Branch Classification: a New Mechanism for Improving Branch Predictor Performance

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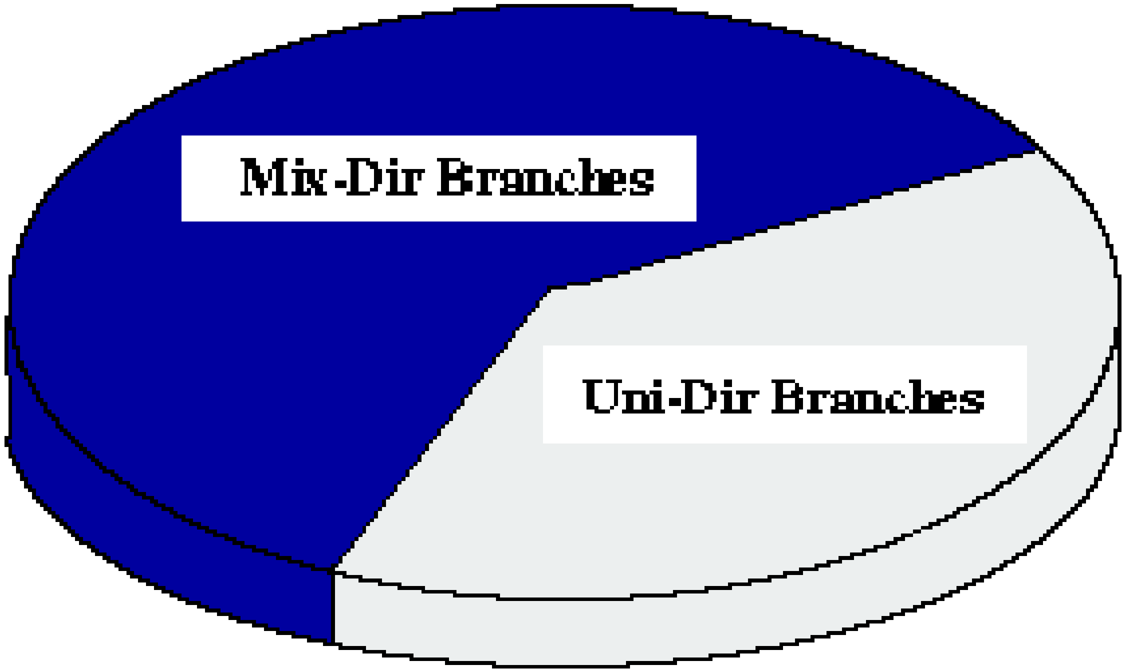
Outline

- Branch Classification
- Per-Class Predictor Analysis
- Hybrid Branch Predictors
- Conclusion

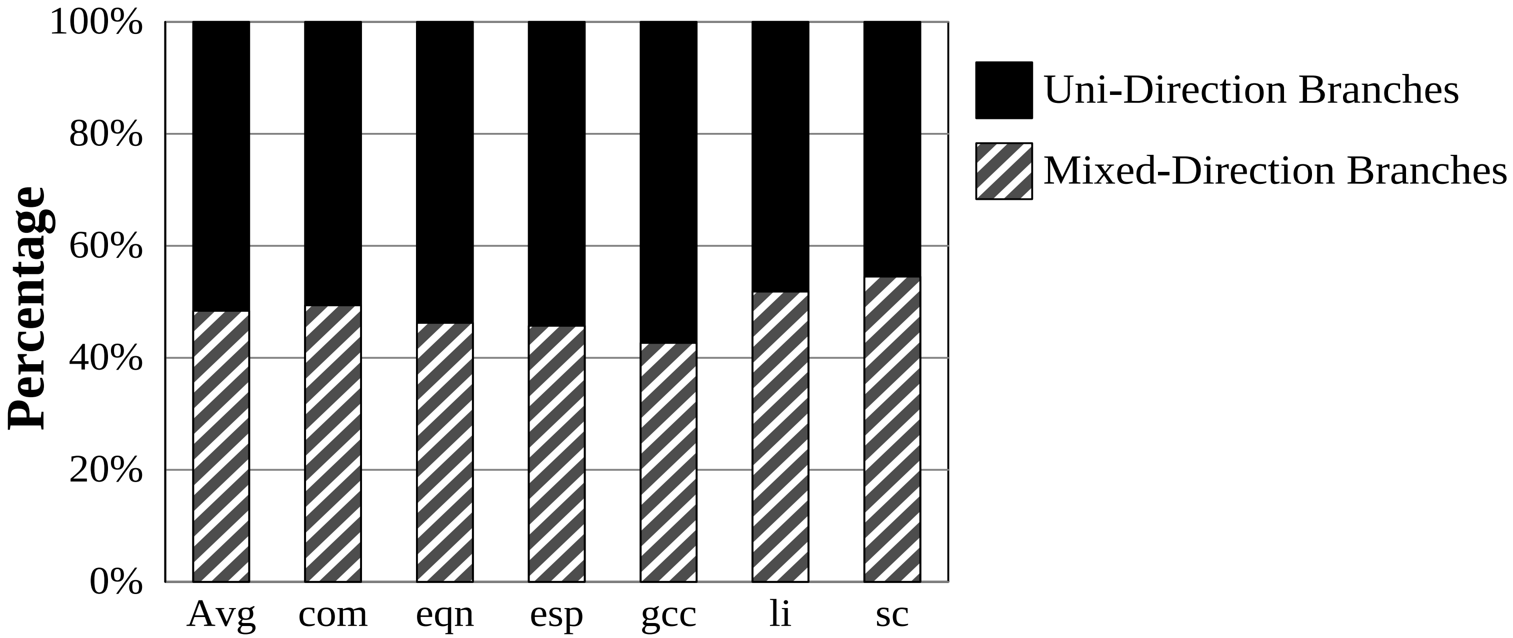
Branch Classification



Static Classes

	Classes	Descriptions
Uni-Direction Branches	SC1	0% <= pr(br) <= 5%
	SC2	5% < pr(br) <= 10%
	SC5	90% < pr(br) <= 95%
	SC6	95% < pr(br) <= 100%
Mixed-Direction Branches	SC3	10% < pr(br) <= 50%
	SC4	50% < pr(br) <= 90%

