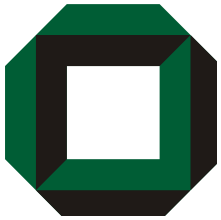

Universität Karlsruhe (TH)

Forschungsuniversität · gegründet 1825

Parallelism in curricula – An international survey

November 7, 2008
Stuttgart, Germany

David Meder

Dr. Victor Pankratius

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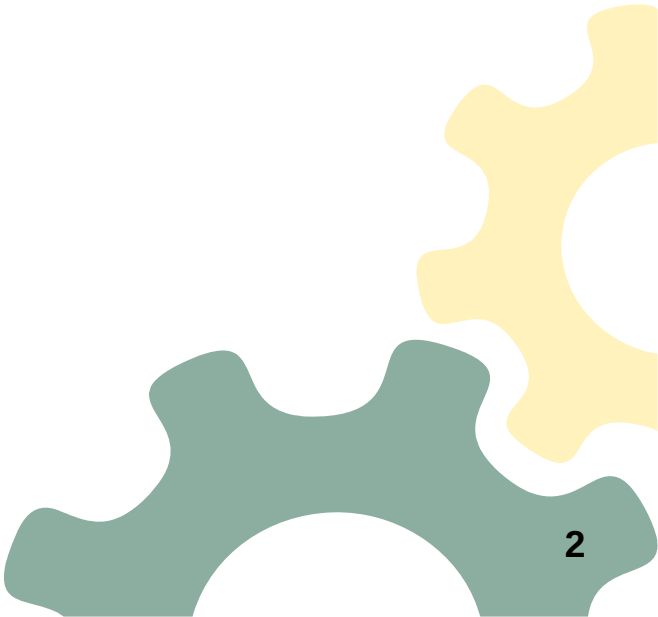
Fakultät für **Informatik**

Lehrstuhl für Programmiersysteme

Objective

- Provide an overview of lectures addressing parallelism
- Compare curricula
  - Also between Germany and other countries



Difficulties

- Amount of data, many sources
- Changing Web sites
- Courses offered in different languages
  - Difficult to find (e.g., Chinese)
- List will necessarily be incomplete

→*Pragmatic approach:*

- *Take top universities and add universities with known departments on parallel computing*
- *Send us updates if you miss something*

Approach

Wirtschafts Woche
wiwo.de
DIE ZEIT STUDIENFÜHRER
CHE UNIVERSITY RANKING

- Selection mainly based on popular rankings

  plus manual additions of universities with known groups in the area of parallelism

- Find lectures addressing parallelism
  - Sources: course catalogs, Web sites
  - **Search terms:** cell, cluster, concurrency, concurrent, distributed, grid, gpgpu, gpu, hpc, mpi, multicore, multi-core, multiprocessor, multi-processor, openmp, parallel, scientificcomputing (+ substrings)

- Categorize results
  - Algorithms, architecture/hardware, programming, distributed computing, multi-core, scientific computing/HPC, theory of parallel computing

Approach – Classification of lectures

Class	Topics, keywordsrelatedto
Algorithms	Design, usage, … of parallel algorithms.
Architecture/Hardware	Parallel hardware, such as memory organization.
Programming	OpenMP, MPI, (optional) practical sessions or project work,etc
Distributed Computing	Clusters,grids, … (hard- &software).
Multicore	Multi-core computers (architecture, programming).
Scientific Computing/HPC	Solving scientifc problems with parallel computers.
Theoryof Parallel Comp.	Theoretical aspects, such as synchronization, scheduling, …
NoClassification	Course on parallelism, but does not fit in any other class.

