The Role of Adaptivity in Two-Level Adaptive Branch Prediction

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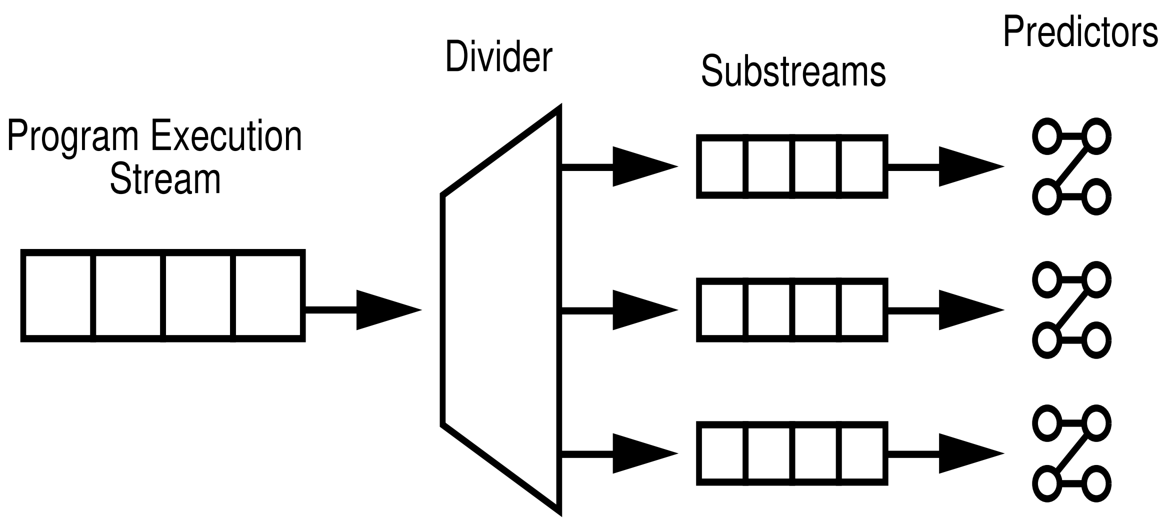
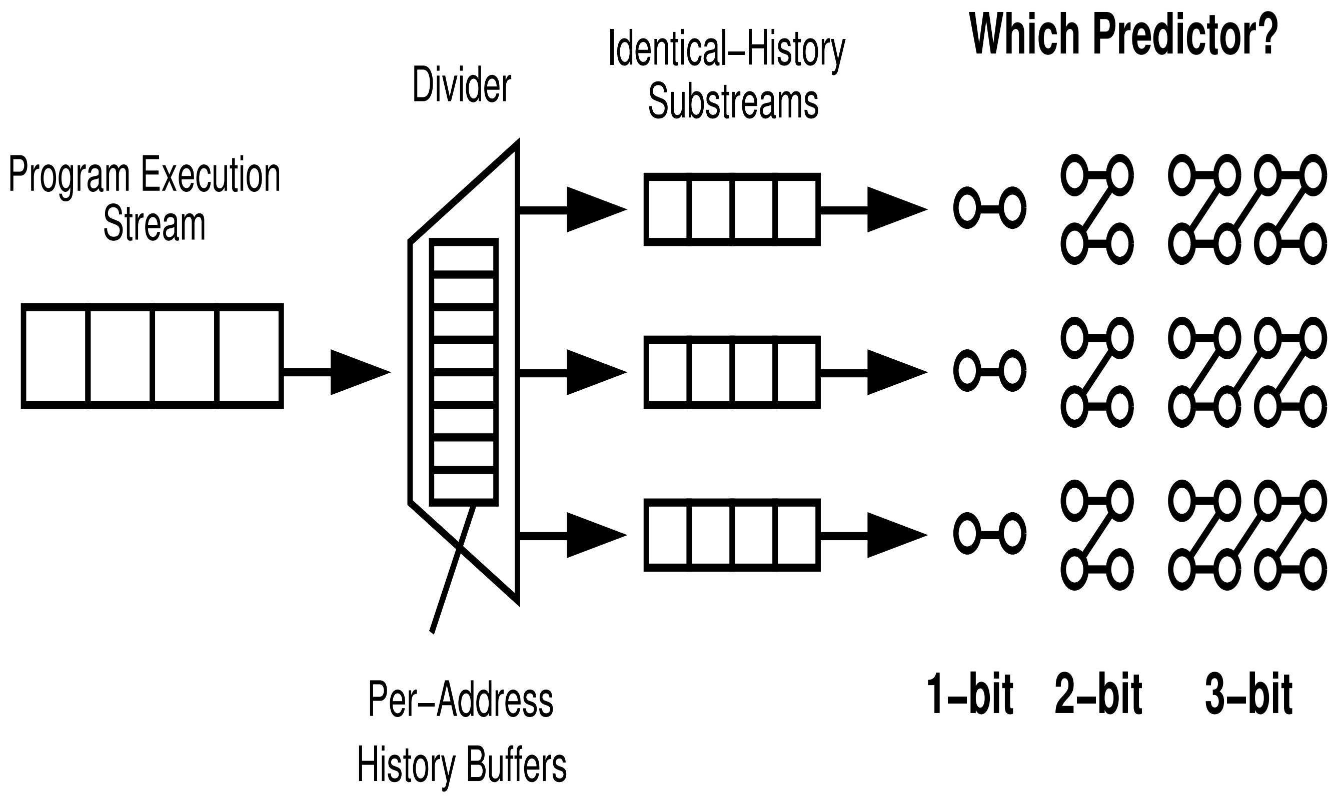
Branch Prediction: Divide and Conquer

