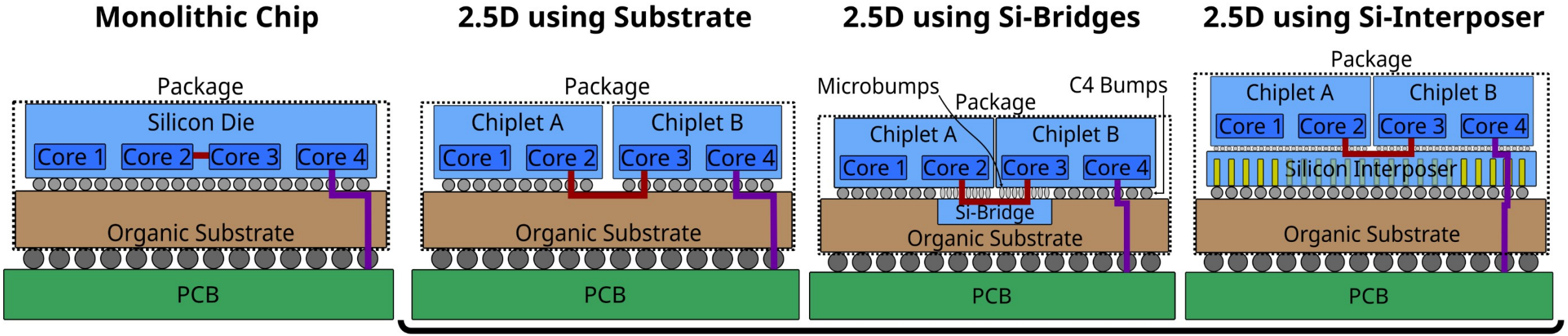
PATRICK IFF, BENIGNA BRUGGMANN, MACIEJ BESTA, LUCA BENINI, TORSTEN HOEFLER

PlaceIT: Placement-Based Inter-Chiplet Interconnect Topologies

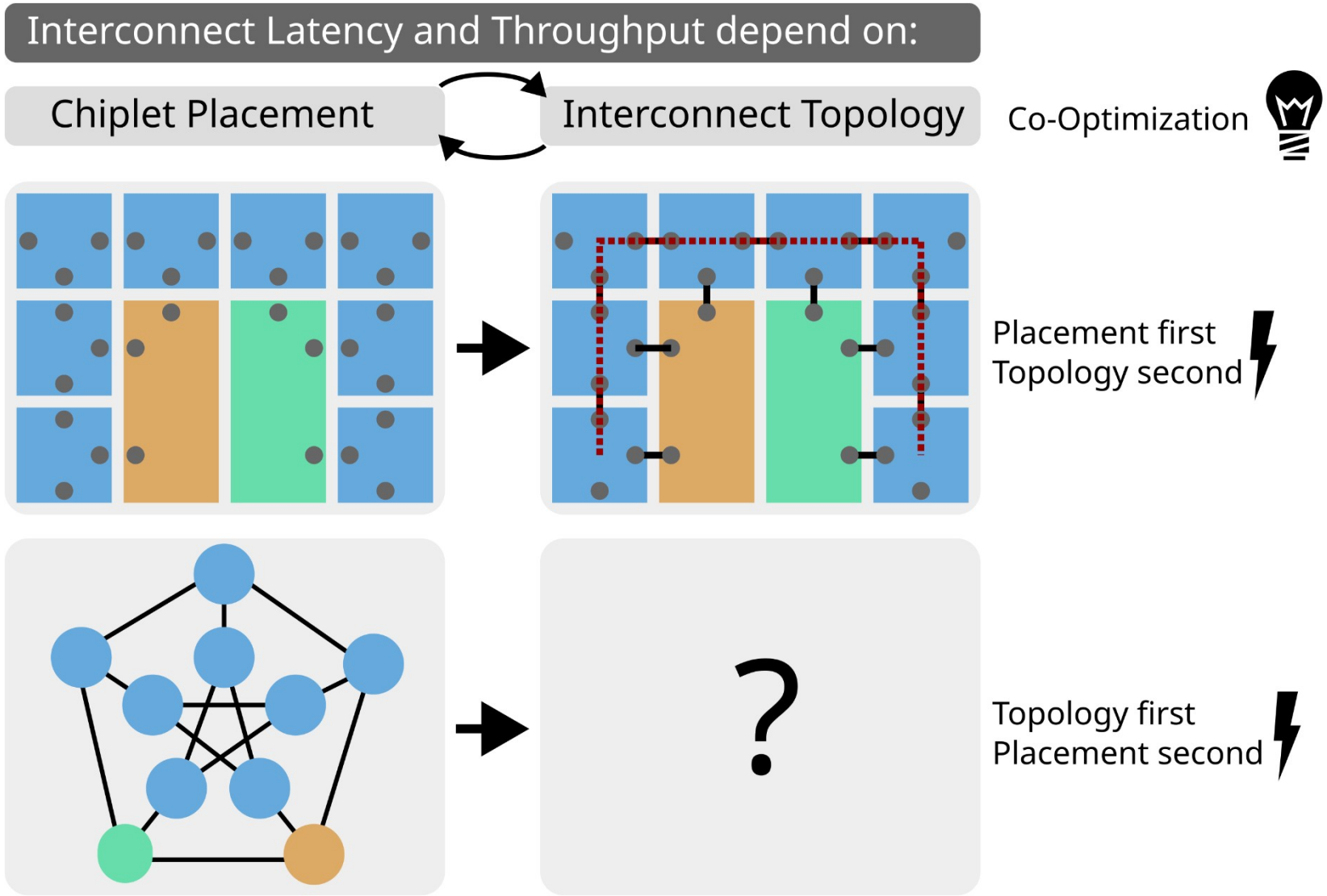
Background on 2.5D Integration



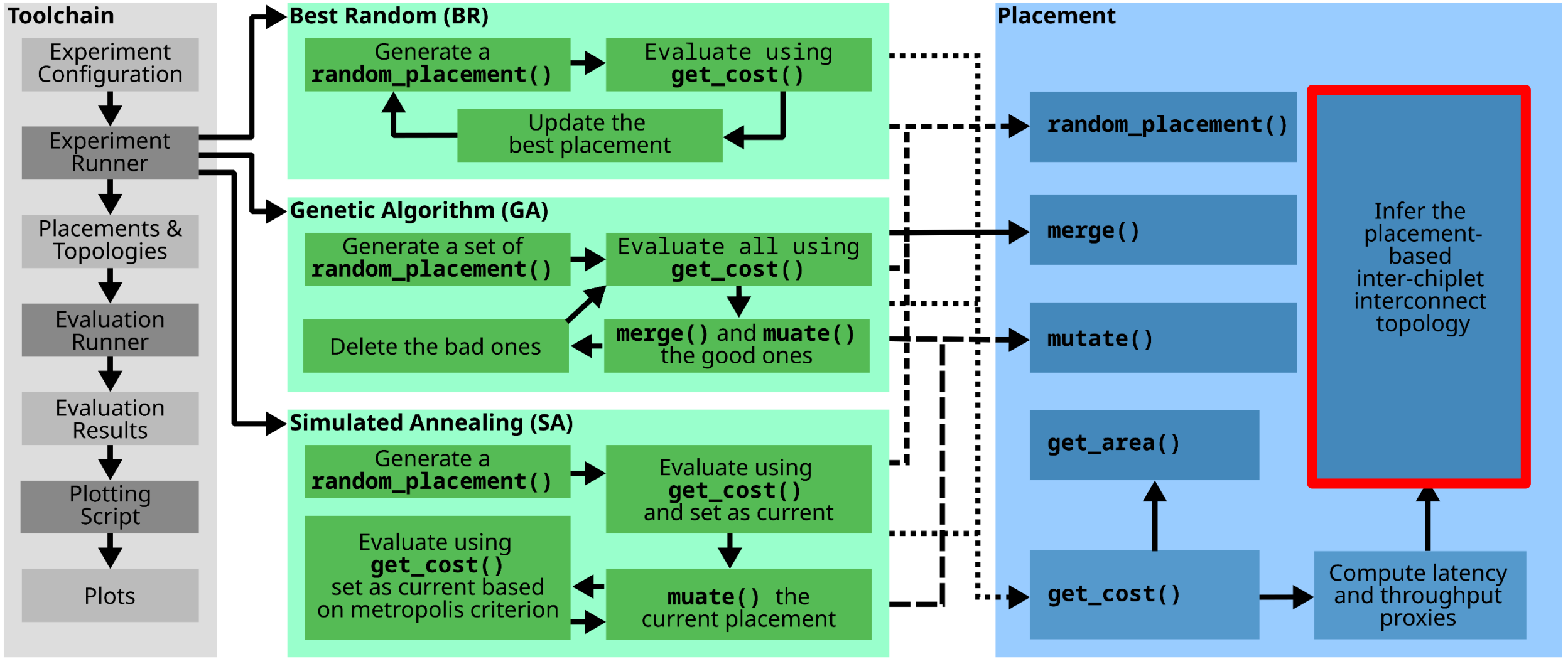
Advantages	Challenges
Heterogeneity	Increased Complexity