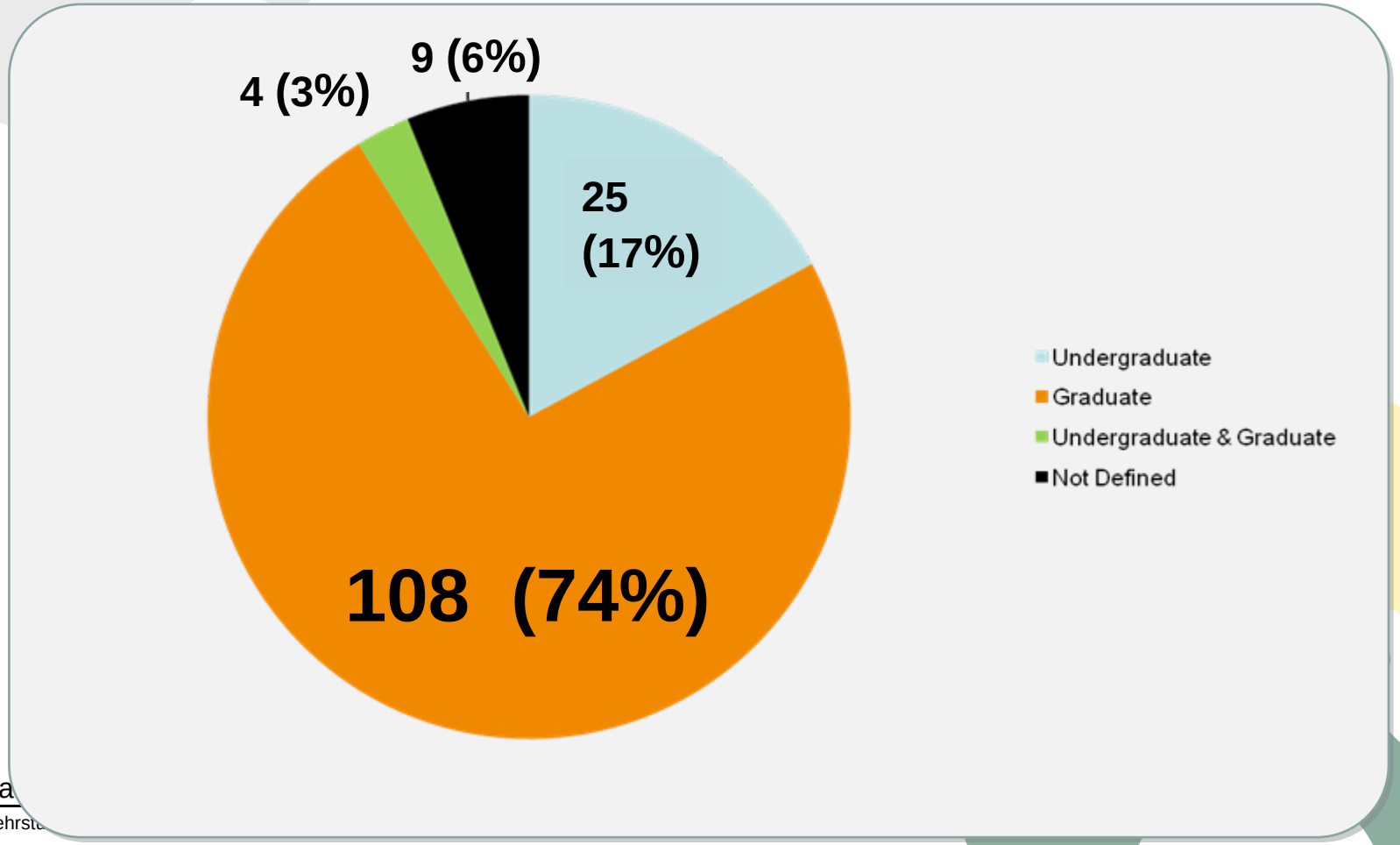
- One course may belong to more than one class
- Course must be offered on a regular basis

Results

- **46** universities with lectures addressing parallelism
  - **13** in the United States and Canada,
  - **3** in the United Kingdom,
  - **20** in Germany
  - **10** located in othercountries(Australia, PR China, Japan)