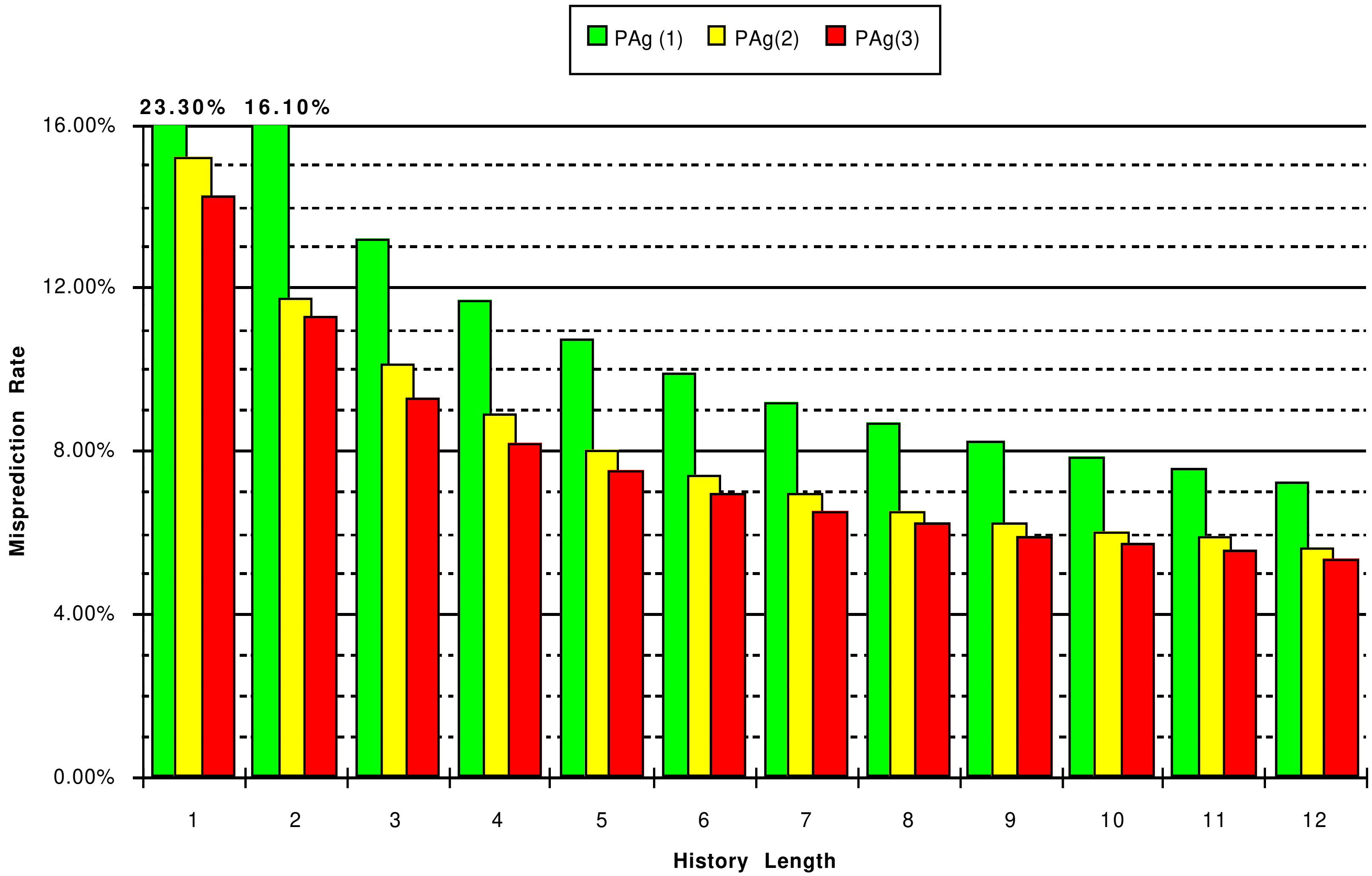


to'tct Young, Gloy, and Smith ISCA '95

PAg: Per-address, Adaptive, Global