Distribution of dynamic branches



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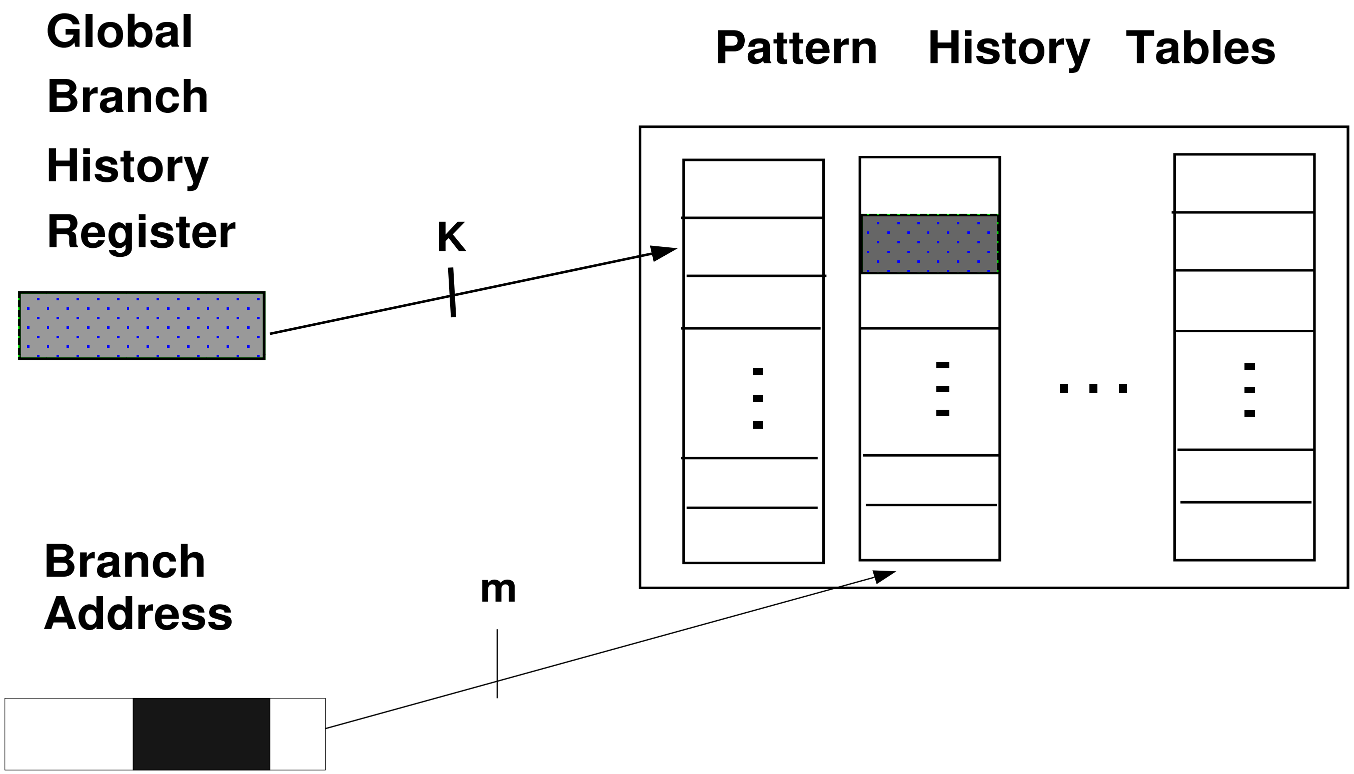
