Algebraic tiling facing loop skewing

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Loop tiling is powerful & well-known loop optimising transformation

- to improve data locality
- to adjust the grain of parallelism

Last year we introduced algebraic loop tiling:

- Dynamic tiles of quasi-equal volume
- To address load-balancing among threads
Rectangularly tiled triangle domain

Algebraically tiled triangle domain
Issues when facing skewing

• No problem when handling sequential programs
• Some kernels need a last transformation over tiles to exhibit a parallel dimension.
  • Leads to an incorrect program when using algebraic tiling
Rectangular tiling parallelization

Standard tiled domain of seidel-2d

$(t_0 + t_1, t_1)$

Parallel tiles of seidel-2d after tile skewing. Same color means concurrent
Algebraic tiling parallelization

Algebraically tiled domain of seidel-2d

Invalid tile skewing of seidel-2d
Same color means concurrent
Algebraic tiling parallelization

Algebraically tiled domain of seidel-2d

Invalid tile skewing of seidel-2d
Same color means concurrent
Our solution

Algebraically tiled domain of seidel-2d

Valid tile skewing of seidel-2d
Same color means concurrent
Performance of algebraic tiling vs standard tiling (lower is better).
Algebraic scheduling

- Precompute all tile bounds
- Build a tile schedule at runtime

Algebraically tiled iteration domain of seidel-2d
Build a valid schedule of algebraic tiles
Build a valid schedule of algebraic tiles
Build a valid schedule of algebraic tiles
Build a valid schedule of algebraic tiles
Build a valid schedule of algebraic tiles
Build a valid schedule of algebraic tiles
Build a valid schedule of algebraic tiles
Performance of algebraic scheduling vs rectangular tiling (lower is better).
Conclusion

- We proposed a strategy to apply algebraic tiling when a skewing is required
- Valid program, but results are not satisfying
- New strategies should be investigated
- Algebraic scheduling seems promising
- Strategies similar to diamond tiling should be investigated
Thank you!