

NSF/IEEE-TCPP Parallel and Distributed Computing Curricular Recommendations

Topics	B L O O M #	Where Covered	Items
--------	----------------------------	------------------	-------

Architecture Topics

Classes			
Taxonomy	C	Systems	
<i>Data vs. control parallelism</i>	K,C	Systems	Superscalar (ILP); SIMD/Vector; Pipelines; Streams (e.g., GPU); MIMD; Simultaneous Multi-Threading; Multicore; Heterogeneous (e.g., Cell, on-chip GPU)
<i>Shared vs. distributed memory</i>	K,C	Systems	SMP (Buses); Message passing (Latency, Bandwidth)
Memory Hierarchy	C	Systems	Cache organization
Floating point representation	K	CS1, CS2, Systems	Range; Precision; Error propagation; IEEE 754 standard
Performance metrics	K,C	Systems	Cycles per instruction (CPI); Benchmarks (incl. Spec mark); Peak performance (incl. MIPS/FLOPS); Sustained performance

Programming Topics

Parallel Programming paradigms and Notations			
<i>By the target machine model</i>	K,C,A	CS2, DS/A, Systems, Lang	SIMD (incl. Processor vector extensions); Shared memory (incl. Language extensions, Compiler directives/ pragmas, Libraries); Distributed memory (incl. Client Server); Hybrid
<i>By the control statement</i>	C,A	CS2, DS/A, Lang	Task/thread spawning; SPMD (incl. SPMD notations); Data parallel (incl. Parallel loops for shared memory)
Semantics and correctness issues	K,C,A	CS2, DS/A, Systems, Lang	Tasks and threads; Synchronization (incl. Critical regions, Producer-consumer, Monitors); Concurrency defects (incl. Deadlocks, Data Races); Tools to detect concurrency defects
Performance issues			
<i>Computation</i>	C	CS2, DS/A, Systems	Computation decomposition strategies (Owner computes rule, Decomposition into atomic tasks); Load balancing; Scheduling and mapping (Static, Dynamic)
<i>Data</i>	K,C	CS2, DS/A, Systems, Lang	Data distribution; Data layout; Data locality; False sharing; Performance monitoring tools; Performance metrics (Speedup, Efficiency, Amdahl's law, Gustafson's Law)

Algorithm Topics

Parallel and Distributed Models and Complexity	K,C,A	CS1, CS, DS/A, SWE	Costs of computation (Asymptotics, Time, Space/Memory); Cost reduction (Speedup); Scalability in algorithms and architectures; Model-based notions (Notions from complexity-theory [PRAM, BSP/CILK], Notions from scheduling [Dependencies, Task graphs, Work, (Make)span])
Algorithmic Paradigms	K,C	CS2, DS/A, Systems, Alg2	Divide & conquer (parallel aspects); Recursion (parallel aspects); Reduction (map-reduce); Dependencies; Series-parallel composition
Algorithmic problems	K,C,A	CS, DS/A, ParAlg	Communication (Broadcast, Multicast, Scatter/gather); Asynchrony; Synchronization; Sorting; Selection; Graph algorithms (Search); Specialized computations; Termination detection; Leader election/symmetry breaking

Cross Cutting and Advanced Topics

High level themes	K	CS1, CS2	Why and what is parallel/distributed computing?
Cross-Cutting topics	K,C	CS2, DS/A, Systems	Locality; Concurrency; Non-determinism; Power Consumption; Fault tolerance
Current/Advanced Topics	K	CS1, CS2, DS/A, Systems	Cluster Computing; Cloud/grid Computing; Peer to Peer Computing; Consistency in Distributed Transactions; Web search; Security in Distributed Systems