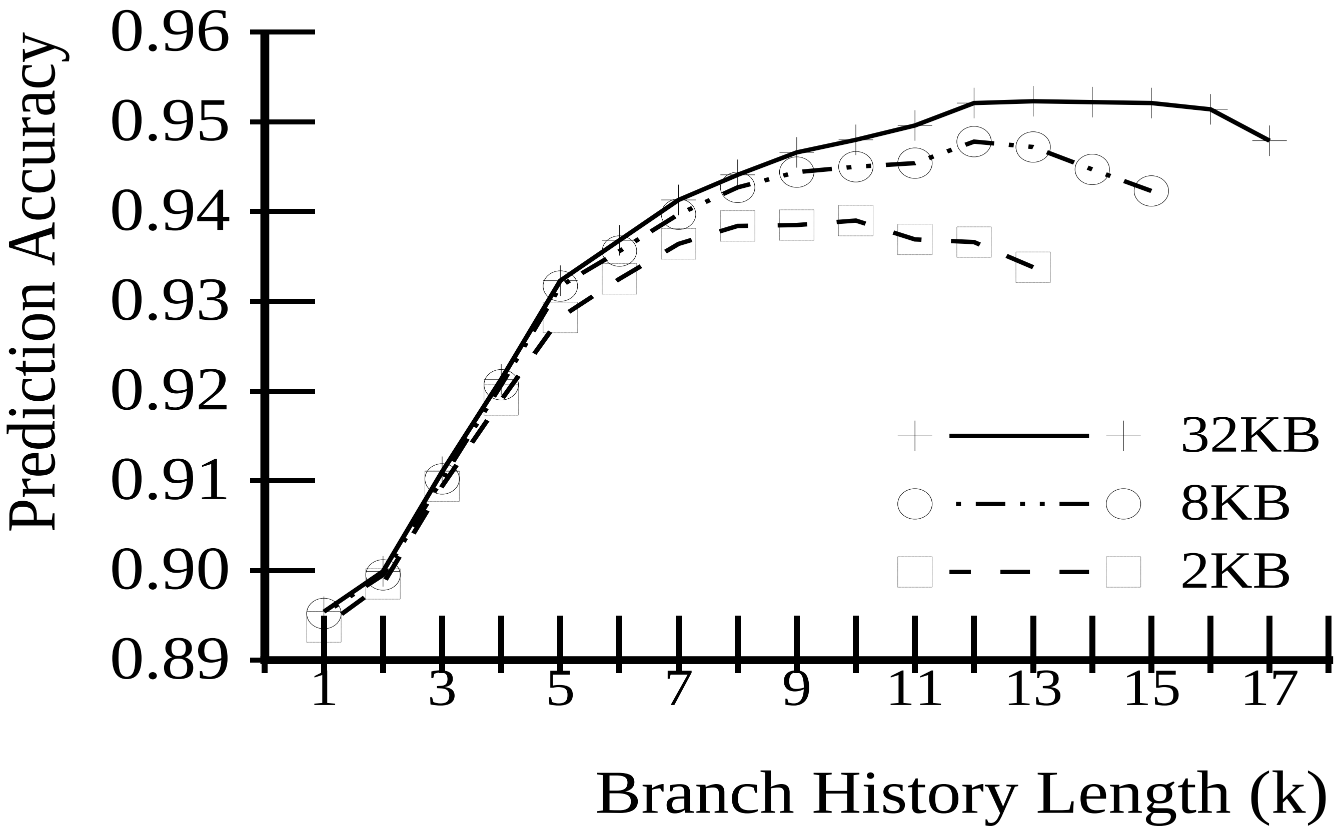
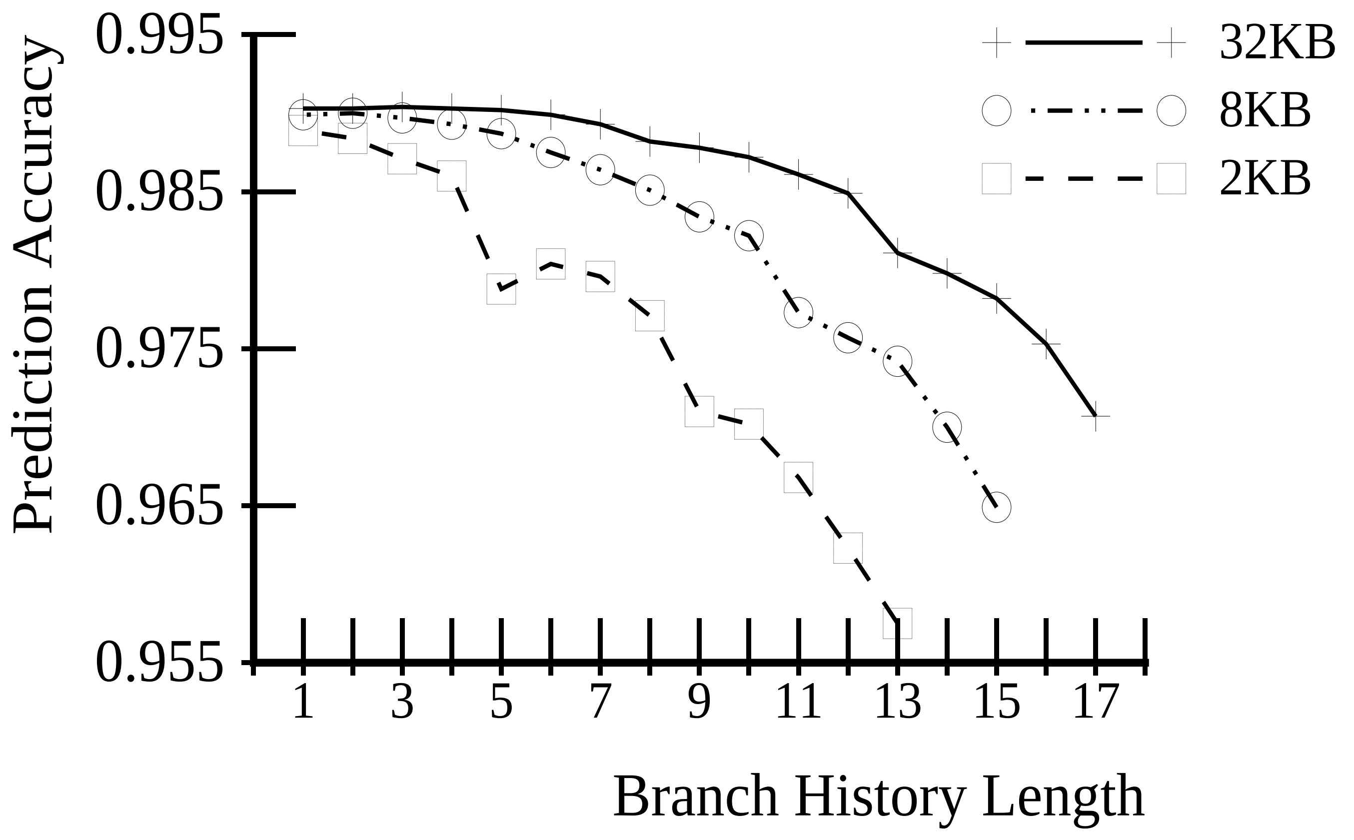
Structure of the GAs Branch Predictor



