Title: Forecasting LSST Cosmology: Building Pipelines in the Era of Systematics

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Collection/Series: Cosmology and Gravitation

Subject: Cosmology

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Abstract:

The Vera C. Rubin Observatory’s LSST promises unprecedented cosmological constraints, but achieving them requires more than just statistical power—it demands forecasting pipelines that can account for complex astrophysical systematics and modeling challenges on small scales. In this talk, I present work within the LSST Dark Energy Science Collaboration (DESC) to develop a modular forecasting framework that connects realistic data modeling with infrastructure built for extensibility and validation. Drawing on my role as forecasting group lead, I will outline key challenges in pipeline design, the role of validation in maintaining forecast credibility, and the use of good coding practices—such as modularization and model registries—to ensure long-term adaptability. I’ll close with a look at new directions, including forecasts at high redshift and multi-probe combinations, underscoring how thoughtful infrastructure enables reliable science in the LSST era.

FORECASTING LSST COSMOLOGY
building pipelines
in the era of systematics

WCA // PI // MAY 2025

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LSST DESC/NASA ROMAN/DES

WHY FORECASTING MATTERS?

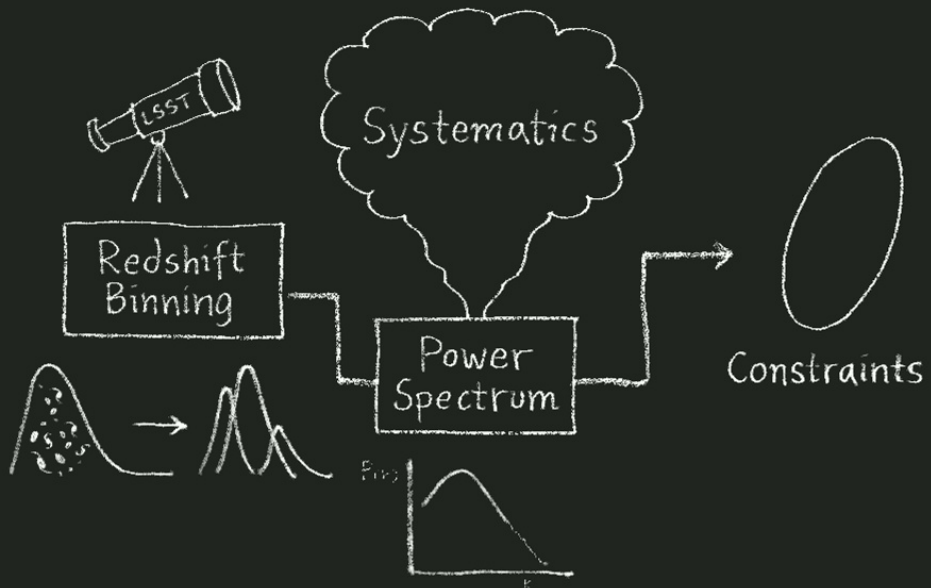
- stage-IV surveys: statistical power
- systematics dominated (scales, nlin)
- we must model what we don't know
- forecasting must include realism, not just precision
- infrastructure must scale with complexity

'we are doing astrophysics with cosmological probes'

