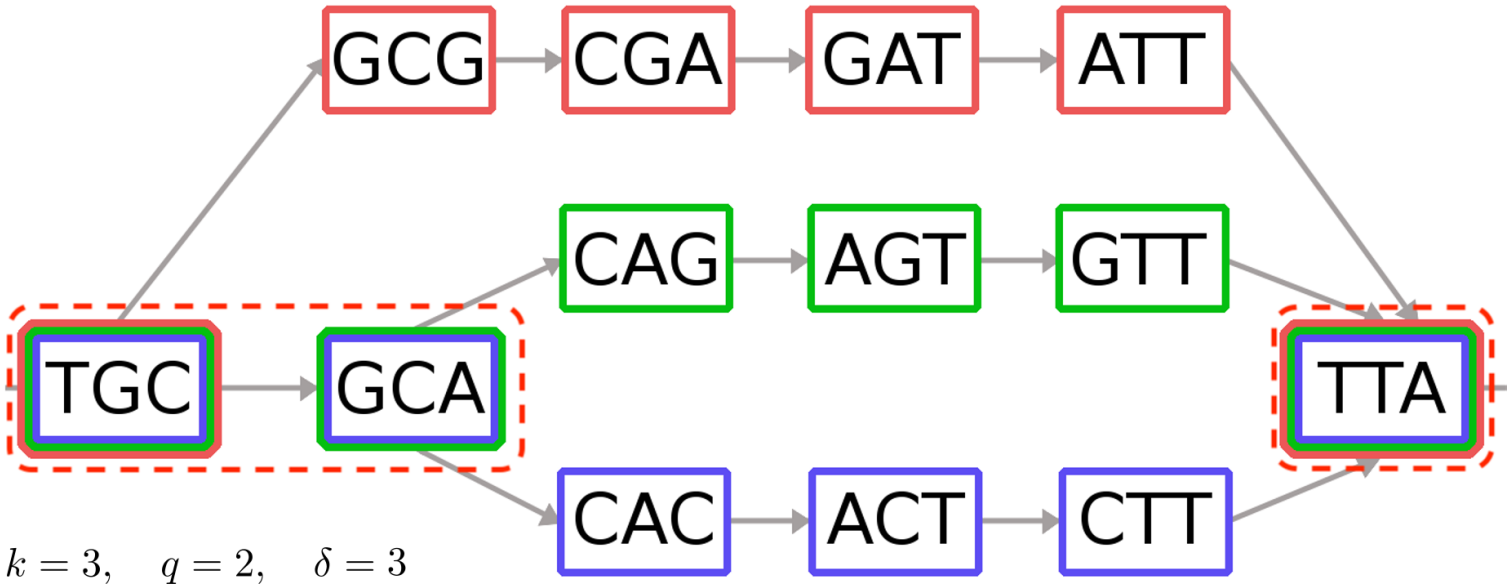


Variations occur frequently even in core sequences!

Our Core Definition

Definition Core k-mer

Let $G = (V, E, C)$ be a C-DBG representing a pangenome $p = \{g_1, g_2, \ldots, g_n\}$. Let $q \in [1, n]$ and $\delta \geq 0$ be two integers. A k-mer $v \in V$ is called *core k-mer* if and only if $|C(v)| \geq q$