Chiplet Reuse	PHY Overheads
Improved Yield	Increased Inter-Chiplet Latency
Per-Chiplet Power-Binning	Reduced Inter-Chiplet Throughput

!

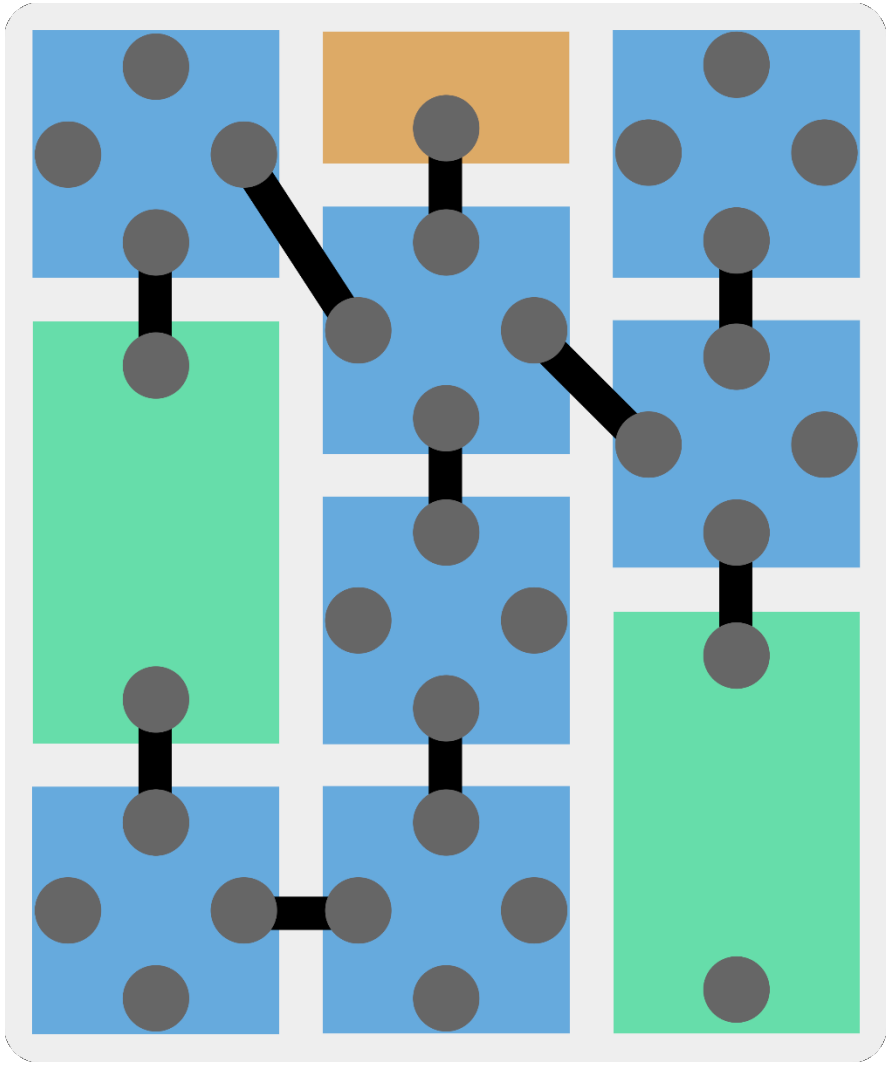
Motivation


Interconnect Latency and Throughput depend on:
Chiplet Placement
Interconnect Topology
Co-Optimization
Placement first
Topology second
?
Topology first
Placement second