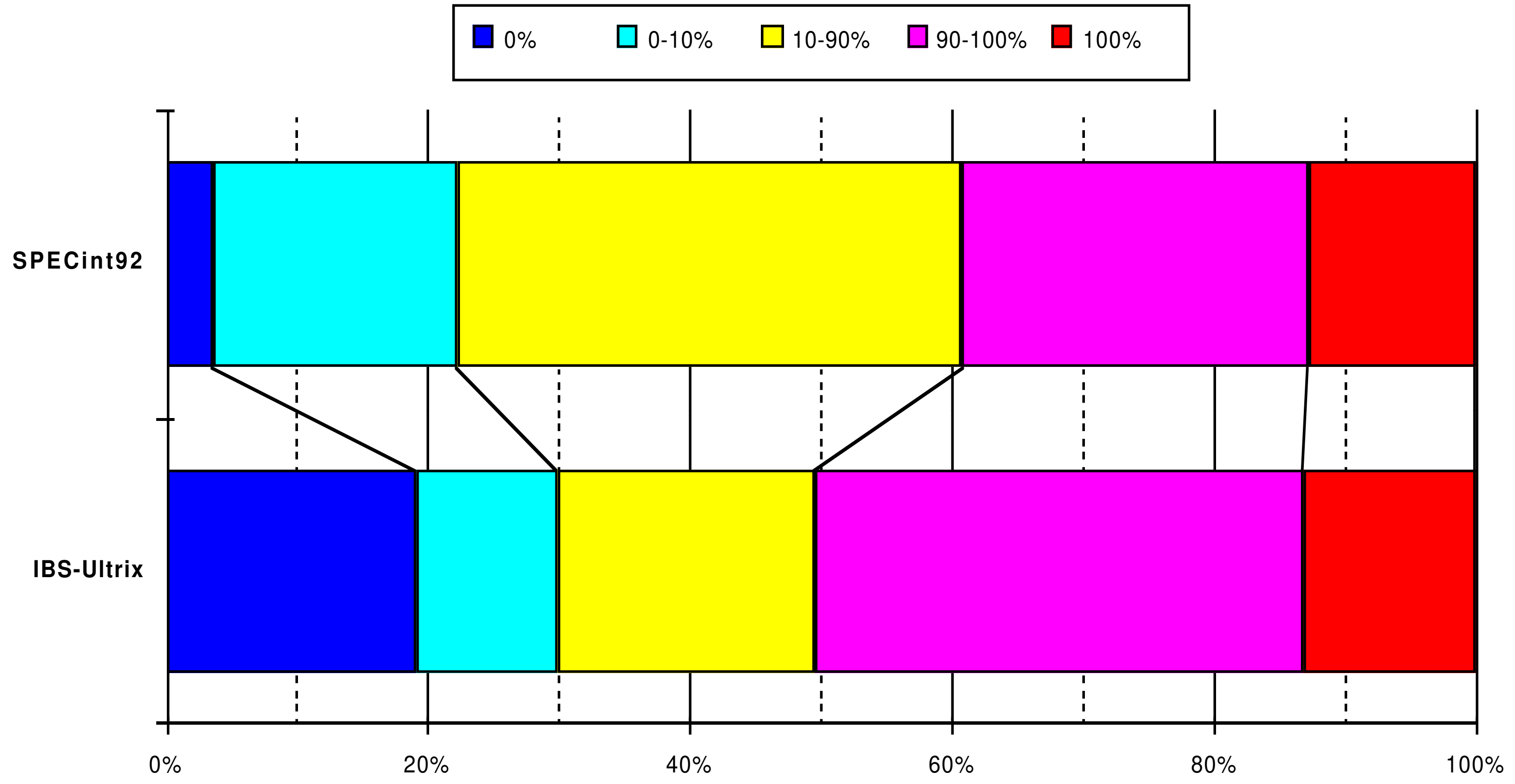
Hysteresis: 1-bit, 2-bit, and 3-bit predictors for SPECint92



