Mapping Cancer's Hidden Logic in Cancer Genomics:
context-specific fitness cancer landscapes and predictive genomics

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As a computational biologist, my vision is to transform cancer prevention and treatment by integrating multi-omics data with advanced computational methods. By decoding context-specific cancer fitness landscapes, I aim to bridge cancer insights with global population perspectives, driving forward equitable and personalized cancer genomics. My research has led to several impactful discoveries. I systematically identified a new class of cancer predisposition genes (CPGs) by linking Mendelian disease genes to cancer risk. This work, now patented, laid the foundation for population-specific risk prediction in collaboration with Korea's largest patient biobank. I also discovered high-order genetic interactions in cancer, showing how combinations of mutations modulate cancer progression and treatment response. Building on this, I demonstrated that cancer fitness landscapes differ between primary and metastatic tumors, providing insights into context-dependent gene functions. I developed ALFRED, a statistical framework based on Knudson's two-hit hypothesis, which predicted novel CPGs across 10,000+ tumors from 30+ cancer types. This work revealed how rare and common germline variants shape somatic mutation patterns. Earlier in my career, I used systems biology to connect genotype to phenotype, developing tools for predicting protein localization and mapping disease network structures—efforts that my lab is now reviving using machine learning and network biology. Beyond scientific outcomes, my research journey has been shaped by constant learning and overcoming challenges—both technical and personal. From building interdisciplinary collaborations to navigating uncertainty in large-scale data, I've learned to turn obstacles into innovation. These experiences have strengthened my resilience and shaped who I am as a scientist. I remain committed to advancing impactful research while fostering collaboration and inclusivity.