Branch Prediction and OoO Techniques

Ryan Lee

(slides adapted from prior 6.823 offerings)

Since Last Time…

1. Branch Prediction
   - Relates to your lab 2!
   - Covered several different schemes, from simple to more complex…

2. Speculation
   - Data-in-ROB vs. unified-register-file
   - Centralized vs. distributed
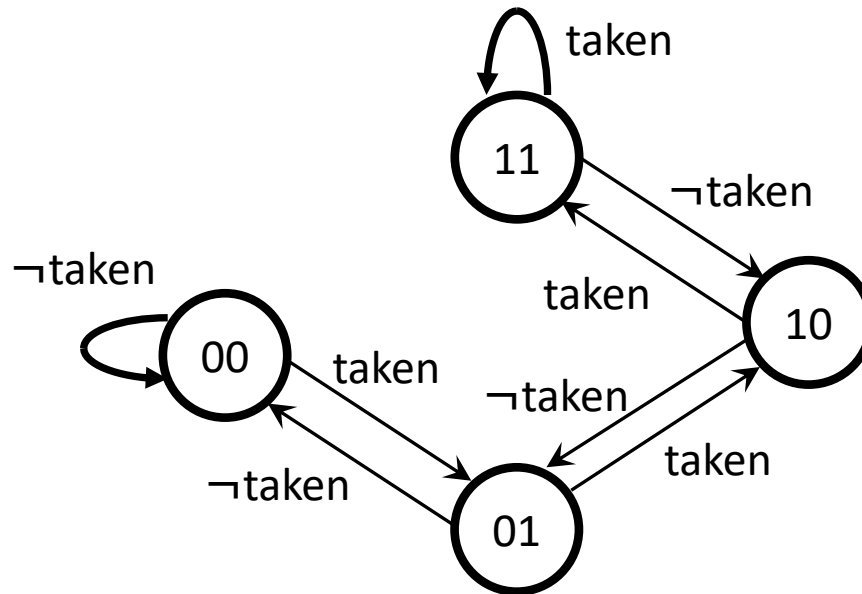   - ROB vs. issue queue + commit queue

Branch Prediction

Control Flow Dependences. How to handle them?

- Stall: Delay until we know the next PC
- Speculate: Guess next value
- Do something else: Multi-threading