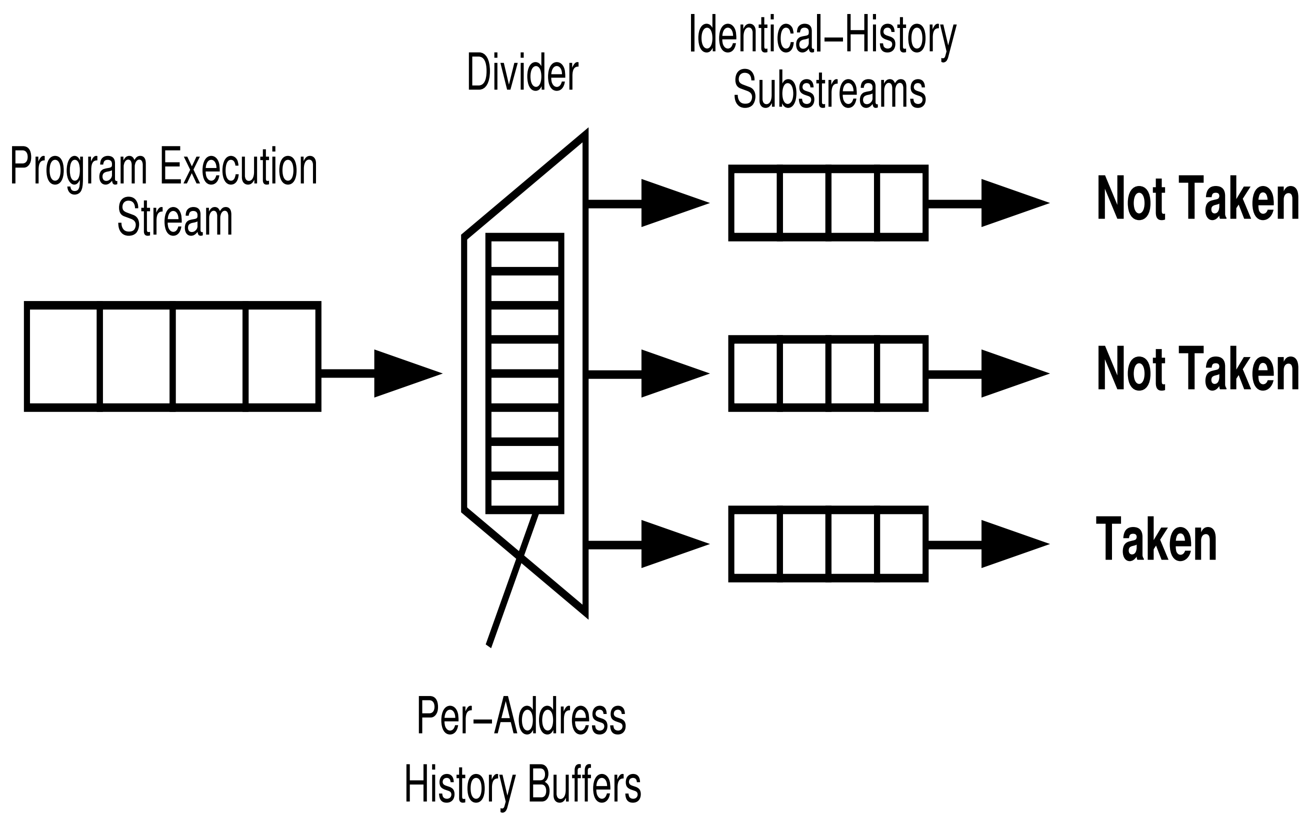
SPECint92 and IBS-Ultrix

Benchmarks	Dynamic Conditional Branches (Percent of Total Instructions)	Static Conditional Branches	# of Static Branches Constituting 90% of Total Dynamic Conditional Branches
compress	11,739,532 (14.0%)	236	13
eqntott	342,595,193 (24.6%)	494	5
espresso	76,466,489 (14.7%)	1,784	110
gcc	21,579,307 (15.2%)	9,531	2,020
xlisp	147,425,333 (11.3%)	489	48
sc	150,381,340 (16.9%)	1,269	157
groff	11,874,183 (11.3%)	6,325	461
gs	16,275,133 (13.8%)	12,768	1,142
mpeg_play	9,549,954 (9.6%)	5,592	532
nroff	22,542,119 (17.3%)	5,243	229
real_gcc	14,281,721 (13.3%)	17,354	3,196
sdet	4,965,098 (11.8%)	5,309	532
verilog	6,195,248 (13.2%)	4,631	845
video_play	5,579,331 (10.6%)	4,603	724

Branch Bias



PSg: Per-address, Static, Global



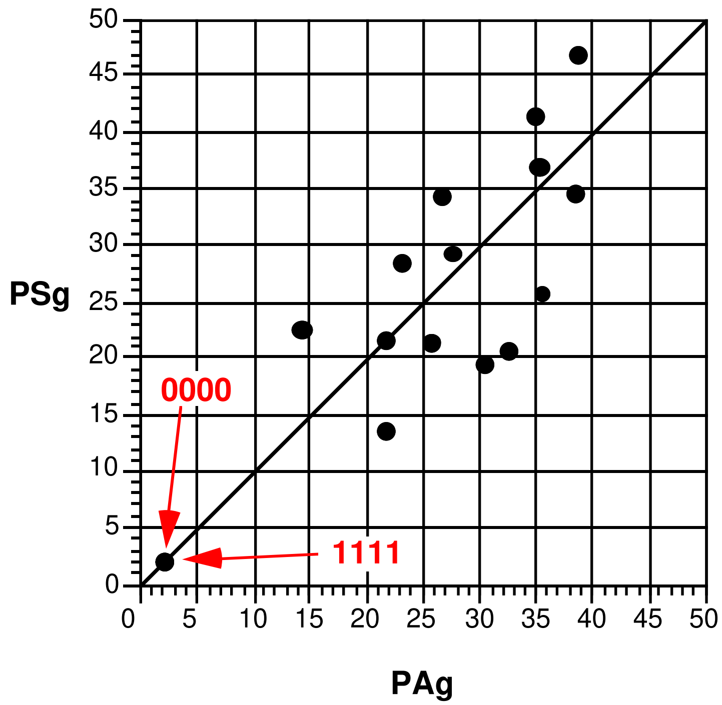
Fixed Prediction Tables

- **What Comes Next?**
  - _?_111111111
  - _?_010101010
  - _?_001001001
  - _?_000100010
  - _?_000010000
- **What about these?**
  - _?_010101000
  - _?_101110011