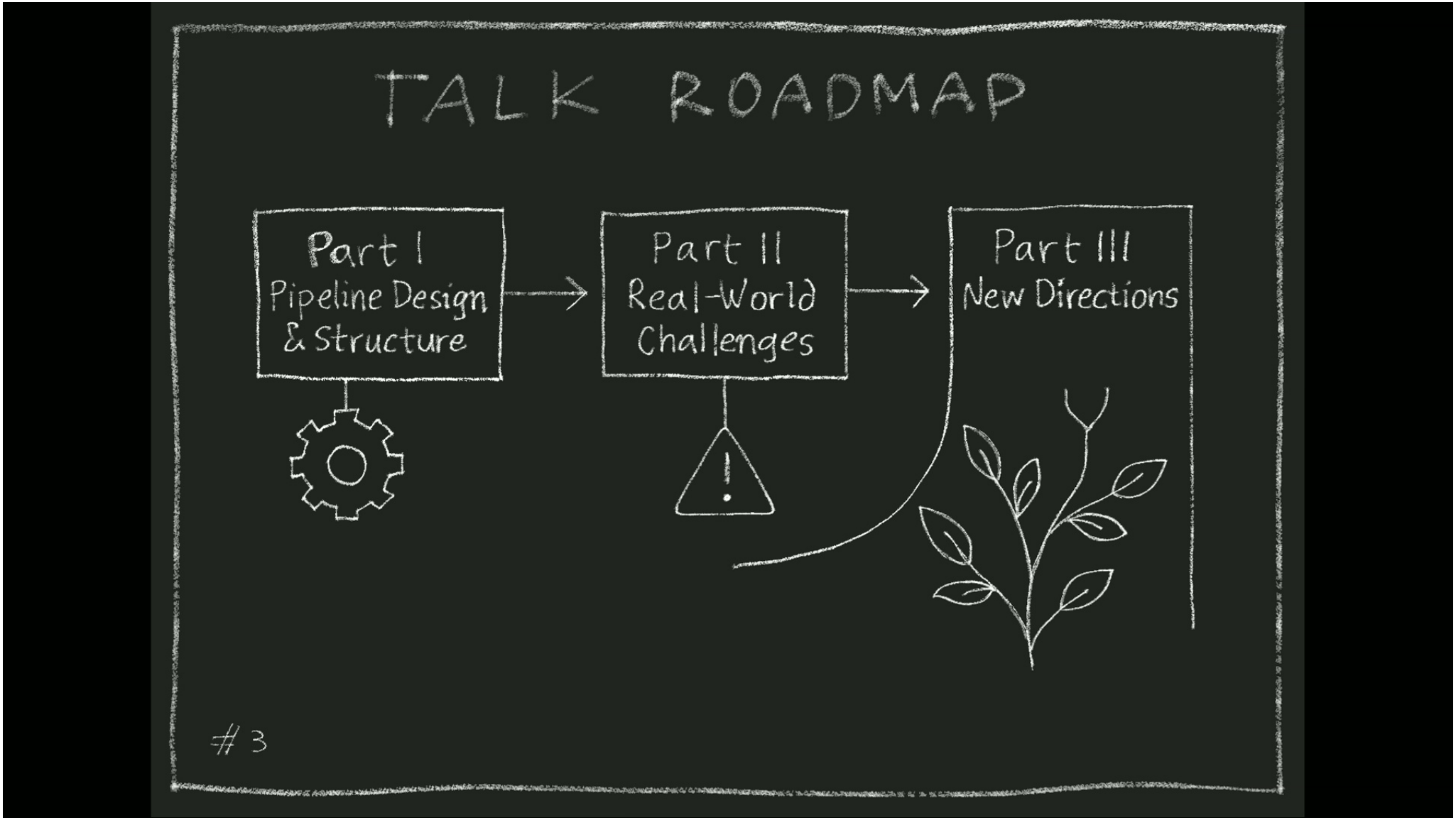
#1

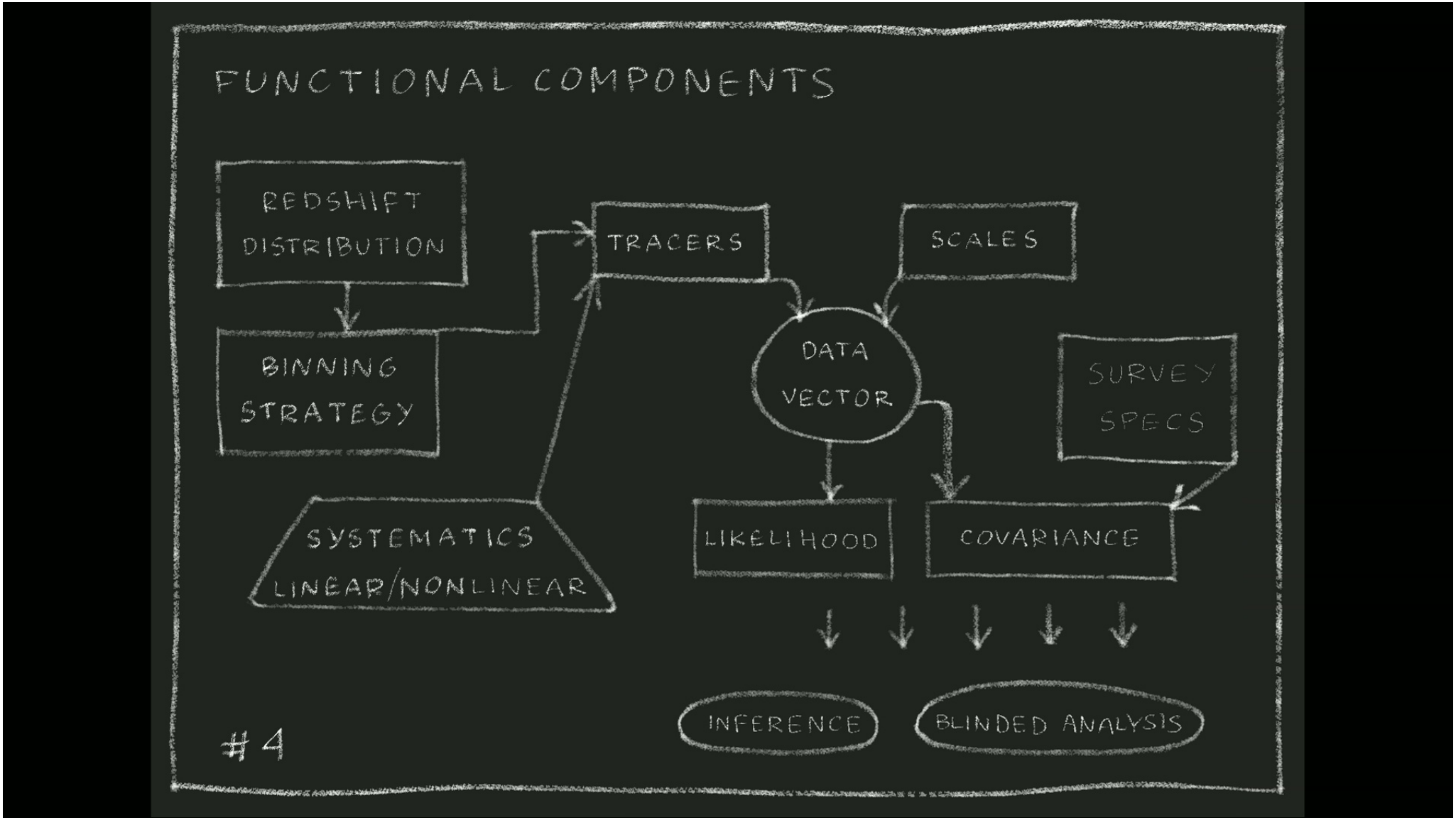
FORECASTING ≠ JUST STATISTICS

- then: small Fisher + idealized model
- now: realistic modeling + survey conditions
- forecasting must simulate full analysis pipeline
- systematics affect observables, not just parameters
- requires modular, extensible infrastructure