Branch Predictors

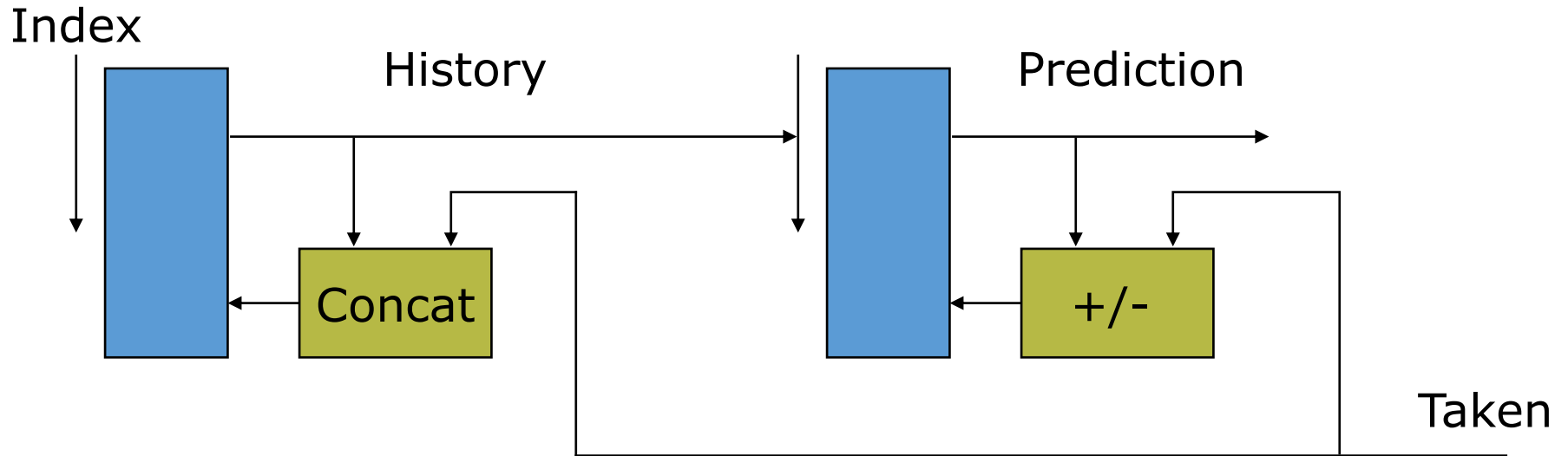- 1-bit predictor

- 2-bit predictor

6.5900 Fall 2023
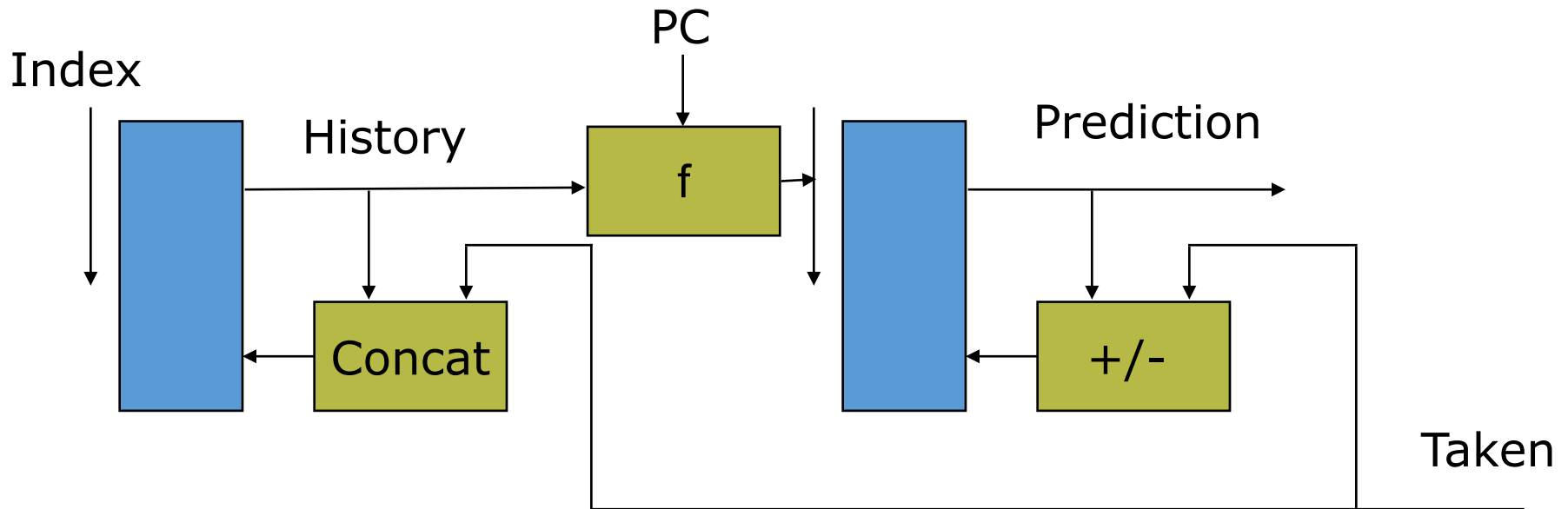
Branch Predictors

Two empirical observations
1. A branch's outcome can be correlated with other branches' outcomes
    - Global branch correlation

2. A branch's outcome can be correlated with past outcomes of the same branch
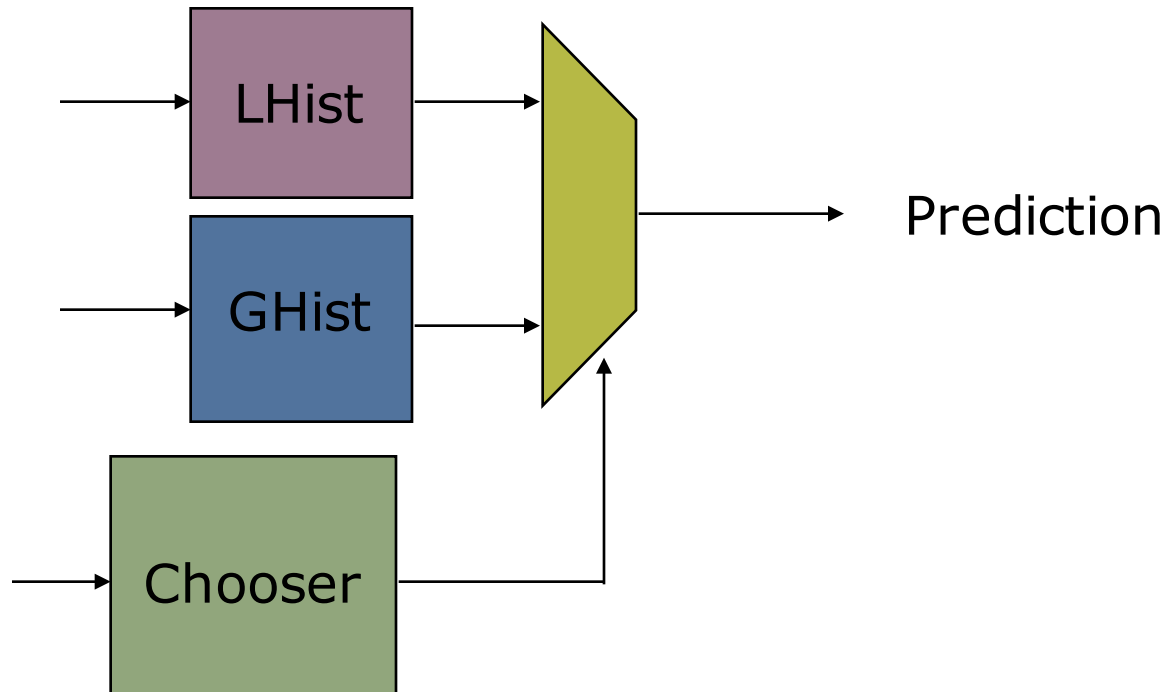   - Local branch correlation