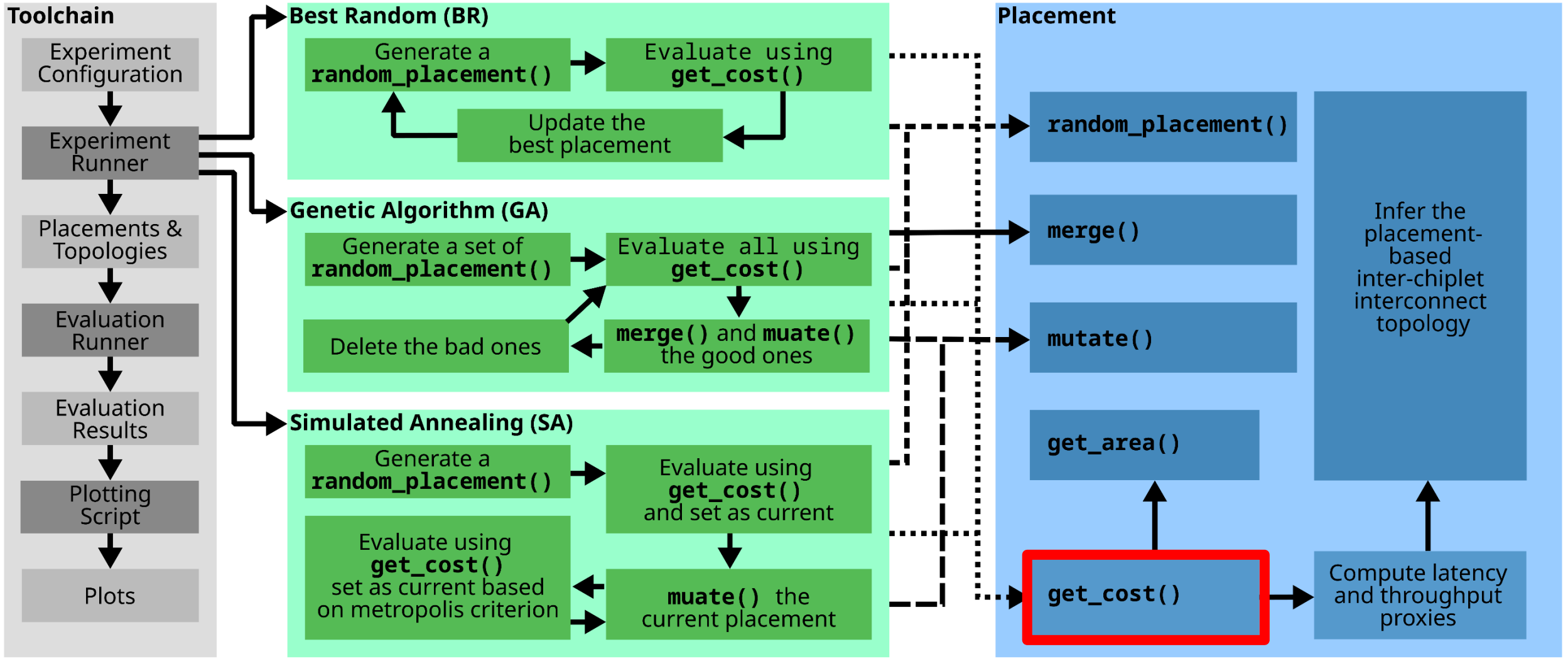
PlaceIT: Architecture



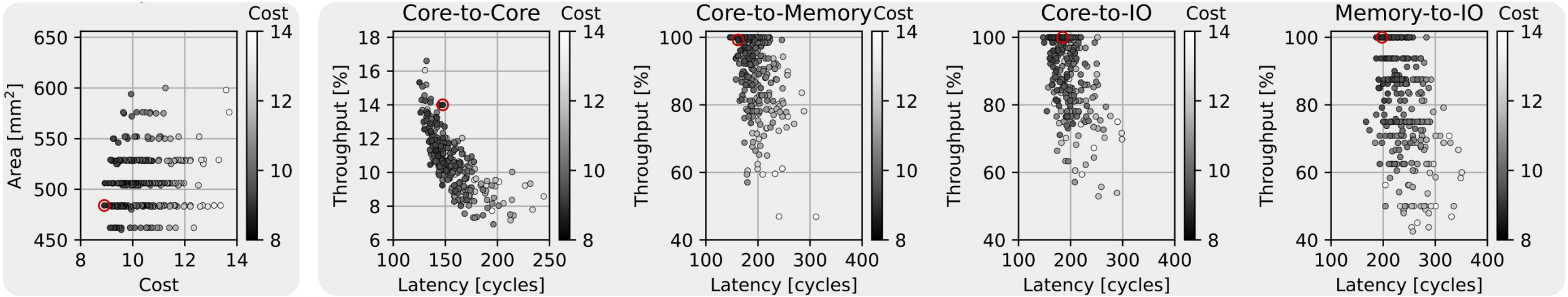
PlaceIT: Inferring Placement-Based Interconnect Topologies