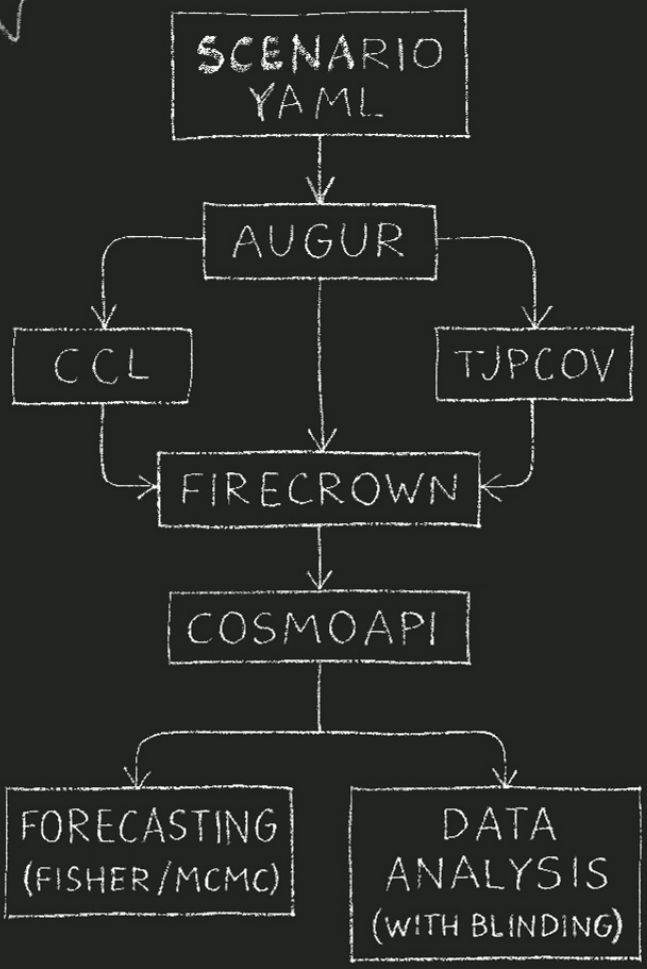
#2


TALK ROADMAP
Part I
Pipeline Design & Structure
Part II
Real-World Challenges
Part III
New Directions
#3


FUNCTIONAL COMPONENTS
REDSHIFT DISTRIBUTION
TRACERS
SCALES
BINNING STRATEGY
DATA VECTOR
SURVEY SPECS
SYSTEMATICS LINEAR/NONLINEAR
LIKELIHOOD
COVARIANCE
INFERENCE
BLINDED ANALYSIS
#4