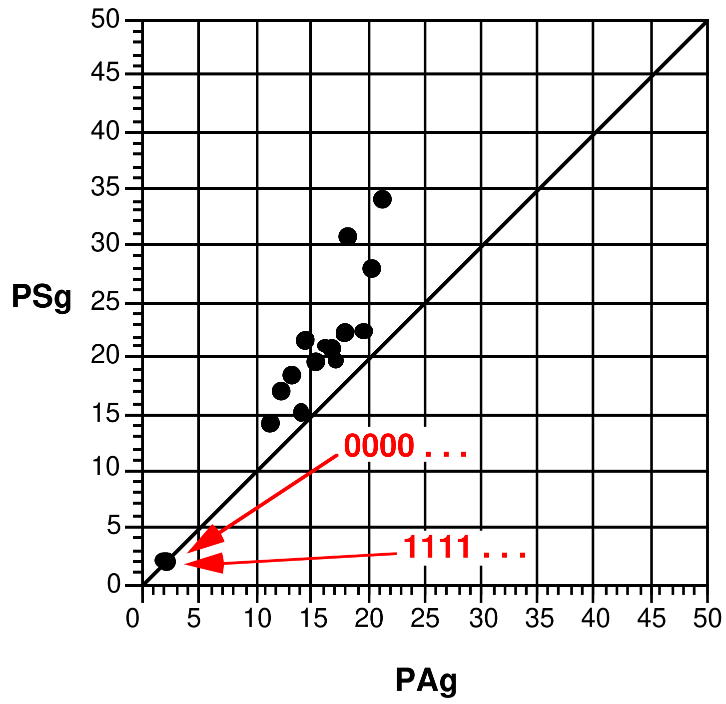
Fixed Tables

- **PSg(algorithm)**
  - Simple. Based on cyclic patterns and majority votes
  - Not based on measurements
- **PSg(compromise)**
  - Fixed table derived from training data.
  - Not tuned to individual benchmarks.
  - Chooses "average" behavior for each pattern.