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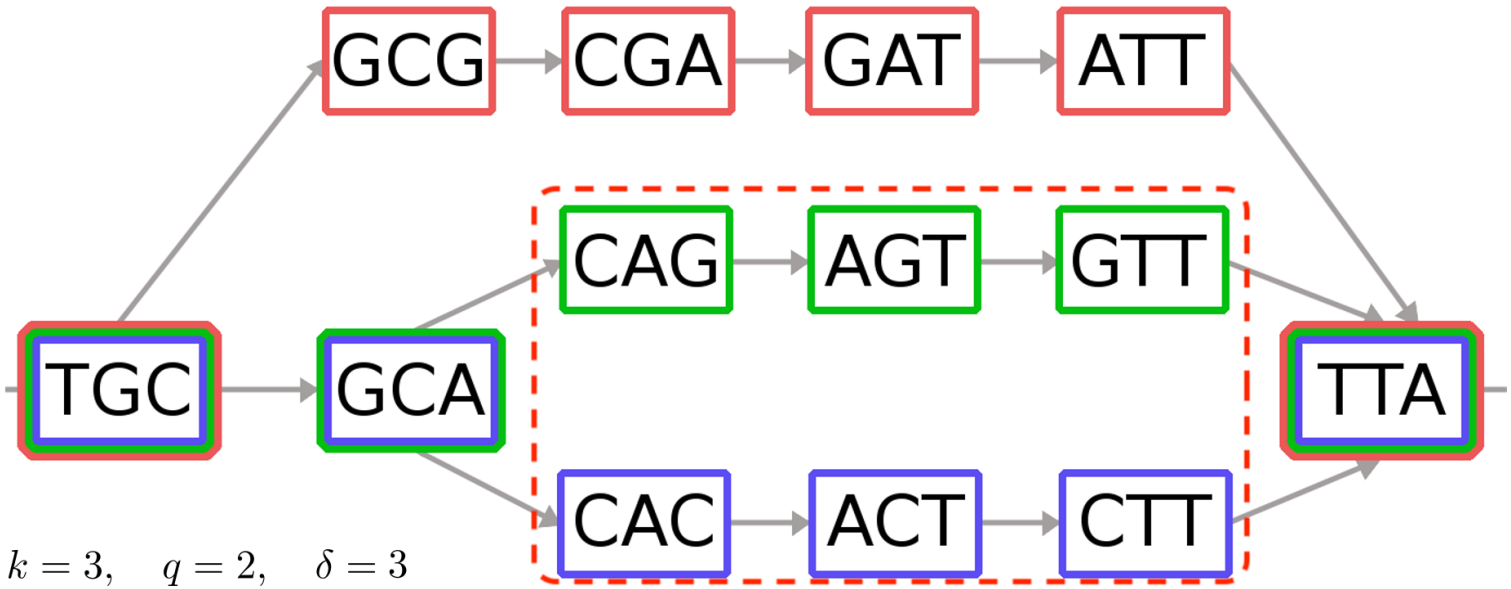
Definition Bridging *k*-mer

A *k*-mer $v \in V$ is called *bridging k-mer* if and only if it lies on a path π connecting two core *k*-mers and $|\pi| \leq \delta + 2$



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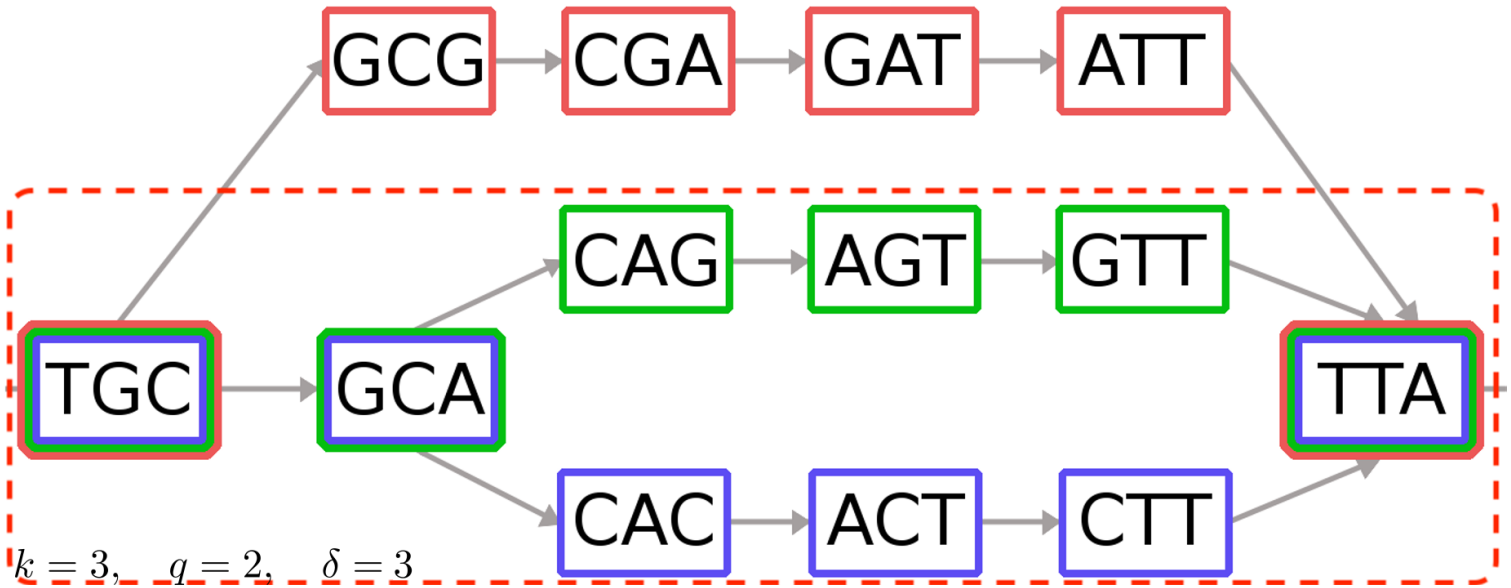
Definition Core Genome

The *core genome* of p is defined as the set of all core and bridging k-mers of G.