PIPELINE DESIGN

current / in development



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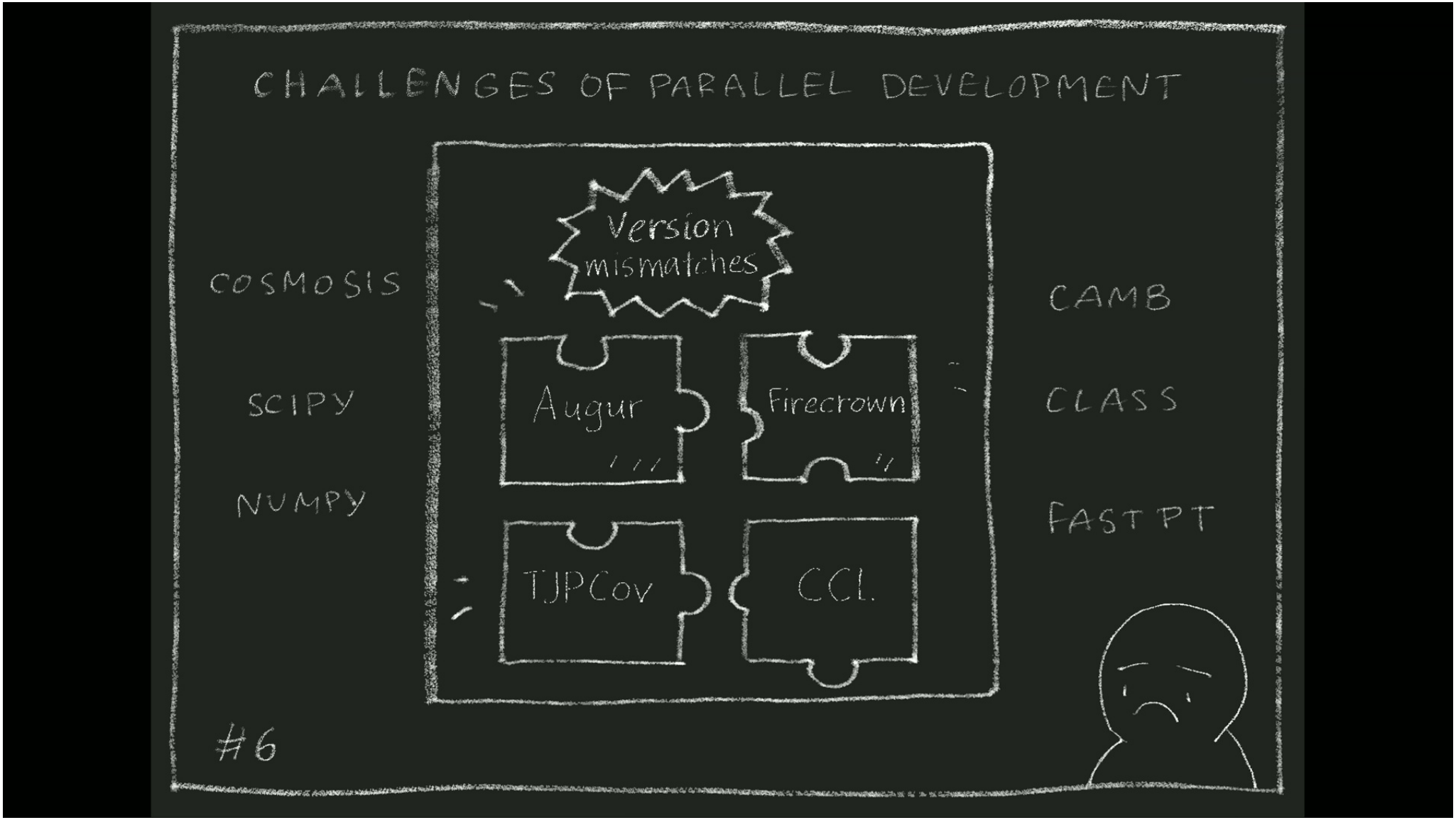
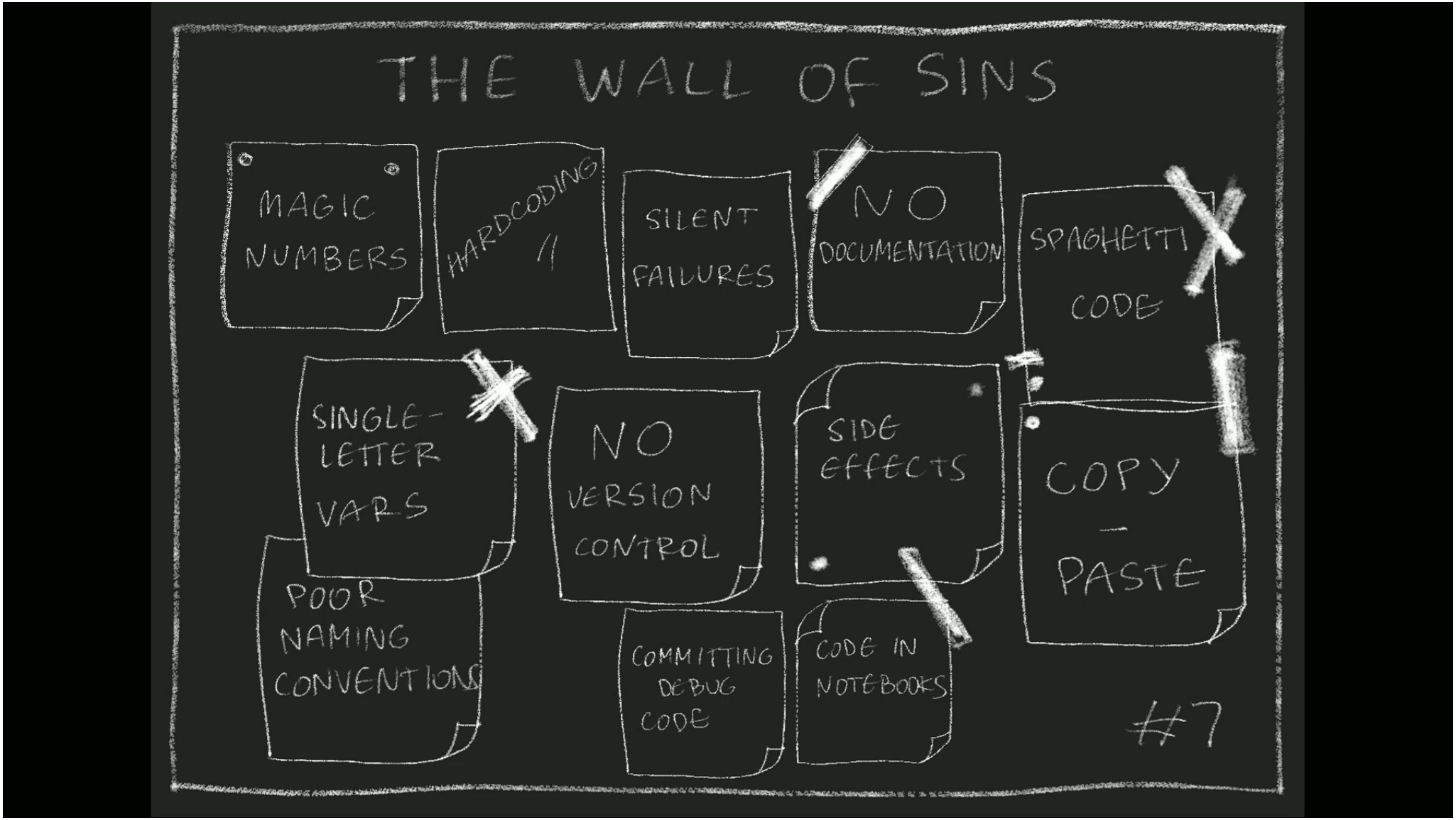
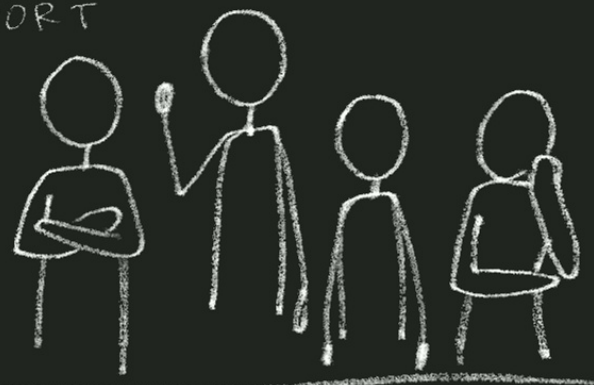