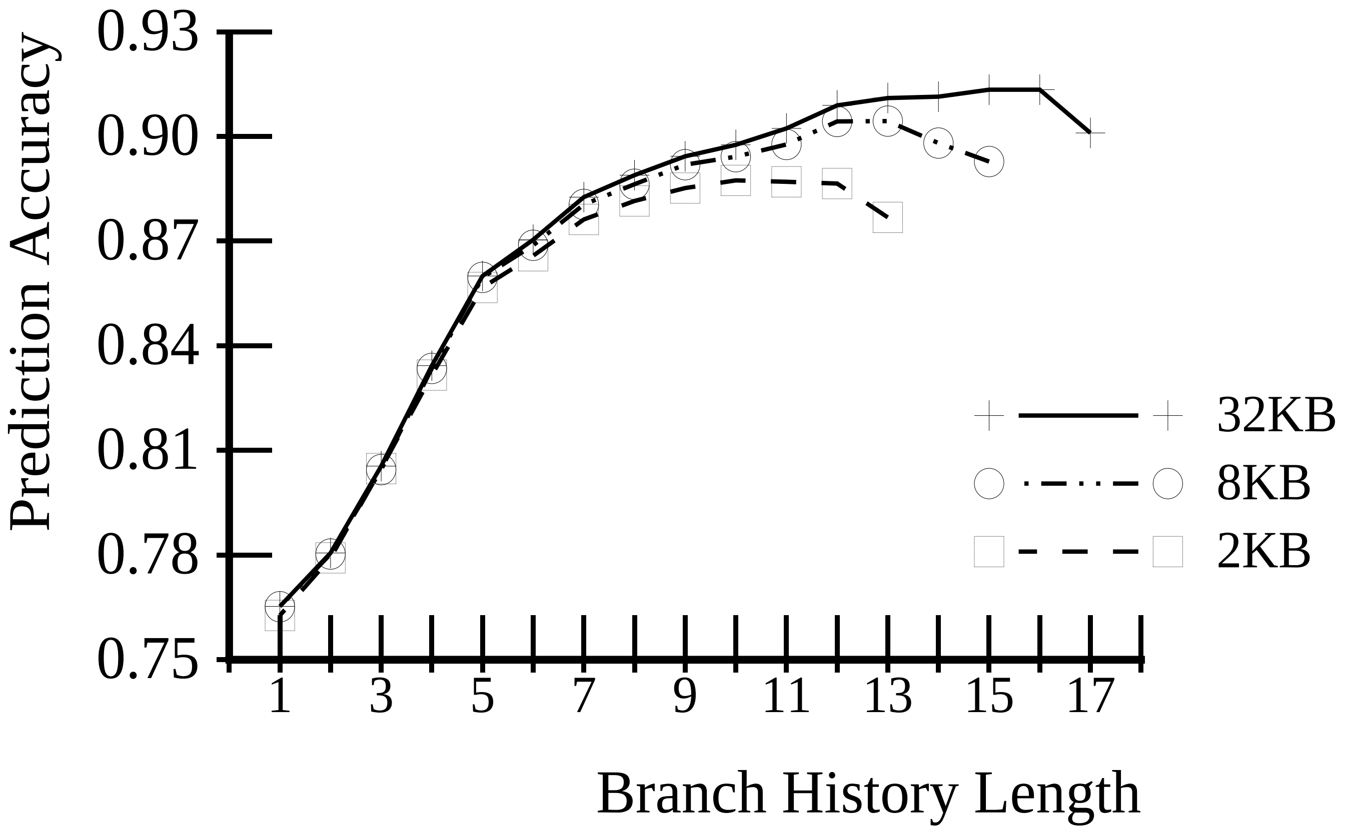
GAs Prediction Accuracy



Uni-Direction Branches (e.g. SC1)



Mixed-Direction Branches (e.g. SC3)



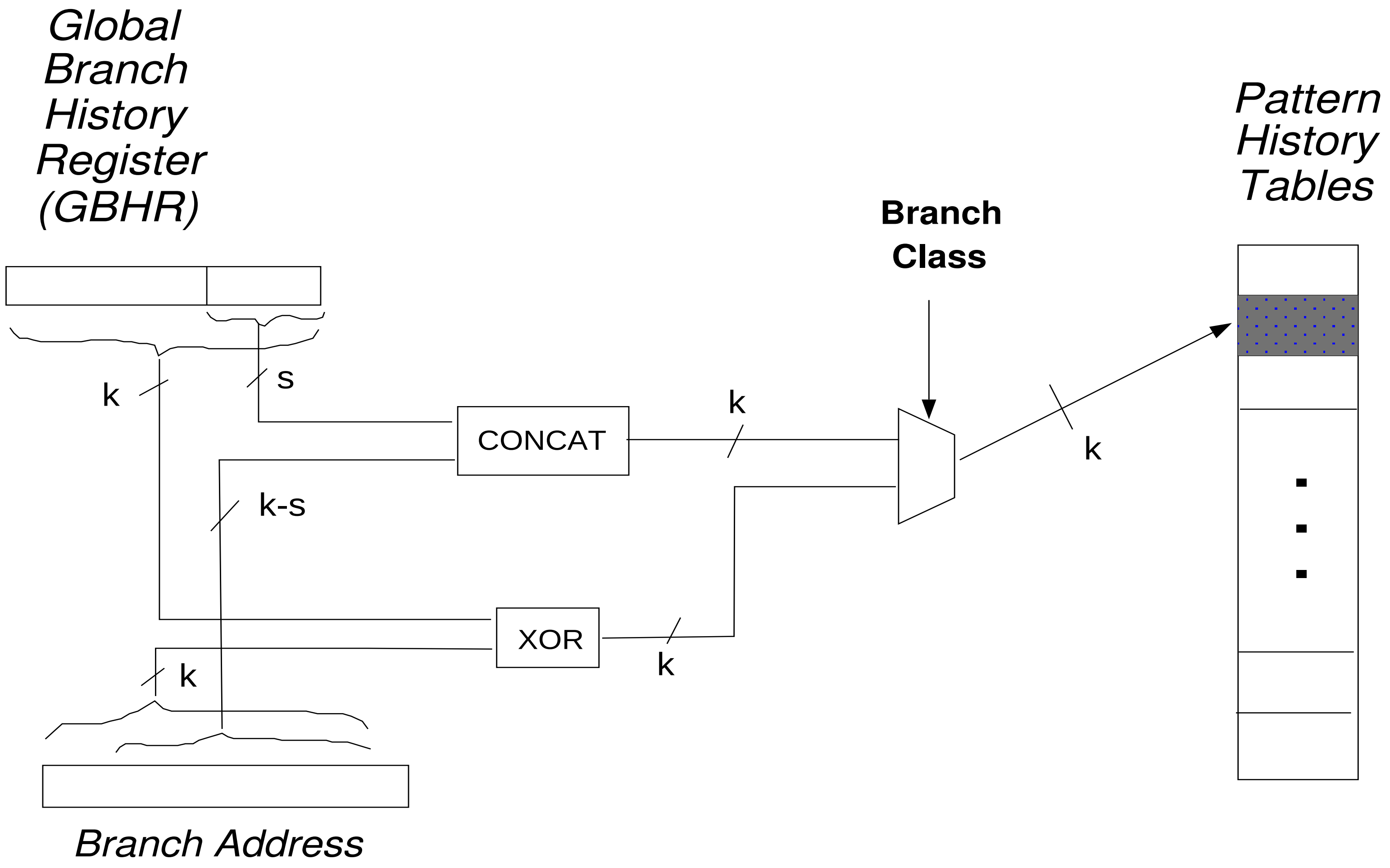
Hybrid Branch Prediction Schemes

- **Static Predictor Selection**
- Dynamic Predictor Selection
- Static Plus Dynamic Selection