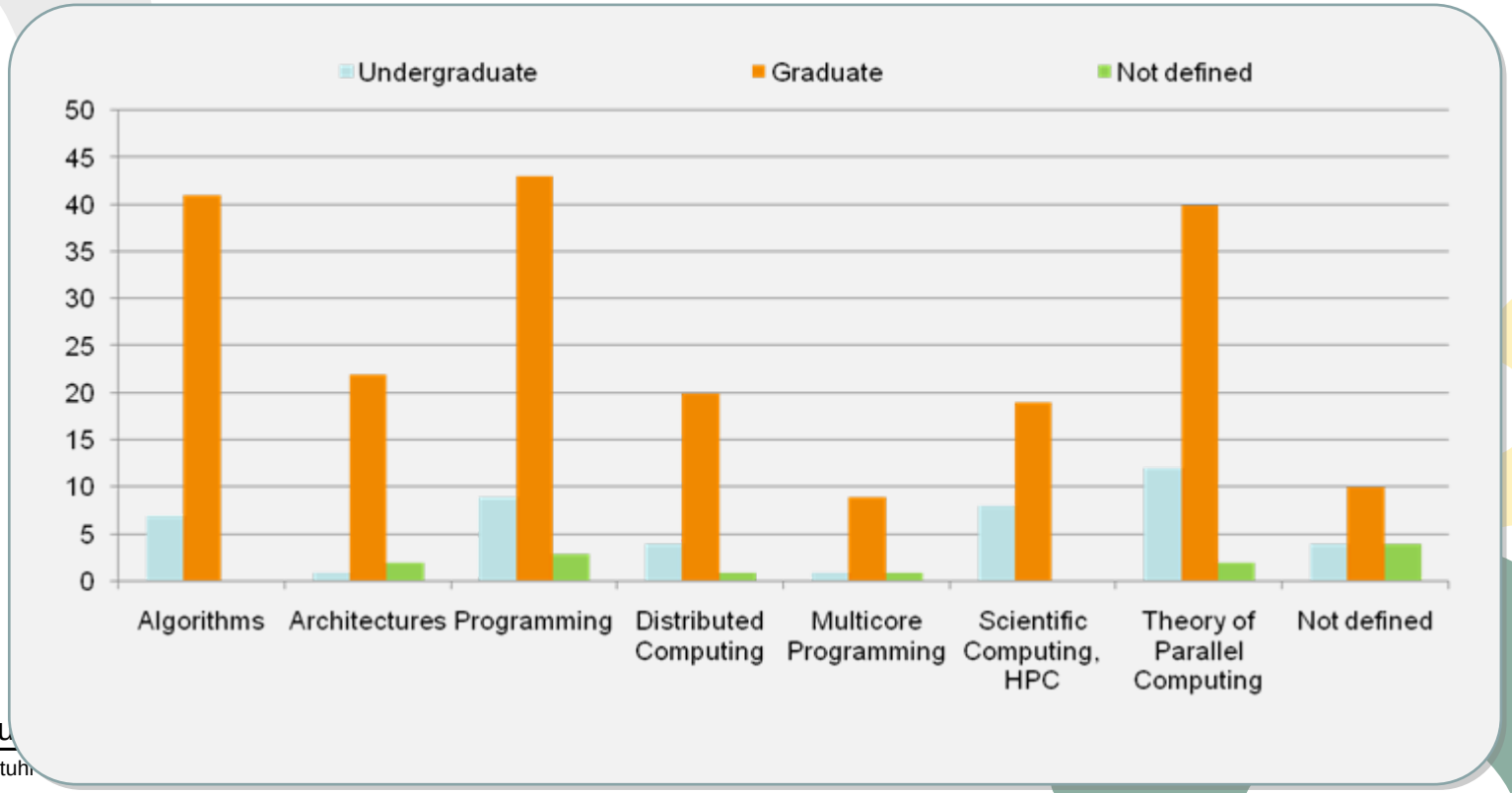
Results – International Universities

- **146** lectures addressing parallelism



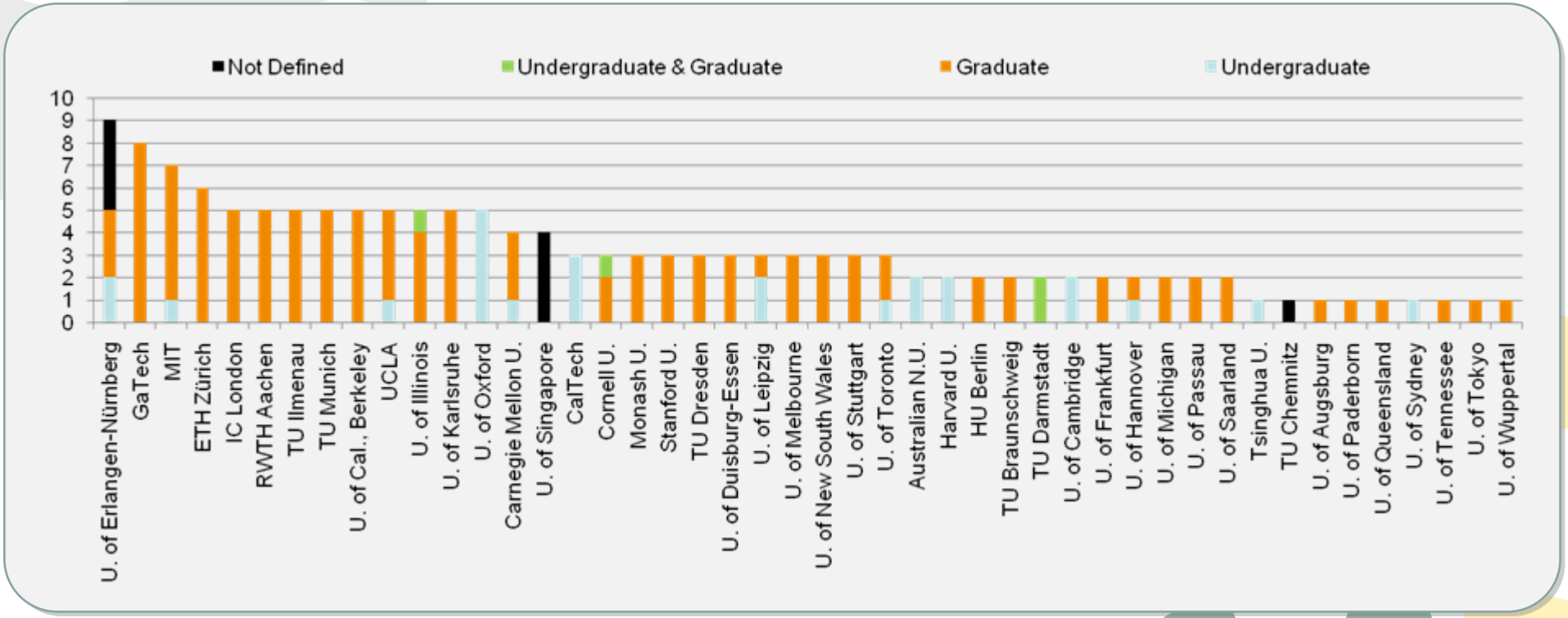
Results – International Universities

- **146** lectures addressing parallelism
- Main categories „Algorithms“, „Programming“, „Theory of Parallel Computing“