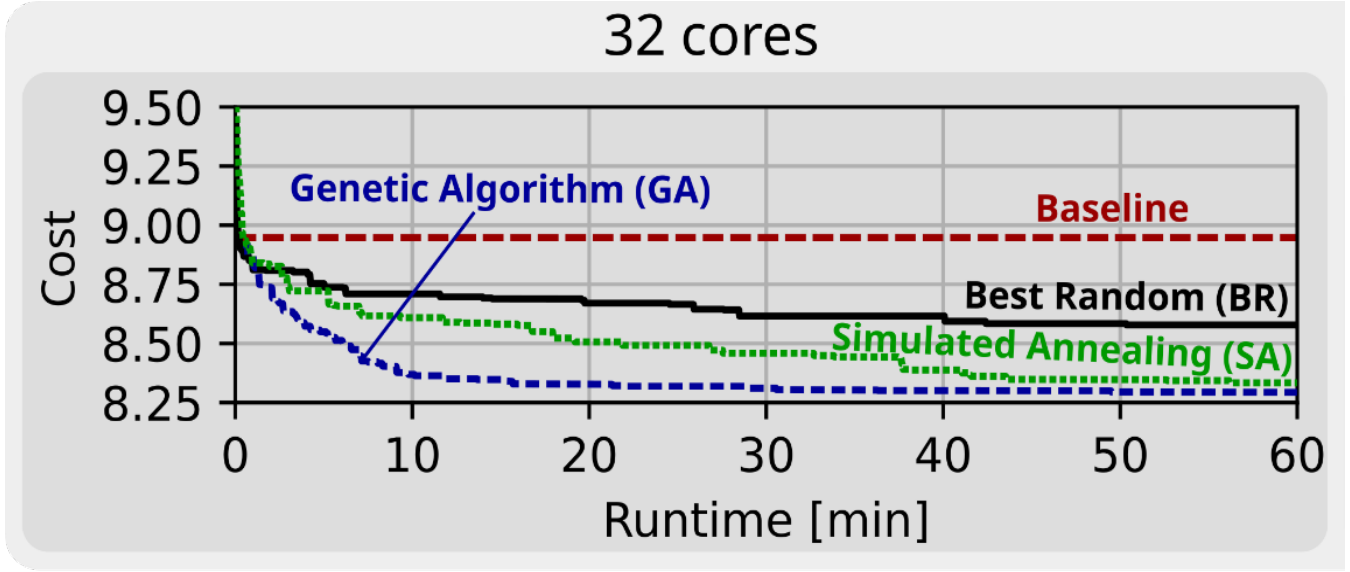
PlaceIT: Architecture

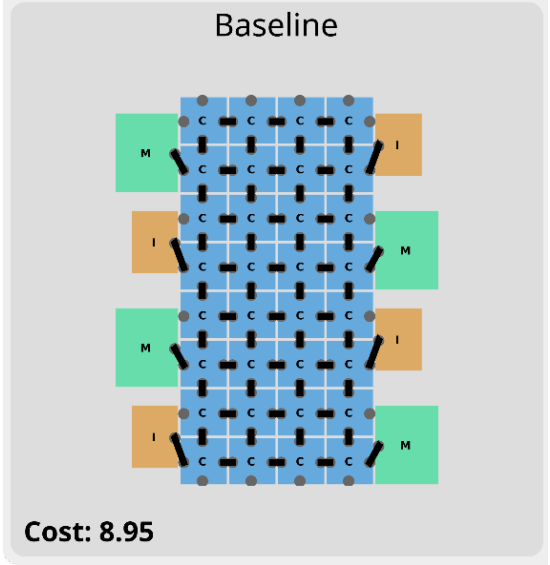


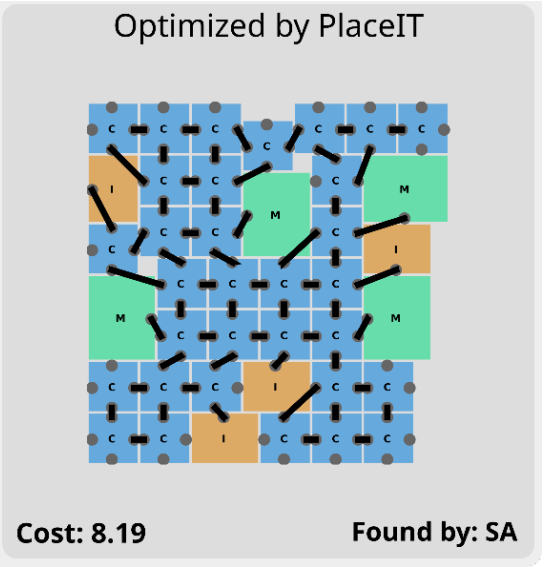
PlaceIT: Cost Function

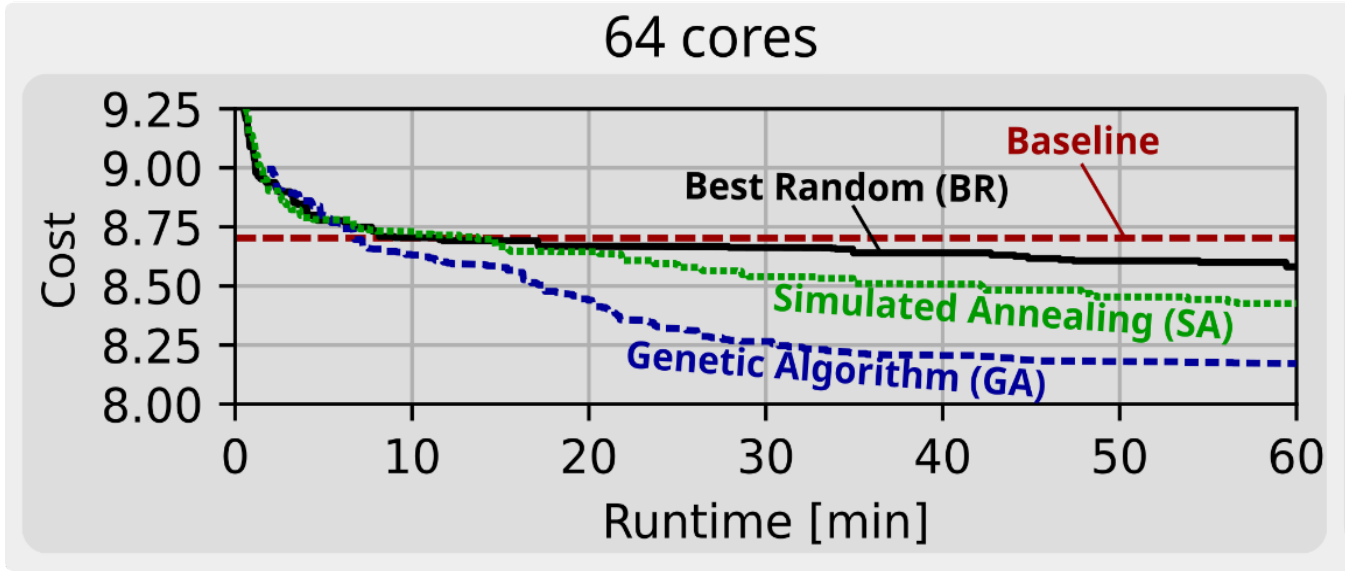


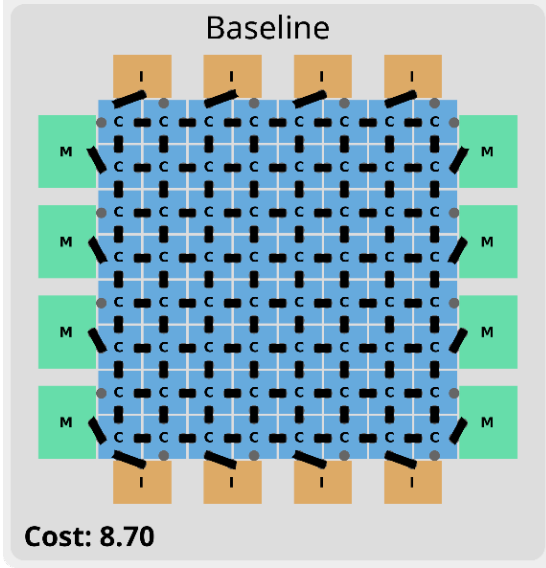
Optimizing Chips with Heterogeneously Shaped Chiplets