Static Predictor Selection

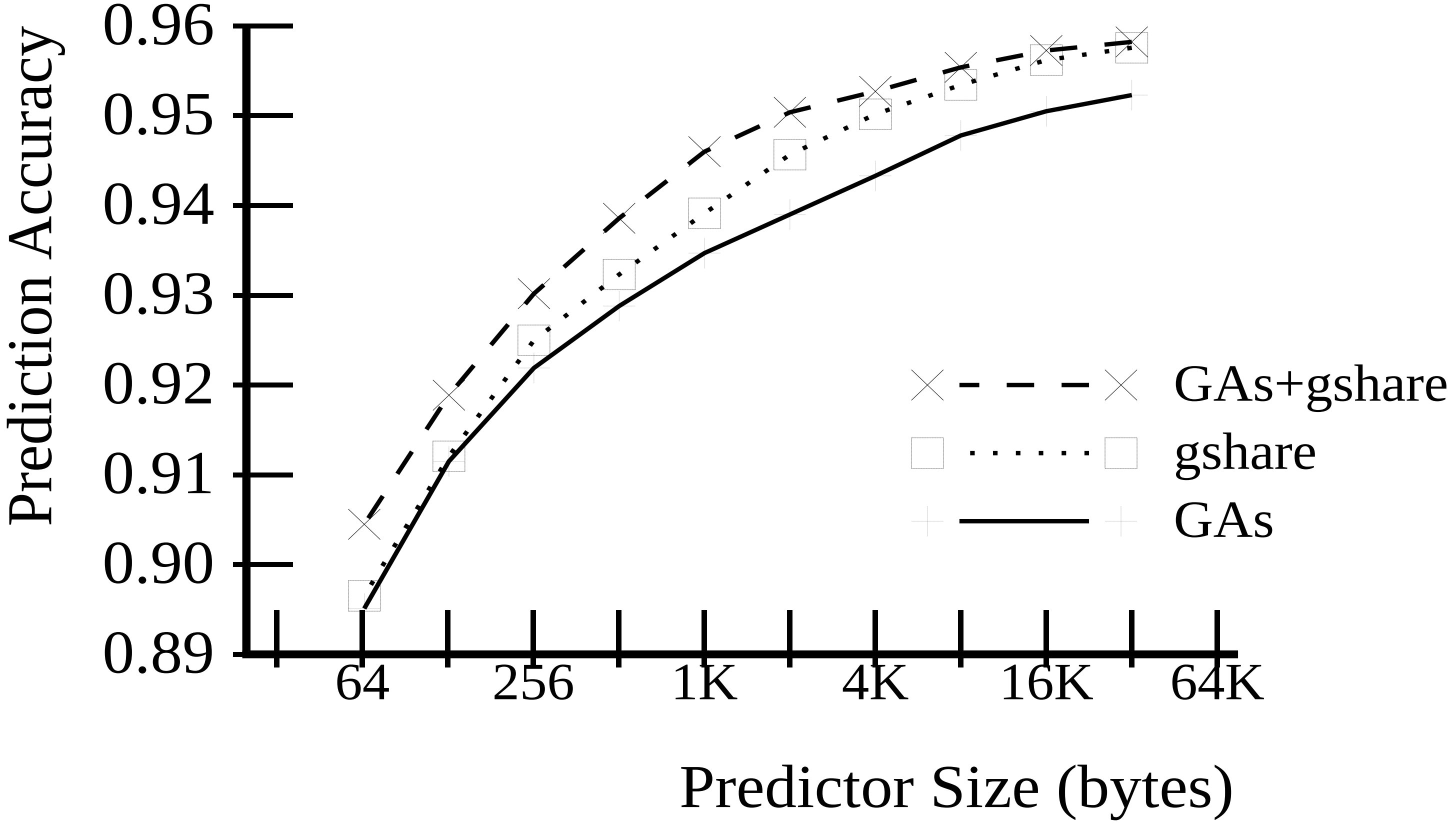
- GAs plus Modified GAs (gshare)
- Profile-guided Predictor (PG) plus gshare

GAs+gshare



Global Branch History Register (GBHR)
k
s
CONCAT
k
k-s
XOR
k
k
Branch Class
k
Pattern History Tables
Branch Address

GAs+gshare

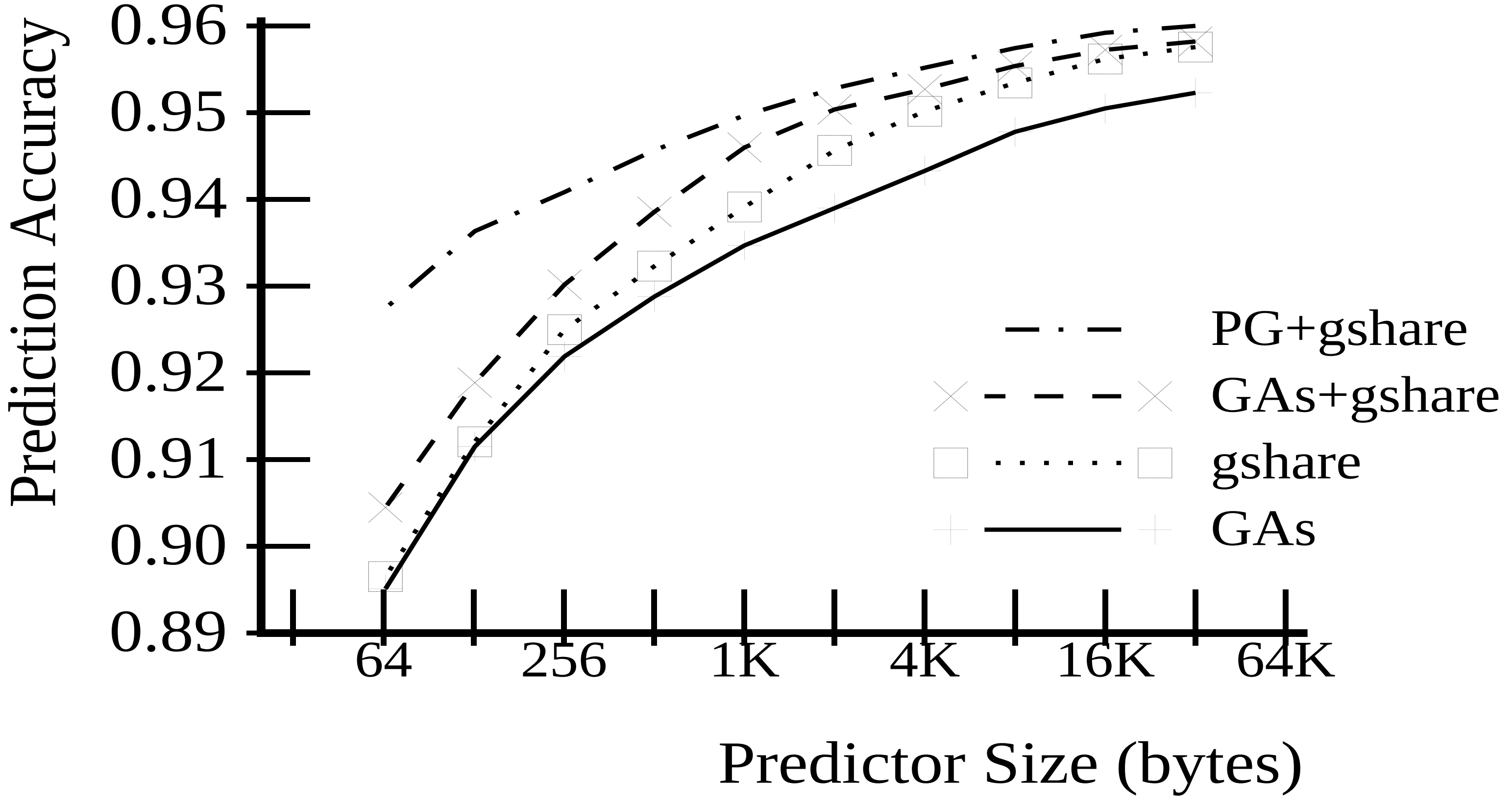

Prediction Accuracy
0.96
0.95
0.94
0.93
0.92
0.91
0.90
0.89
64
256
1K
4K
16K
64K
Predictor Size (bytes)
GAs+gshare
gshare
GAs