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Given a pangenome $p = \{g_1, g_2, \ldots, g_n\}$ represented as a C-DGB of dimension $k \geq 1$. Let $q \in [1, n]$ and $\delta \geq 0$ be two integers. The *Core Detection Problem* is to find the core genome of p.

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Implementation (based on Bifrost) is called *Corer*

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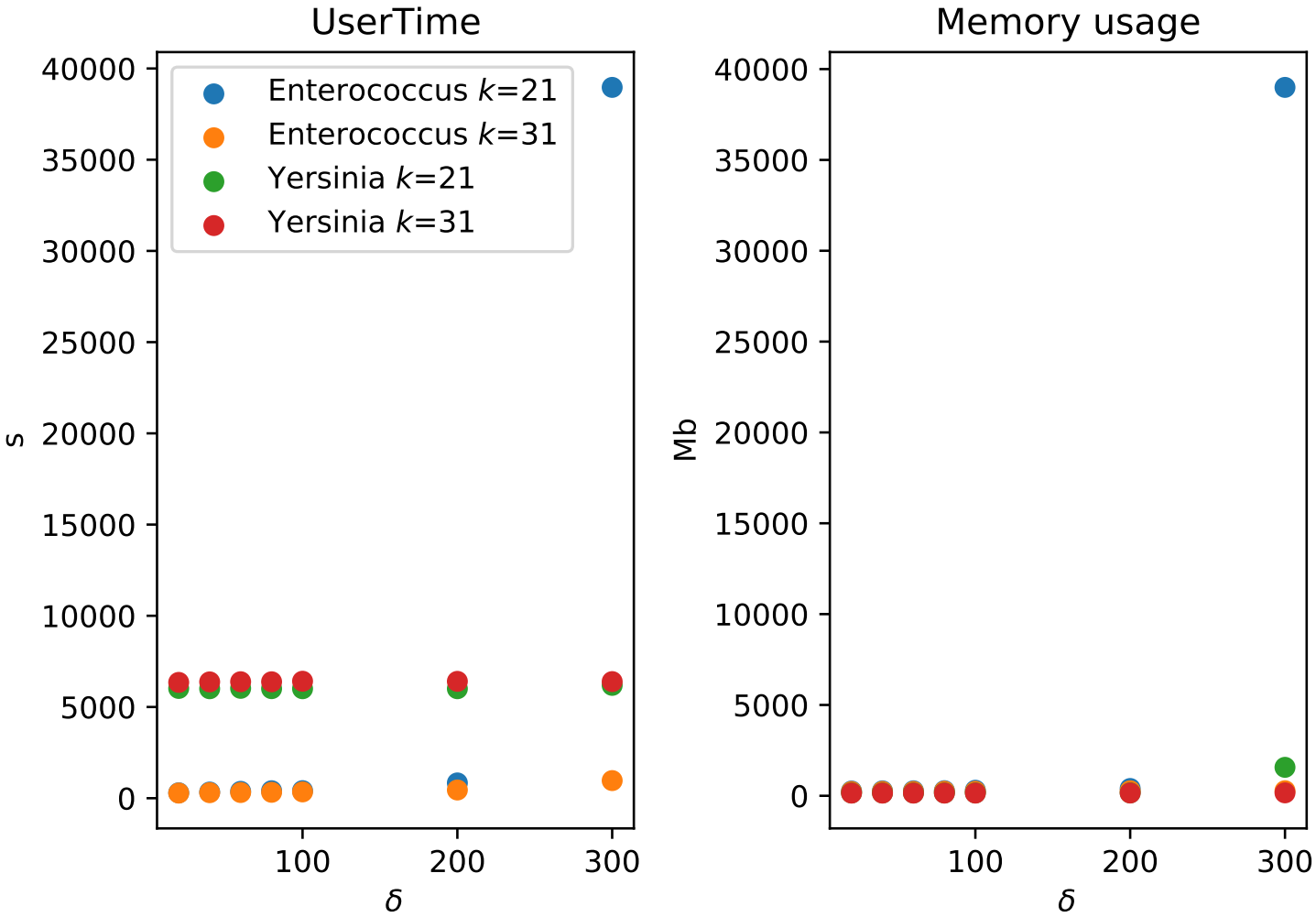
Experiments performed single-threaded on compute cluster

Runtime and memory usage



Comparison to gene based approach

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Directions of future work:

- generalization for accessory genome detection
- hierarchical core genome representation
- generation of a “reference core genome”

End

Thank you for your attention!