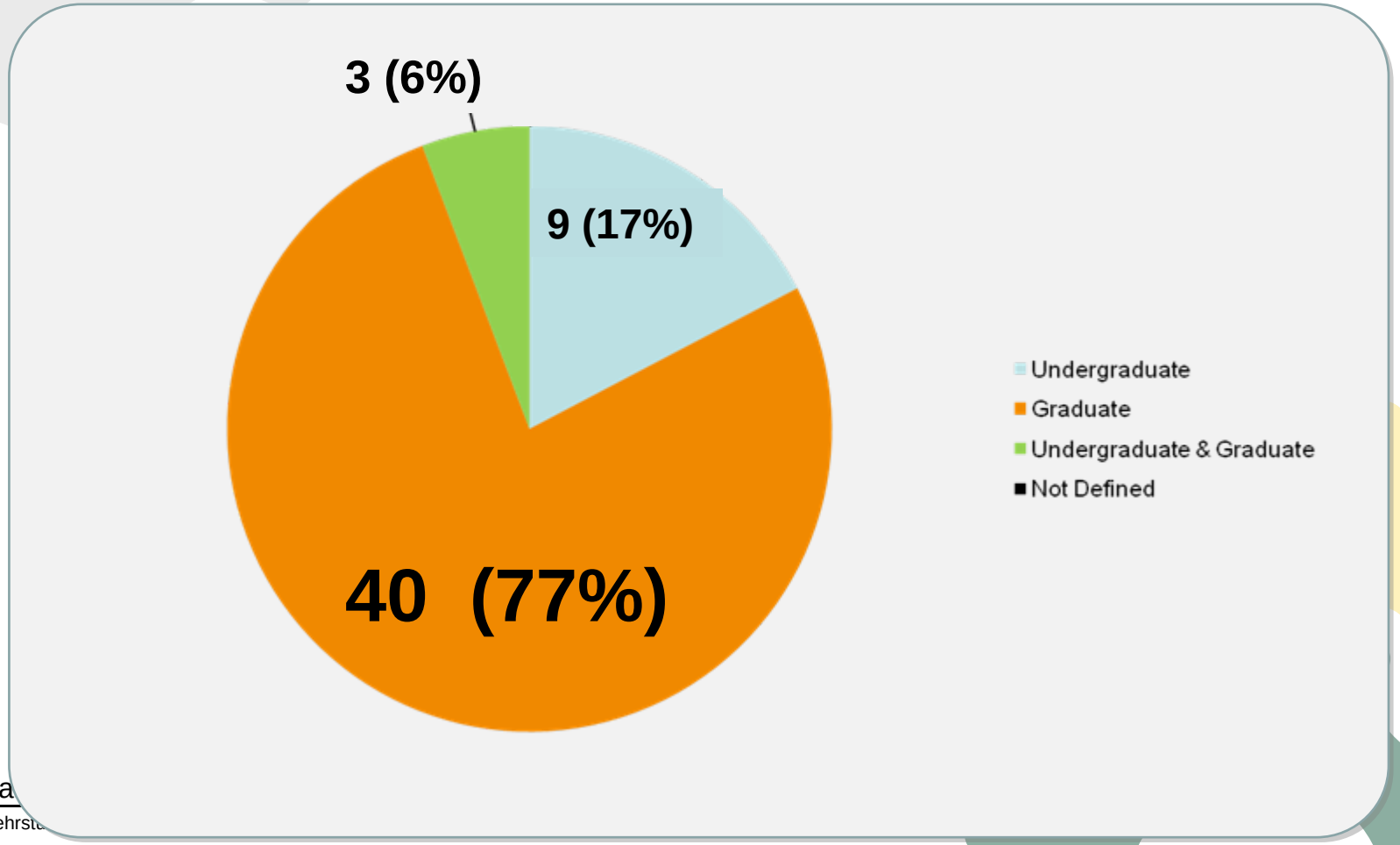
Results – International Universities

- Max: 9, Avg: 3.2



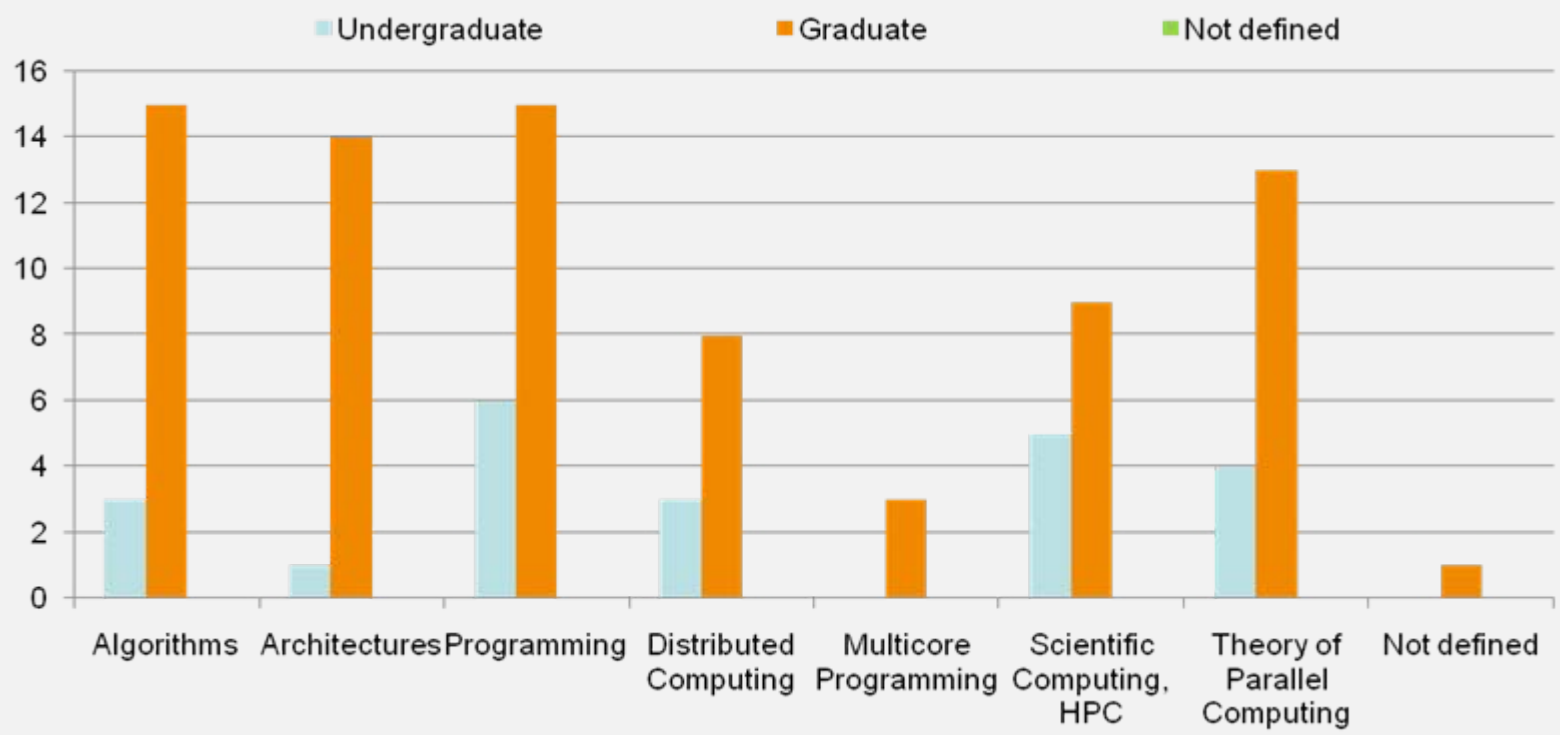
Results – American Universities

- **52** lectures