Profile-guided Predictor plus Modified GAs (PG+gshare)

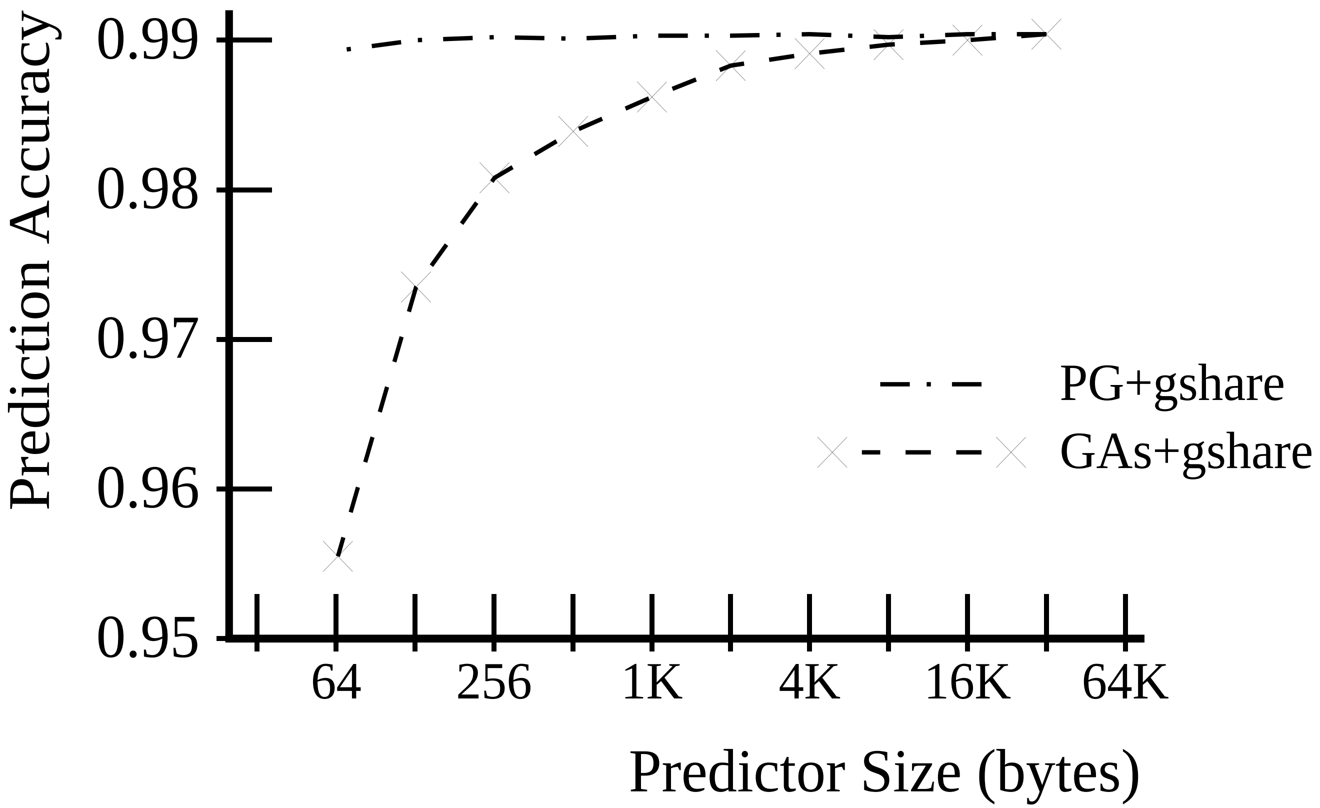
Uni-Direction branches $\Longrightarrow$ Profile-guide Predictor

