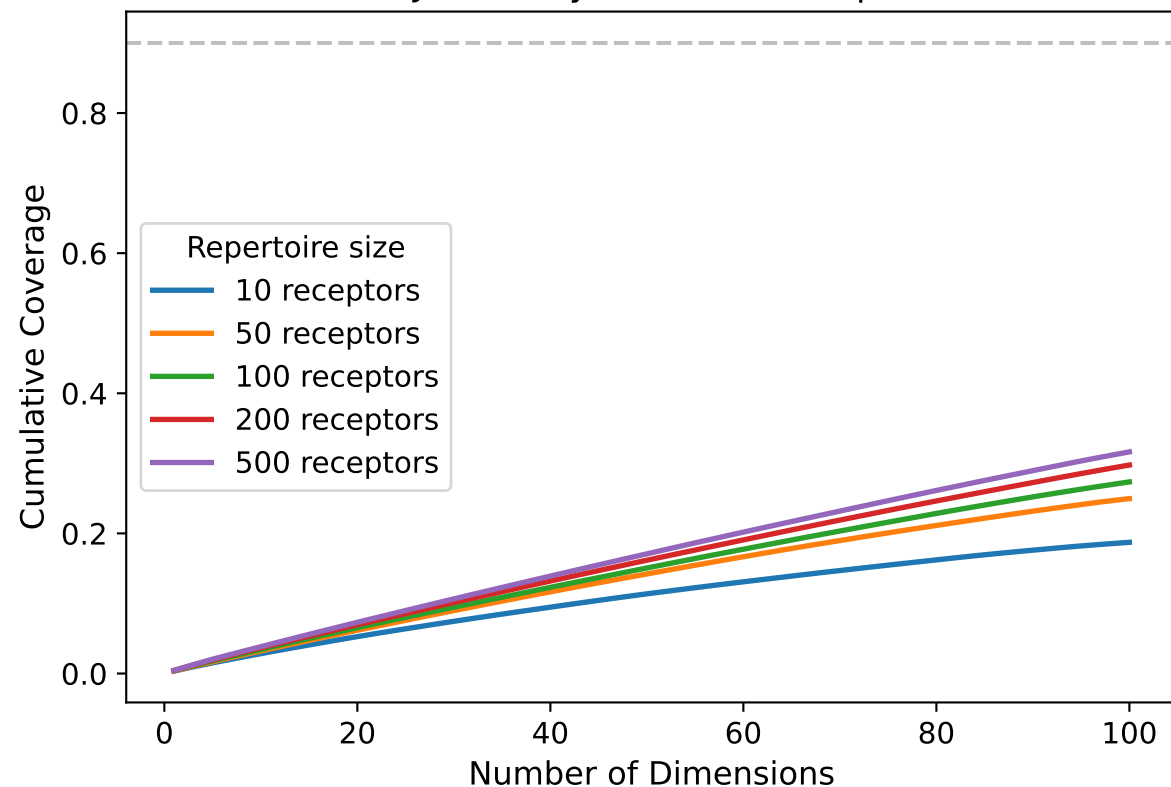


## VDJ Diversity Covers State Space



### V(D)J Recombination Statistics

#### Heavy chain:

- ~50 V segments
- ~25 D segments
- ~6 J segments
- Combinatorial: ~7,500

#### Light chain:

- ~40 V segments
- ~5 J segments
- Combinatorial: ~200

#### Total naive diversity:

~ $1.5 \times 10^6$  combinations

#### With junctional diversity:

~ $10^{11}$  unique receptors

#### Key insight:

This astronomical diversity is not noise—it is systematic exploration of a high-dimensional space.

Random  $\neq$  Purposeless