Misprediction Rate: PAg vs. PSg

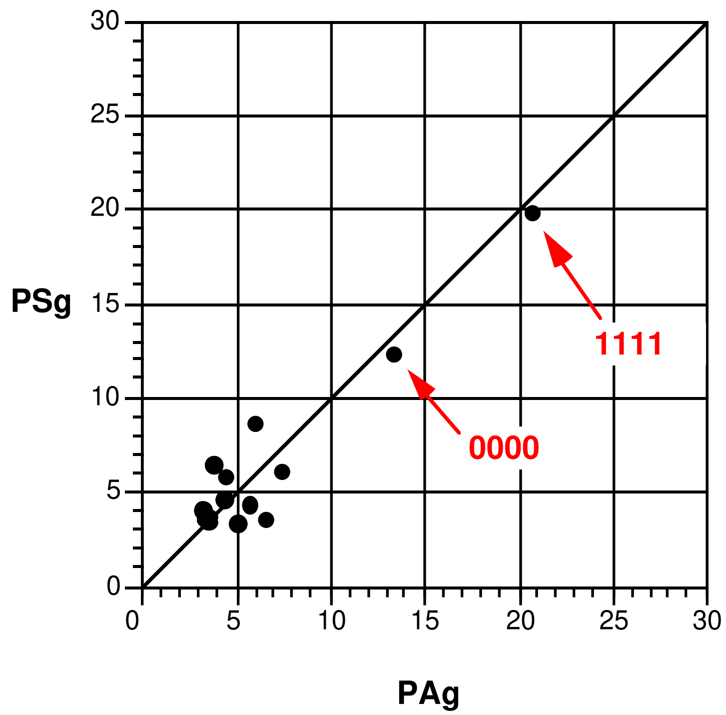


4 bits of history

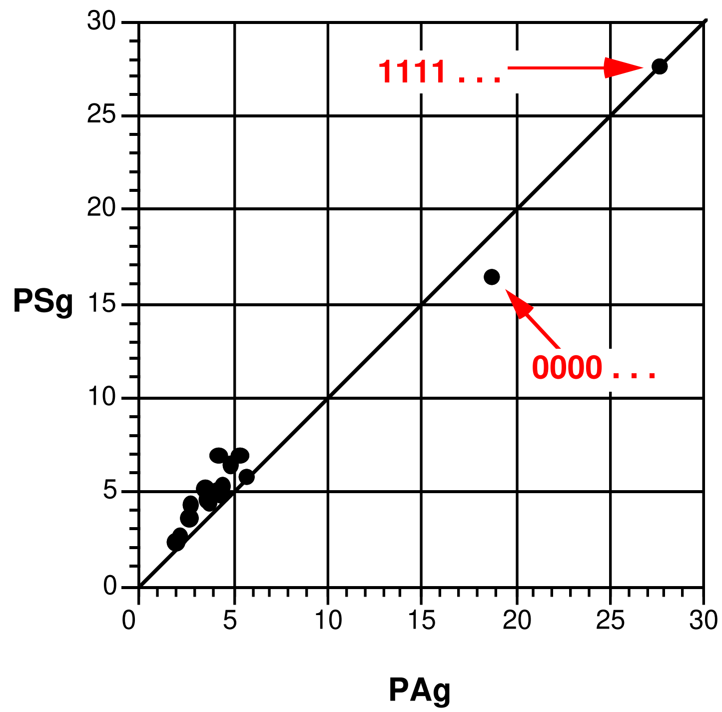


10 bits of history

Contribution to Errors: PAg vs. PSg

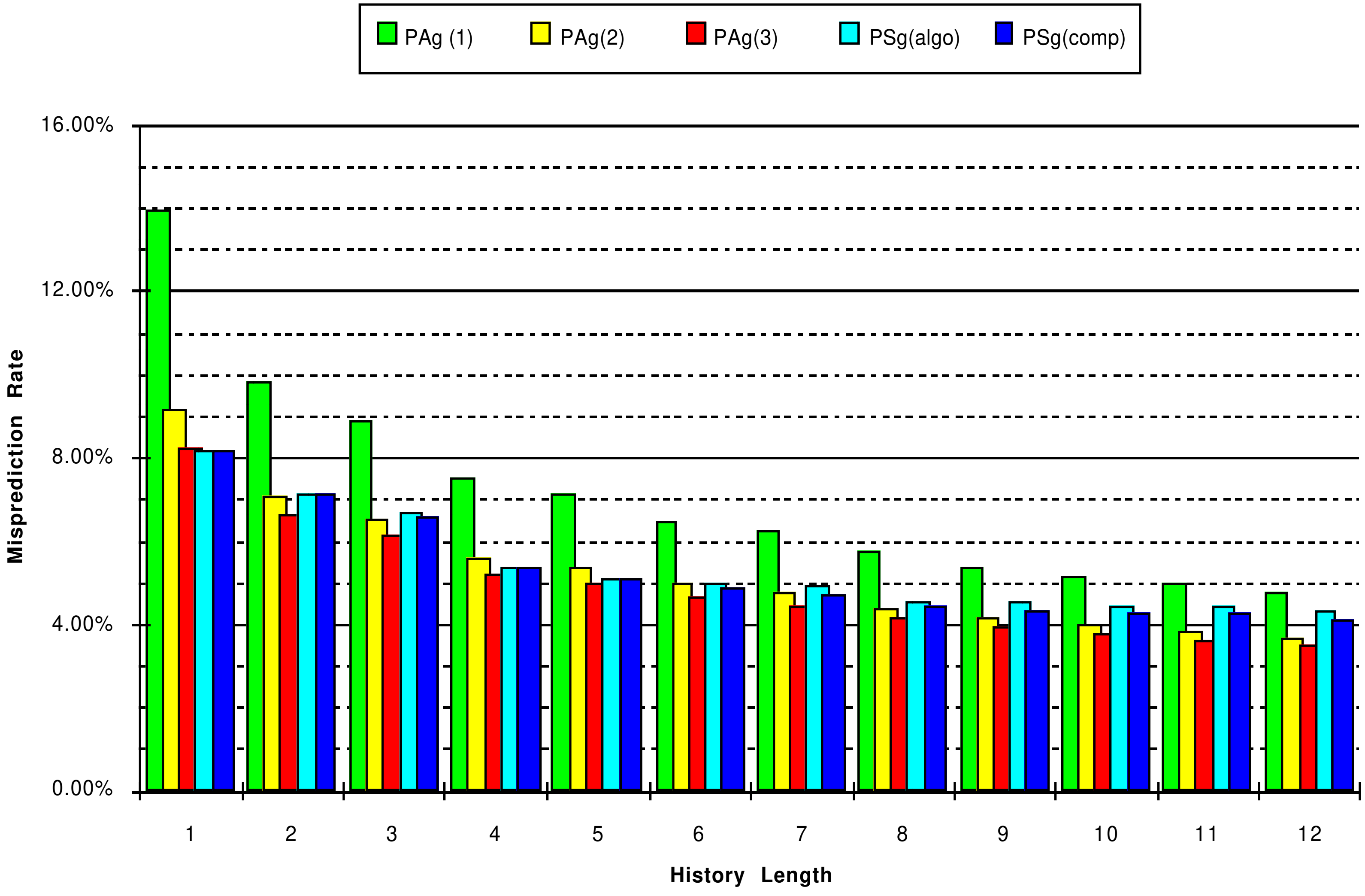


4 bits of history



10 bits of history

Results for PAg and PSg for IBS-Ultrix



Conclusions

- **SPECint92 benchmarks can mislead**
- **Per-address schemes produce two frequent high-bias substreams**
- **PSg schemes offer competitive results**
- **PAg/PAs can beat PSg when aliasing is low**