Mixed-Direction branches $\Longrightarrow$ gshare

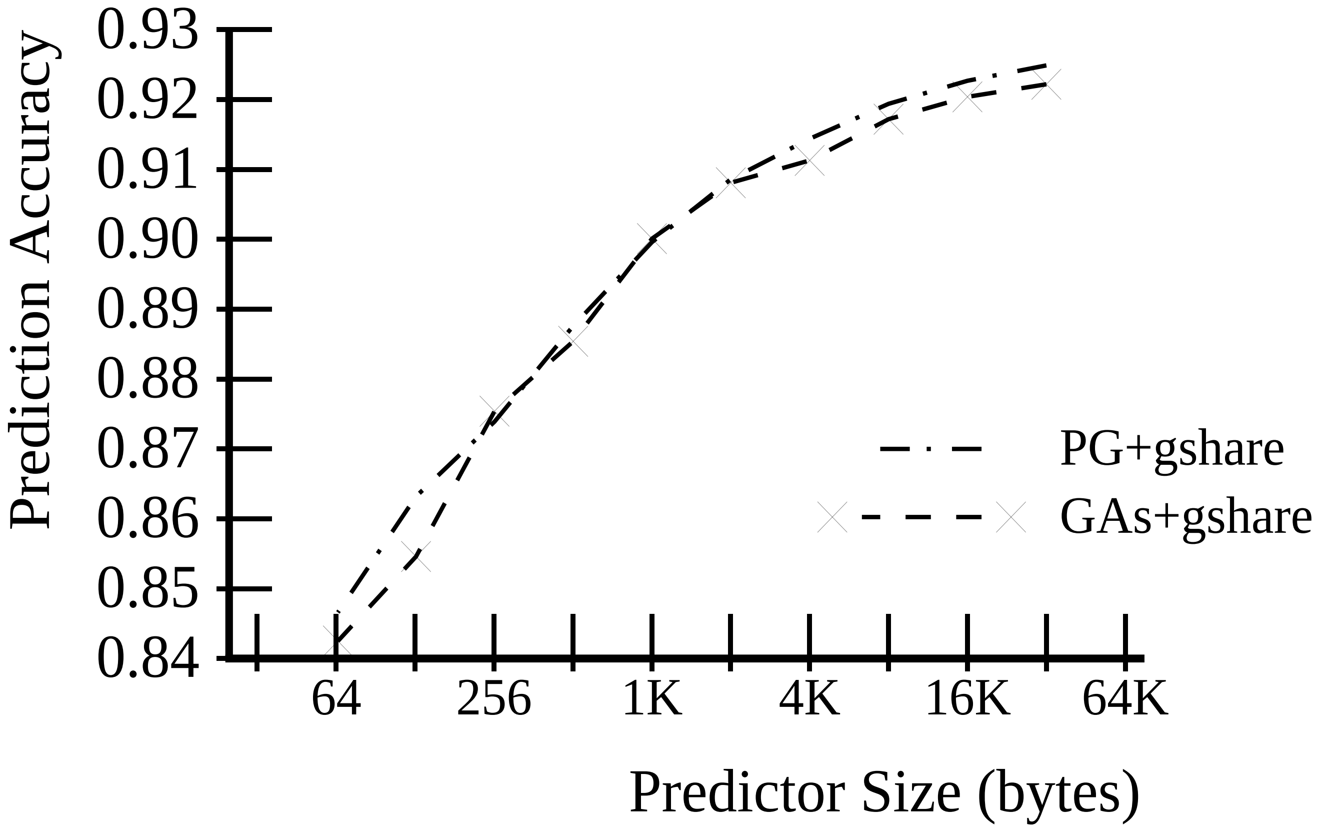
Static Predictor Selection



Uni-Direction Branches (e.g. SC1)



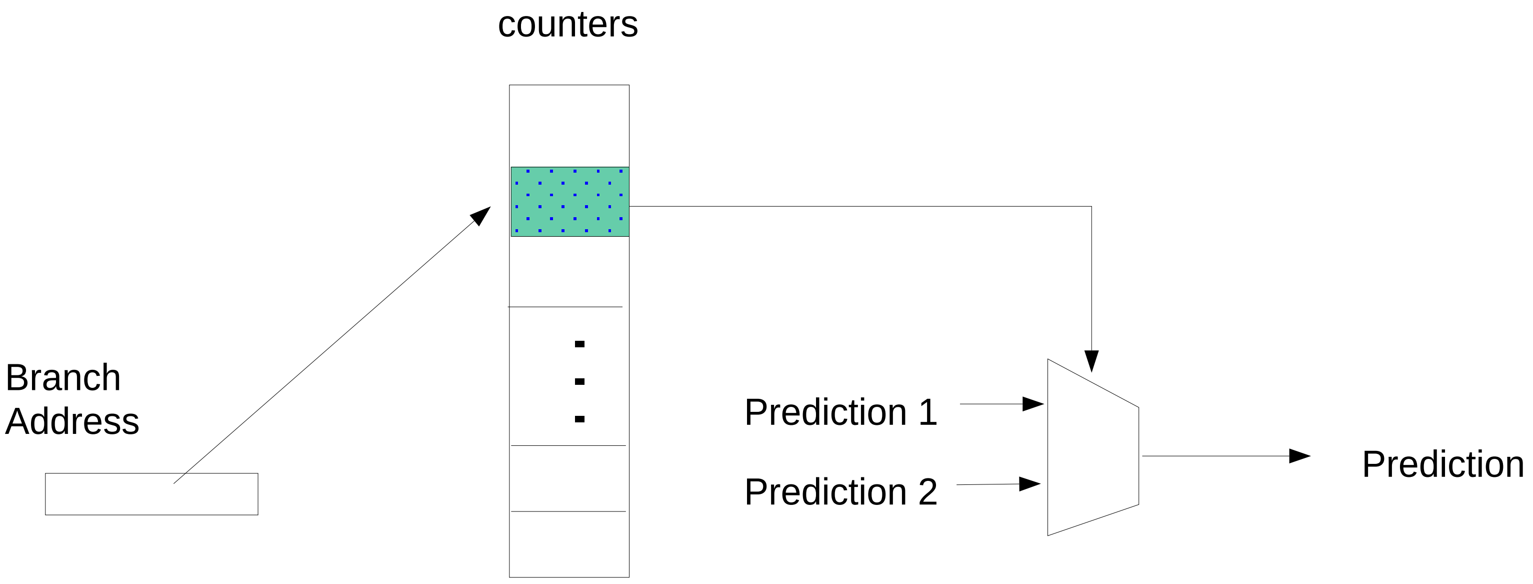
Mixed-Direction Branches (e.g. SC3)