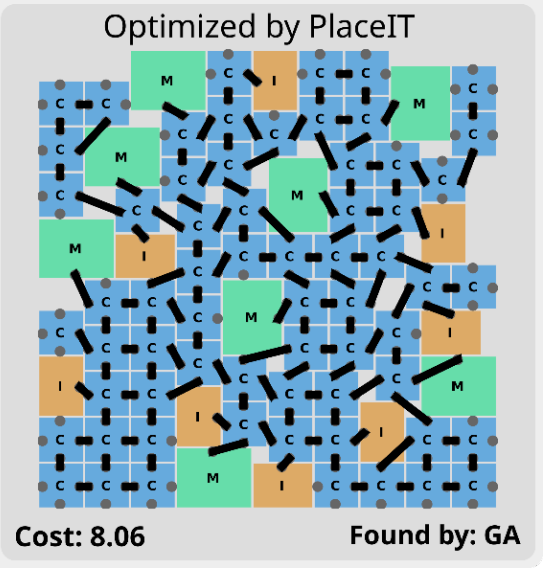




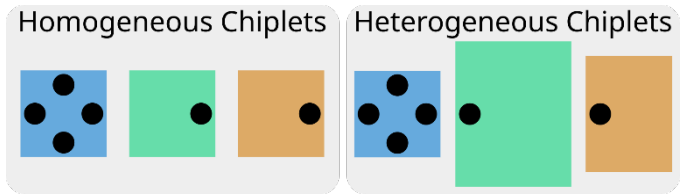


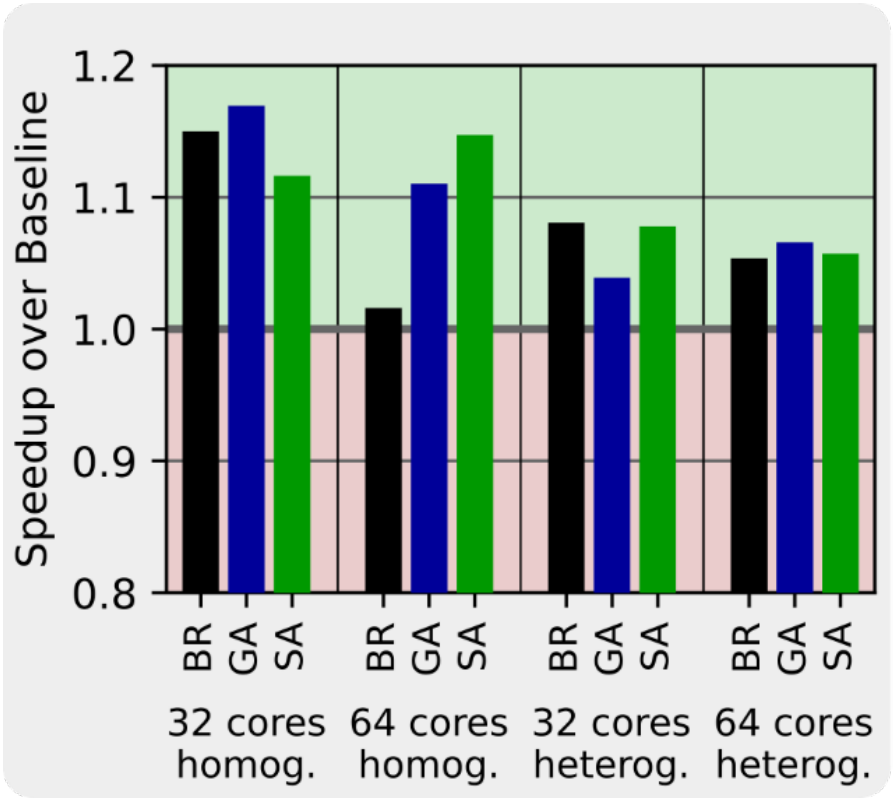


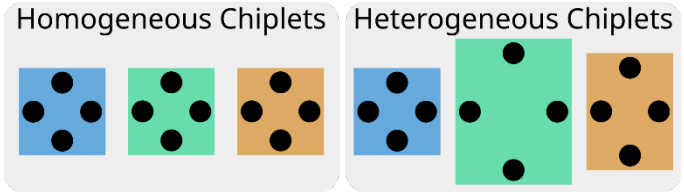


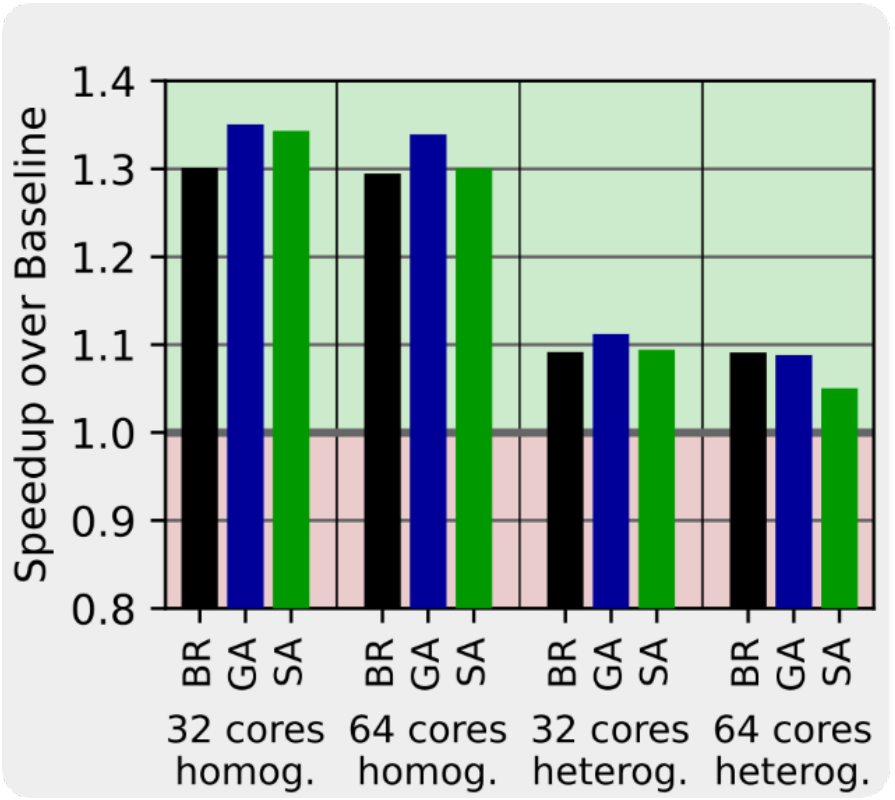


Evaluation using Full Traffic Trace

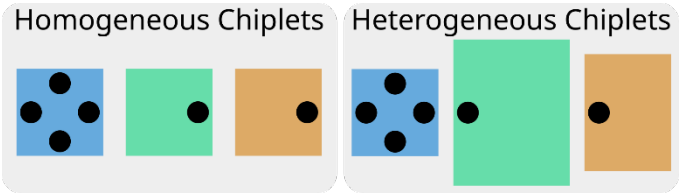








Evaluation using Partial Traffic Trace Regions



Homogeneous

32 cores

	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA
	Region 1			Region 2			Region 3			Region 4			Region 5		
blackscholes	92%	86%	88%	77%	79%	83%	93%	85%	82%	95%	96%	99%	109%	101%	98%
bodytrack	90%	86%	89%	77%	79%	83%	76%	75%	69%	88%	81%	81%	101%	90%	90%
canneal	90%	86%	89%	77%	79%	83%	98%	90%	89%	95%	85%	86%	104%	87%	87%
dedup	92%	86%	88%	77%	79%	83%	157%	119%	122%	87%	86%	92%	75%	81%	87%
ferret	92%	86%	88%	77%	79%	83%	102%	94%	94%	95%	92%	88%	87%	74%	86%
fluidanimate	92%	86%	88%	77%	79%	83%	88%	83%	85%	85%	78%	82%	93%	82%	83%
swaptions	90%	86%	89%	77%	79%	83%	96%	91%	93%	84%	85%	81%	110%	101%	102%
vips	92%	86%	88%	77%	79%	83%	100%	92%	91%	80%	75%	78%	78%	68%	74%
x264	90%	86%	89%	77%	79%	83%	81%	71%	71%	87%	84%	91%	108%	98%	96%

64 cores

	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA
	Region 1			Region 2			Region 3			Region 4			Region 5		
blackscholes	96%	93%	95%	82%	103%	102%	98%	88%	91%	106%	95%	91%	95%	93%	98%
bodytrack	94%	94%	97%	82%	103%	102%	167%	110%	103%	96%	87%	91%	91%	83%	86%
canneal	94%	94%	97%	82%	103%	102%	94%	88%	92%	100%	95%	95%	89%	78%	87%
dedup	96%	93%	95%	82%	103%	102%	97%	95%	107%	97%	93%	87%	90%	90%	104%
ferret	96%	93%	95%	82%	103%	102%	90%	87%	94%	97%	83%	88%	93%	82%	88%
fluidanimate	96%	93%	95%	82%	103%	102%	96%	91%	95%	97%	87%	88%	94%	84%	94%
swaptions	94%	94%	97%	82%	103%	102%	90%	93%	97%	77%	80%	80%	96%	89%	103%
vips	96%	93%	95%	82%	103%	101%	95%	91%	93%	87%	80%	78%	97%	79%	85%
x264	94%	94%	96%	82%	103%	102%	106%	85%	88%	98%	96%	98%	101%	89%	98%