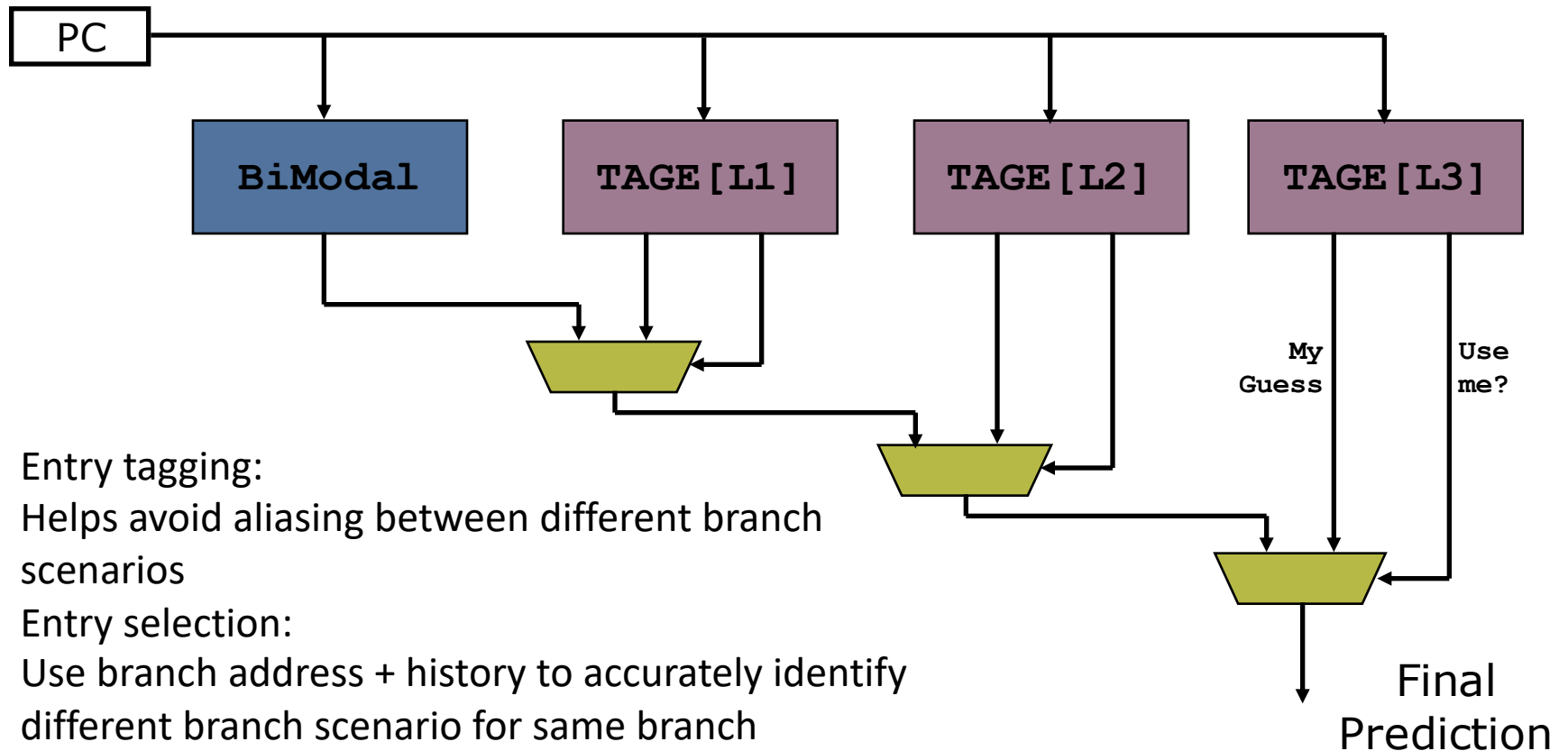# History-based Prediction

Two-level Predictor

Index

PC

History

Prediction

f

Concat

+/-

Taken

Tournament Predictors

TAGE Predictor

PC → BiModal, TAGE[L1], TAGE[L2], TAGE[L3]

My Guess

Use me?

- Entry tagging:
  Helps avoid aliasing between different branch scenarios
- Entry selection:
  Use branch address + history to accurately identify different branch scenario for same branch
- Longer branch histories as required:
  Use long histories for branches that actually benefit

Final Prediction

Lab 2 Due Oct 20

- Get going early
- Incrementally build more complex predictors
  - 2-bit predictor
  - Local history predictor
  - Tournament predictor
- Recommend researching more advanced predictors for full credit
  - TAGE, Perceptron, etc...