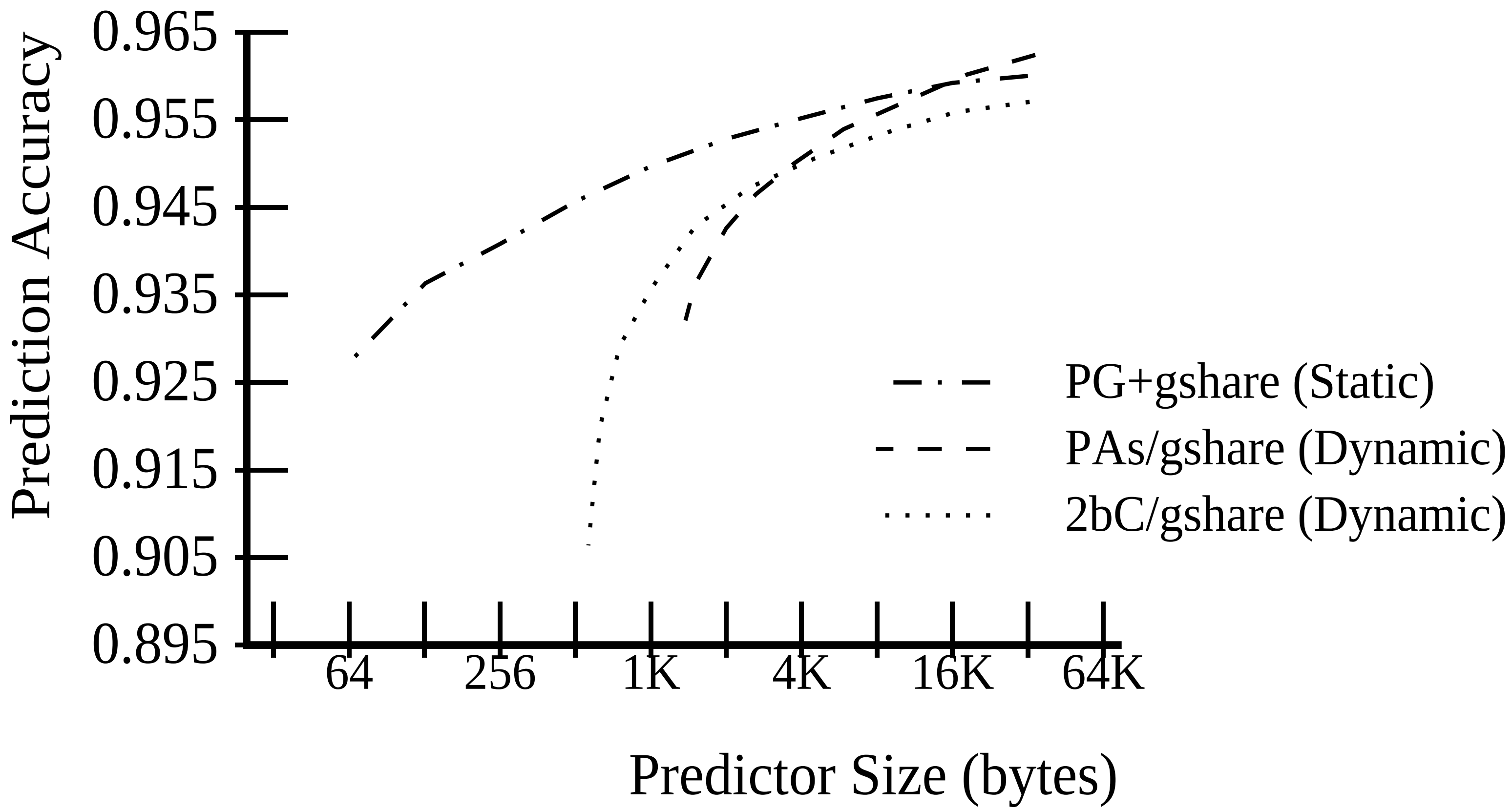
Hybrid Branch Prediction Schemes

- Static Predictor Selection
- **Dynamic Predictor Selection**
- Static Plus Dynamic Selection

Dynamic Predictor Selection



Hybrid Branch Predictors



Hybrid Branch Prediction Schemes

- Static Predictor Selection
- Dynamic Predictor Selection
- **Static Plus Dynamic Selection**

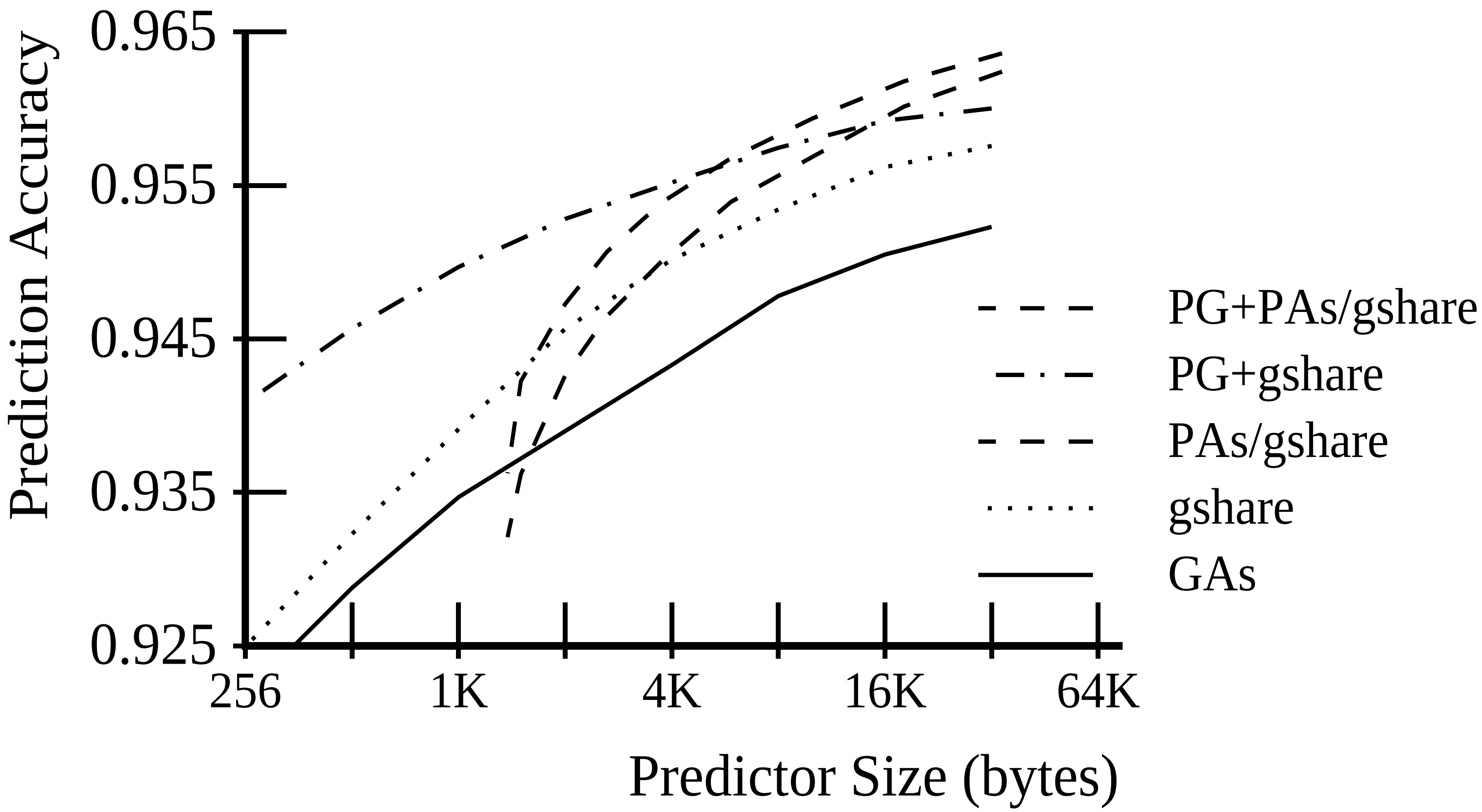
Static Plus Dynamic Selection

Uni-Direction branches $\Longrightarrow$ Profile-guided Predictor

Mixed-Direction branches $\Longrightarrow$ PAs/gshare

(PG + PAs/gshare)

Both Dynamic and Static Selection



Conclusion

- Analysis of Predictors
  - Short Branch History for Uni-Dir Branches
  - Longer Branch History for Mixed-Dir Branches
- Design of Hybrid Predictors
  - PG+PAs/gshare reduces miss rate up to 12.5% (GCC)