CHALLENGES OF PARALLEL DEVELOPMENT
COSMOSIS
SCIPY
NUMPY
Version mismatches
Augur
Firecrown
TJPCov
CCL
CAMB
CLASS
FAST PT
#6


THE WALL OF SINS
MAGIC NUMBERS
HARDCODING /1
SILENT FAILURES
NO DOCUMENTATION
SPAGHETTI CODE
SINGLE-LETTER VARS
NO VERSION CONTROL
SIDE EFFECTS
COPY-PASTE
POOR NAMING CONVENTIONS
COMMITTING DEBUG CODE
CODE IN NOTEBOOKS
#7

THE SOCIOLOGY

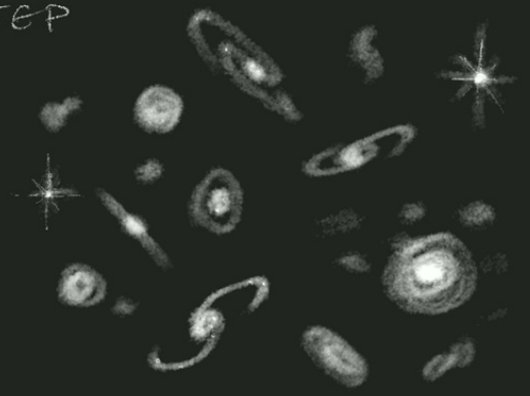
- ☑ MISALINGMENT OF PRIORITIES
- ☑ LEGACY VS INNOVATION
- ☑ UNDERPREPARED STUDENTS PUSHED INTO INFRASTRUCTURE
- ☑ CHATGPT CODE ≠ UNDERSTANDING
- ☑ VALIDATION BURDEN FALLS ON SAME FEW PEOPLE
- ☑ INVISIBLE LABOUR
- ☑ BURNOUT RISK IN LONG TERM SUPPORT



#8

WHERE WE'RE GOING NEXT

- ESTABLISHING ROBUST DEFAULT FORECASTS FOR 3×2PT
- EXPANDING TO INCLUDE SN, SL, CLU...
- SUPPORTING CUSTOM EXTENSIONS (4×2PT W/ IGGL)
- BUILDING TOWARD JOINT LIKELIHOODS AND COMBINED PROBES
- MAKING PIPELINE FLEXIBLE, REPRODUCIBLE & EXTENSIBLE
- EMBEDDING VALIDATION AT EVERY STEP



#9

FINAL THOUGHTS

FORECASTING REQUIRES MORE THAN JUST MODELS

IT NEEDS INFRASTRUCTURE

PIPELINES MUST BE MODULAR & SUSTAINABLE (SCI & SOC)

VALIDATION IS CRUCIAL

THE SYSTEM IS EVOLVING

#10