Heterogeneous

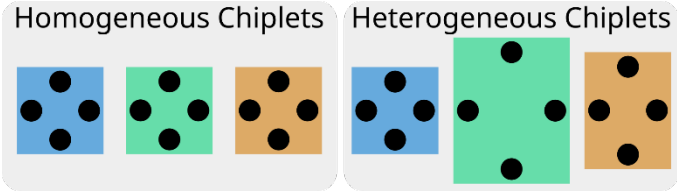
32 cores

	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA
	Region 1			Region 2			Region 3			Region 4			Region 5		
blackscholes	87%	89%	87%	92%	97%	92%	103%	100%	97%	100%	101%	108%	93%	98%	94%
bodytrack	84%	87%	84%	92%	97%	91%	145%	111%	126%	110%	106%	107%	89%	93%	89%
canneal	84%	86%	84%	92%	97%	91%	95%	97%	95%	86%	85%	84%	89%	98%	92%
dedup	87%	89%	87%	92%	97%	91%	79%	93%	78%	88%	94%	92%	98%	96%	100%
ferret	87%	89%	87%	92%	97%	91%	95%	102%	98%	98%	99%	99%	89%	87%	87%
fluidanimate	87%	89%	87%	92%	97%	91%	89%	91%	88%	88%	89%	87%	91%	95%	92%
swaptions	84%	87%	84%	92%	97%	91%	83%	88%	82%	99%	96%	101%	85%	91%	86%
vips	87%	90%	87%	92%	97%	91%	98%	101%	99%	91%	87%	94%	88%	82%	95%
x264	84%	87%	84%	92%	97%	92%	104%	95%	100%	102%	106%	98%	87%	92%	87%

64 cores

	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA
	Region 1			Region 2			Region 3			Region 4			Region 5		
blackscholes	89%	93%	80%	96%	96%	88%	106%	121%	101%	107%	117%	119%	106%	110%	95%
bodytrack	85%	90%	79%	96%	96%	88%	82%	135%	69%	117%	141%	115%	104%	111%	94%
canneal	85%	90%	79%	96%	96%	88%	101%	106%	96%	98%	92%	89%	107%	108%	93%
dedup	89%	93%	79%	96%	96%	88%	122%	132%	103%	94%	90%	97%	96%	81%	81%
ferret	89%	93%	80%	96%	96%	88%	102%	121%	101%	103%	116%	94%	92%	87%	84%
fluidanimate	89%	93%	79%	96%	96%	88%	93%	93%	91%	95%	89%	87%	105%	106%	93%
swaptions	85%	90%	79%	96%	96%	88%	88%	93%	85%	101%	120%	96%	118%	113%	99%
vips	89%	94%	80%	96%	96%	88%	103%	111%	99%	86%	93%	101%	86%	96%	97%
x264	86%	90%	79%	96%	96%	88%	100%	109%	90%	98%	105%	92%	99%	105%	90%

Evaluation using Partial Traffic Trace Regions



Homogeneous

32 cores

	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA
	Region 1			Region 2			Region 3			Region 4			Region 5		
blackscholes	73%	80%	76%	49%	65%	66%	66%	76%	79%	90%	77%	77%	74%	95%	96%
bodytrack	72%	81%	75%	49%	65%	66%	52%	70%	72%	59%	78%	76%	68%	85%	84%
canneal	72%	81%	75%	49%	65%	66%	70%	83%	83%	74%	77%	76%	61%	80%	84%
dedup	72%	80%	76%	49%	65%	66%	78%	100%	121%	82%	76%	72%	49%	55%	54%
ferret	73%	80%	76%	49%	65%	66%	67%	93%	86%	65%	82%	80%	81%	69%	71%
fluidanimate	73%	80%	76%	49%	65%	66%	70%	75%	72%	68%	71%	71%	60%	77%	75%
swaptions	72%	81%	75%	49%	65%	66%	76%	83%	79%	64%	91%	80%	73%	99%	97%
x264	73%	81%	75%	49%	65%	66%	54%	66%	65%	64%	82%	82%	68%	91%	89%

64 cores

	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA
	Region 1			Region 2			Region 3			Region 4			Region 5		
blackscholes	82%	79%	75%	74%	75%	75%	78%	80%	79%	80%	73%	80%	80%	80%	79%
bodytrack	83%	81%	75%	74%	75%	75%	81%	99%	94%	72%	74%	66%	70%	68%	66%
canneal	83%	81%	75%	74%	75%	75%	76%	77%	74%	79%	78%	78%	63%	64%	69%
dedup	81%	79%	75%	74%	75%	75%	94%	90%	85%	83%	77%	79%	87%	89%	92%
ferret	81%	79%	75%	74%	75%	75%	78%	79%	72%	72%	72%	71%	77%	78%	77%
fluidanimate	81%	79%	75%	74%	75%	75%	82%	80%	79%	76%	74%	75%	72%	76%	74%
swaptions	83%	81%	75%	74%	75%	75%	85%	83%	77%	66%	64%	60%	81%	80%	78%
x264	82%	81%	75%	74%	75%	75%	71%	73%	68%	76%	81%	79%	78%	79%	77%

Heterogeneous

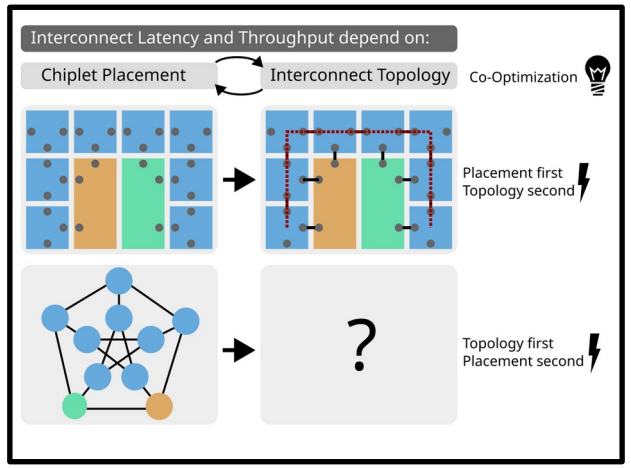
32 cores

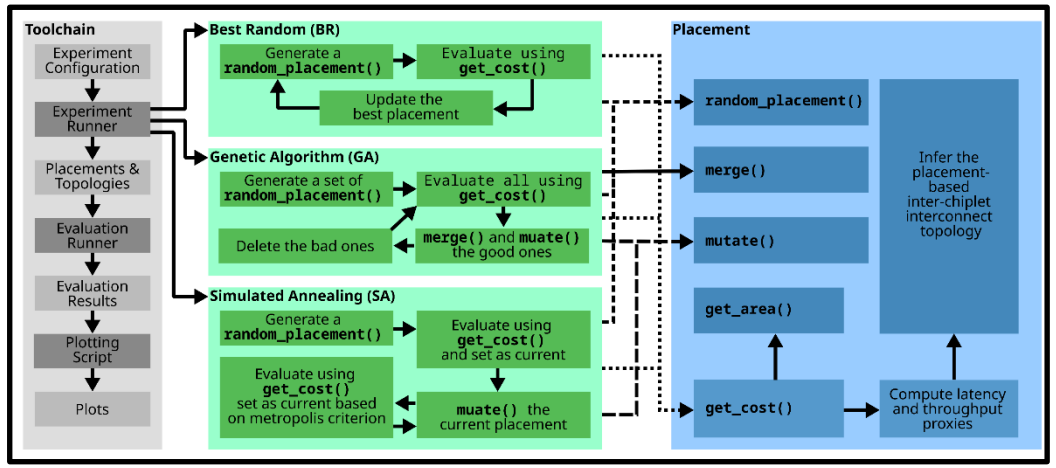
	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA
	Region 1			Region 2			Region 3			Region 4			Region 5		
blackscholes	80%	76%	83%	89%	70%	83%	90%	79%	86%	98%	99%	89%	93%	74%	86%
bodytrack	78%	74%	81%	89%	70%	83%	94%	88%	92%	96%	82%	93%	86%	71%	81%
canneal	78%	74%	81%	89%	70%	83%	93%	79%	89%	90%	80%	85%	87%	72%	79%
dedup	80%	76%	83%	89%	70%	83%	78%	60%	71%	87%	87%	88%	102%	84%	85%
ferret	80%	75%	83%	89%	70%	83%	98%	80%	92%	99%	83%	90%	84%	77%	80%
fluidanimate	80%	75%	83%	89%	70%	83%	89%	84%	85%	83%	80%	81%	88%	73%	80%
swaptions	78%	74%	81%	89%	70%	83%	79%	73%	80%	94%	77%	85%	82%	67%	77%
x264	77%	74%	81%	89%	70%	83%	83%	73%	77%	88%	85%	93%	85%	71%	79%

