Alexandru Calotoiu

DaFlEx

Work and depth and canonicalization

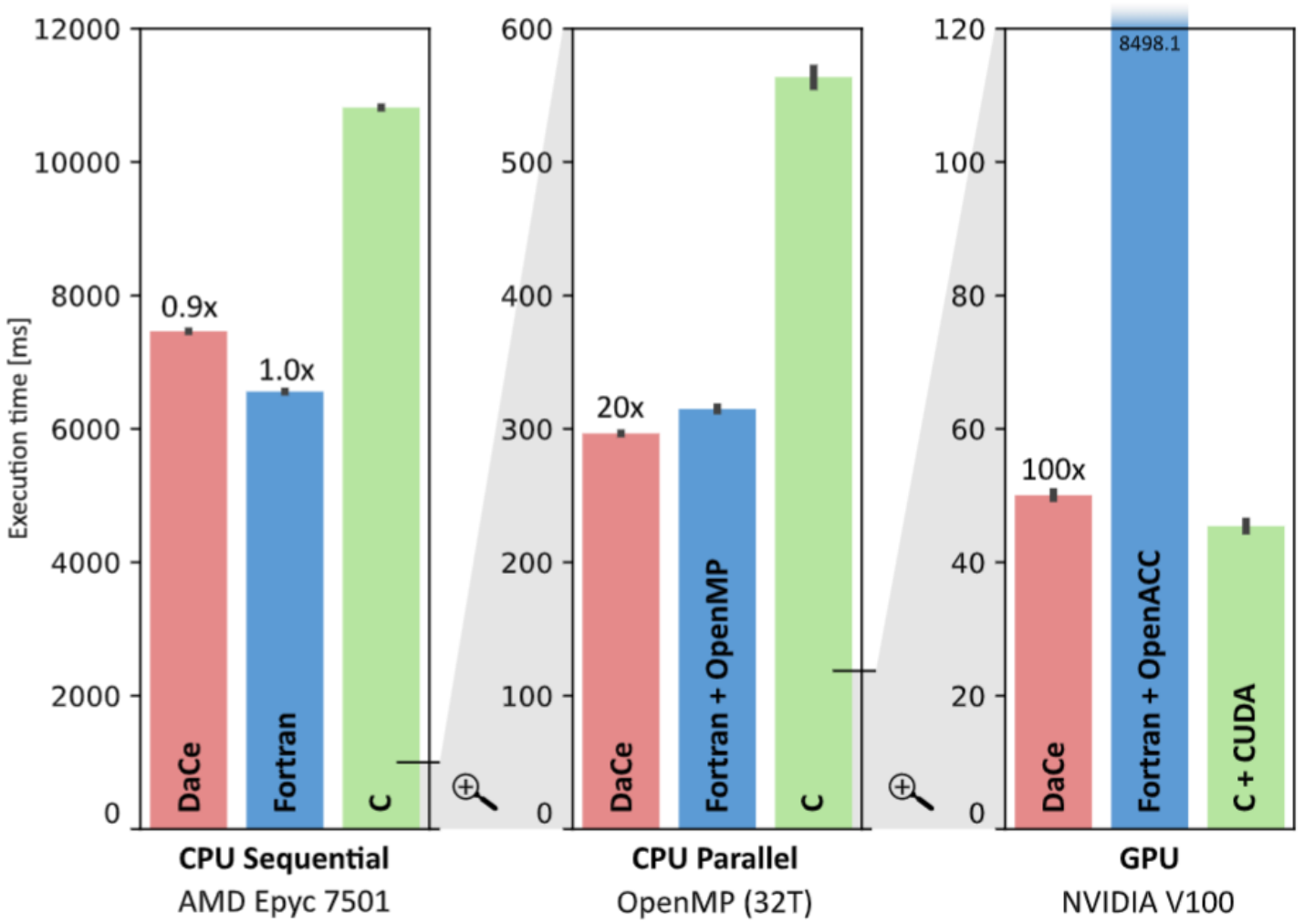
Program Element	Work (T_1)	Depth (T_∞)	Example
Instruction **I**	1	1	A=42
Dependency chain **DC** I_n->...->I_2->I_1	n	n	A=42 B=A+1 C=B+A
Code block **B**	$\sum \forall \mathbf{I} \in \mathbf{B}$	$Max(\forall \mathbf{I} \in \mathbf{B})$	A=42 B=A+1 D=7 E=D*D
Conditional branches (upper bound)	$1 + Max(T_1(\mathbf{B}_{\text{if}}), T_1(\mathbf{B}_{\text{else}}))$	$1 + Max(T_\infty(\mathbf{B}_{\text{if}}), T_\infty(\mathbf{B}_{\text{else}}))$	If (A==42) B=A B=A+1
Loop with **n** iterations	$n * T_1(\mathbf{B})$	$n * T_\infty(\mathbf{B}_{\text{if}})$	A(1)=1 A(2)=1 ... A(n)=A(n-1)+A(n-2)
Parallel loop with **n** iterations	$n * T_1(\mathbf{B})$	$T_\infty(\mathbf{B}_{\text{if}})$	A(1)=1 ... A(2)=3 ... A(n)=$n * \frac{n-1}{2}$

Transformation	**Depth** T_∞
Work of Fortran T_1	$NBlocks(152.656 * NPoints + 32)$
Initial DaCe program	$NBlocks(122.425 * NPoints + 32)$
Parallel DaCe program	$30.108 * NPoints + 38.999$
Data container lifetime & versioning	$8.241 * NPoints + 52.730$
Happens-before edge	60.353

Transformations

- Scalar Fission
- Array Fission
- Dependency Edge State Fusion Combination
- Symbol Replacements
- Stride changes
- Array size quashing via caching

CLOUDSC


Execution time [ms]
12000
10000
8000
6000
4000
2000
0
0.9x
1.0x
DaCe
Fortran
C
CPU Sequential
AMD Epyc 7501
600
500
400
300
200
100
0
20x
DaCe
Fortran + OpenMP
C
CPU Parallel
OpenMP (32T)
120
100
80
60
40
20
0
8498.1
100x
DaCe
Fortran + OpenACC
C + CUDA
GPU
NVIDIA V100