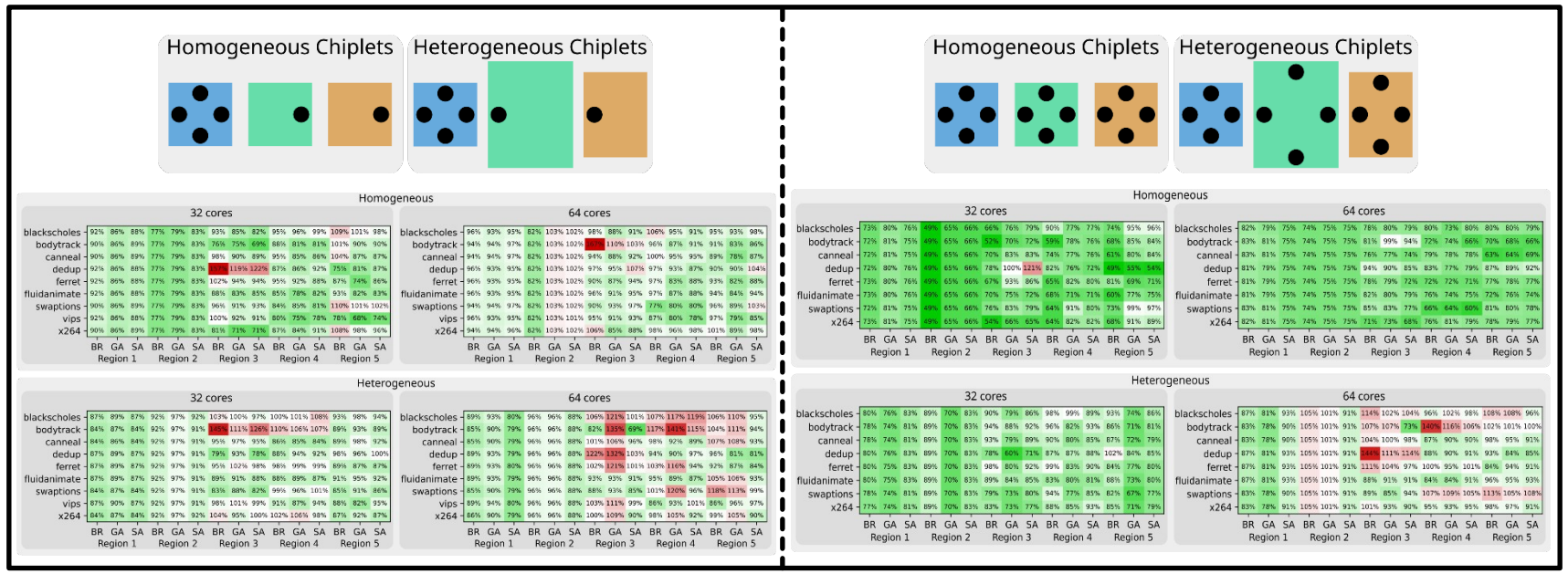
64 cores

	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA	BR	GA	SA
	Region 1			Region 2			Region 3			Region 4			Region 5		
blackscholes	87%	81%	93%	105%	101%	91%	114%	102%	104%	96%	102%	98%	108%	108%	96%
bodytrack	83%	78%	90%	105%	101%	91%	107%	107%	73%	140%	116%	106%	102%	101%	100%
canneal	83%	78%	90%	105%	101%	91%	104%	100%	98%	87%	90%	90%	98%	95%	91%
dedup	87%	81%	93%	105%	101%	91%	144%	111%	114%	88%	90%	91%	93%	84%	85%
ferret	87%	81%	93%	105%	101%	91%	111%	104%	97%	100%	95%	101%	84%	94%	91%
fluidanimate	87%	81%	93%	105%	101%	91%	88%	91%	91%	84%	84%	91%	96%	95%	93%
swaptions	83%	78%	90%	105%	101%	91%	89%	85%	94%	107%	109%	105%	113%	105%	108%
x264	83%	78%	91%	105%	101%	91%	101%	93%	90%	95%	93%	95%	98%	97%	91%

Conclusion







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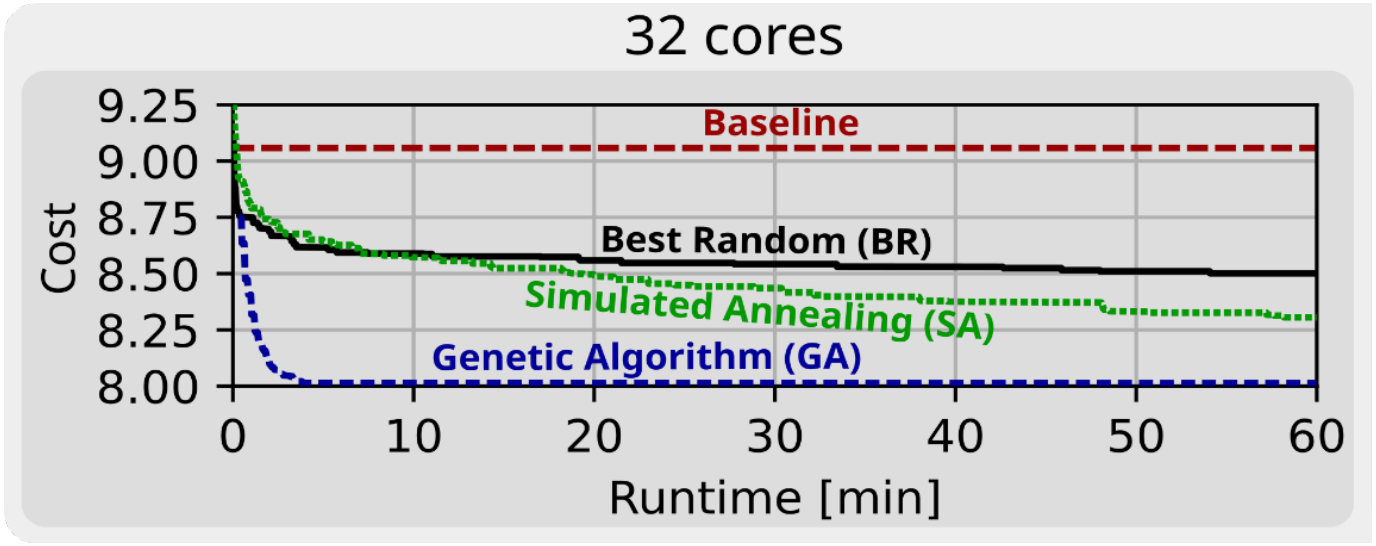
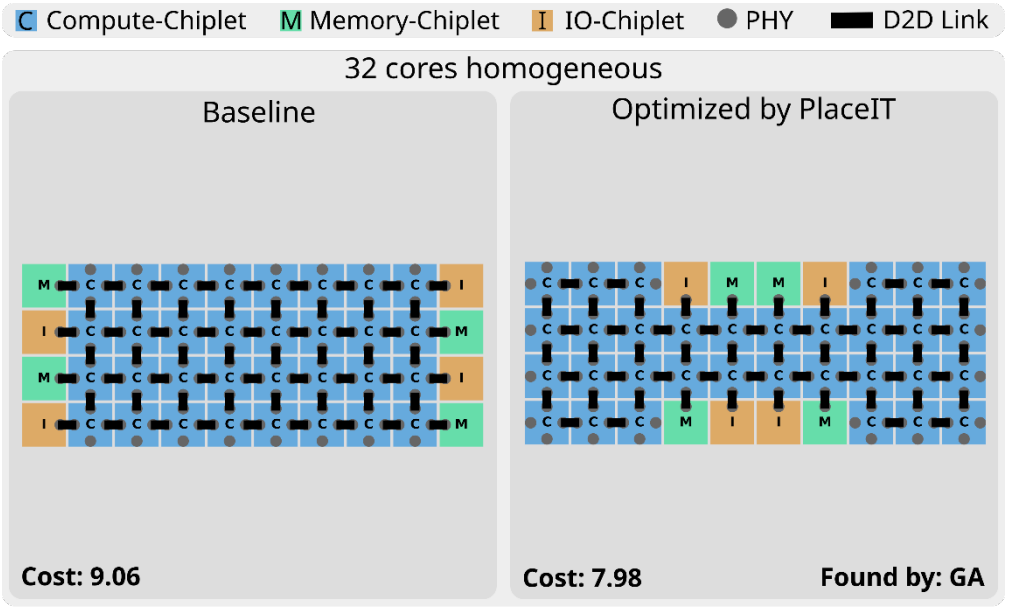
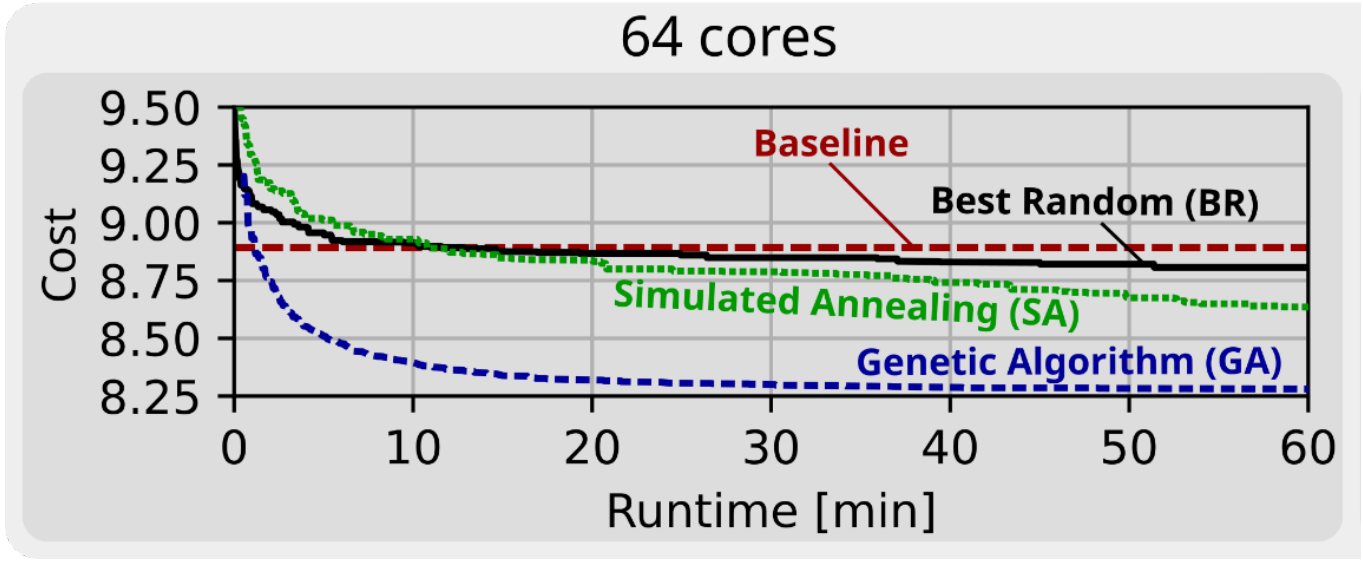
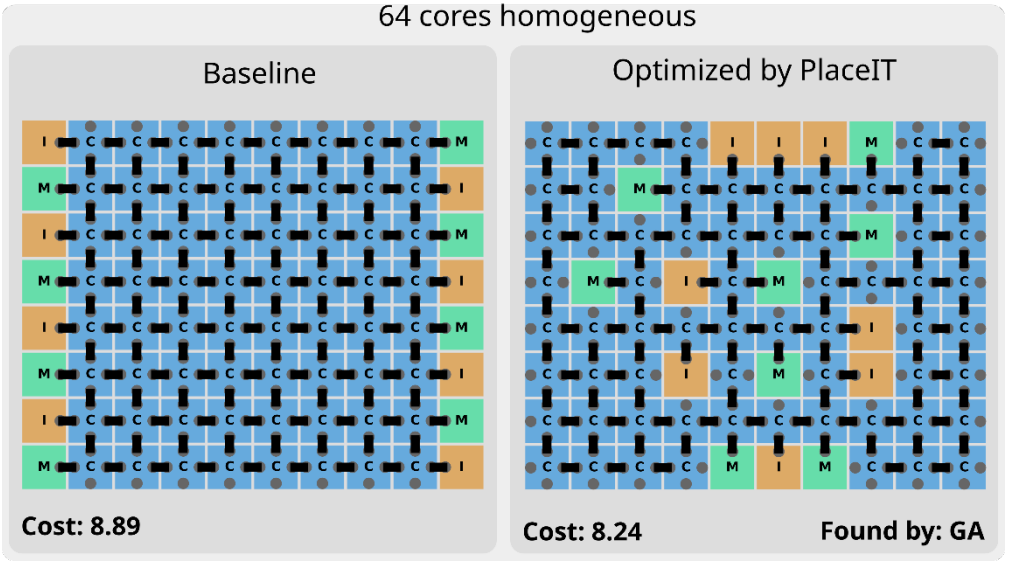
Backup Slides

Optimizing Chips with Homogeneously Shaped Chiplets









Evaluation using Synthetic Traces