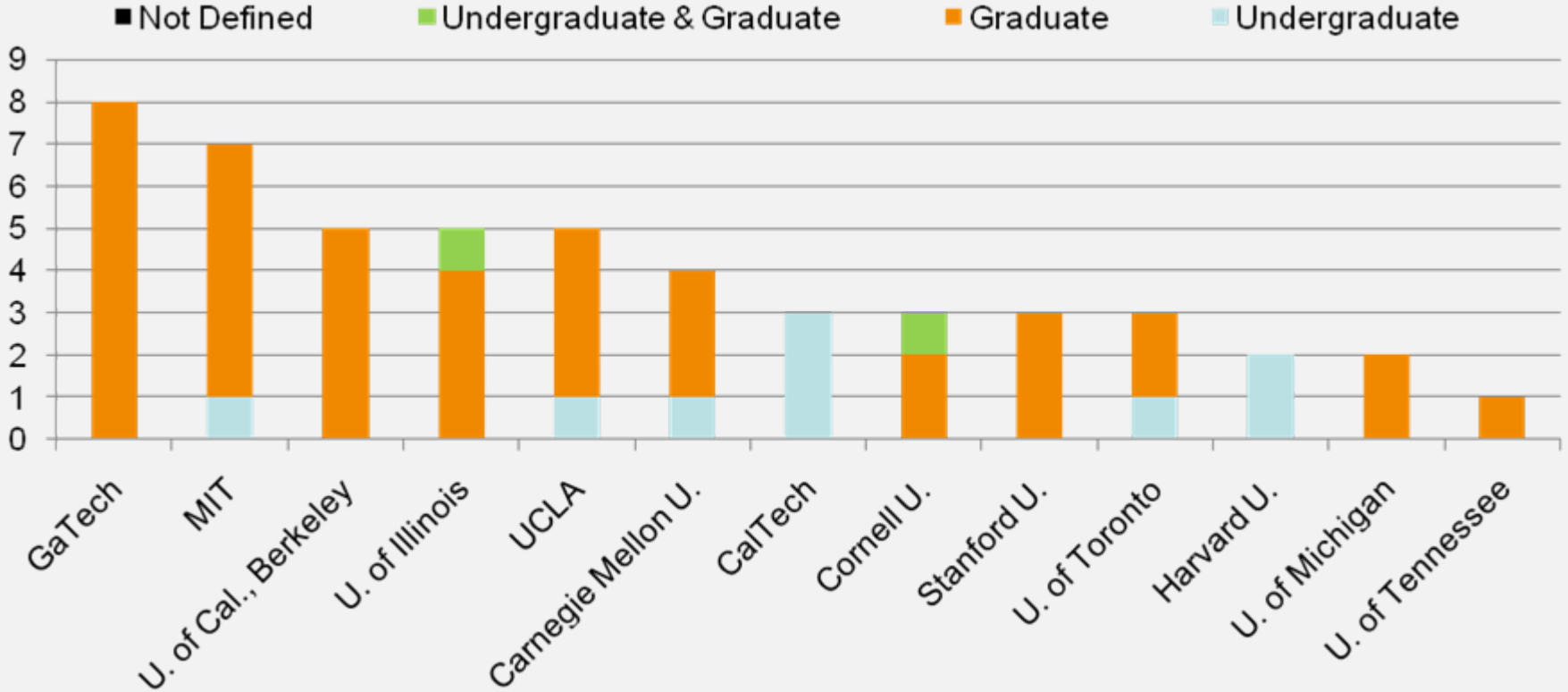
Results – American Universities

- **52** lectures
- Main categories „Algorithms“, „Architectures“, „Programming“ and „Theory of Parallel Computing“



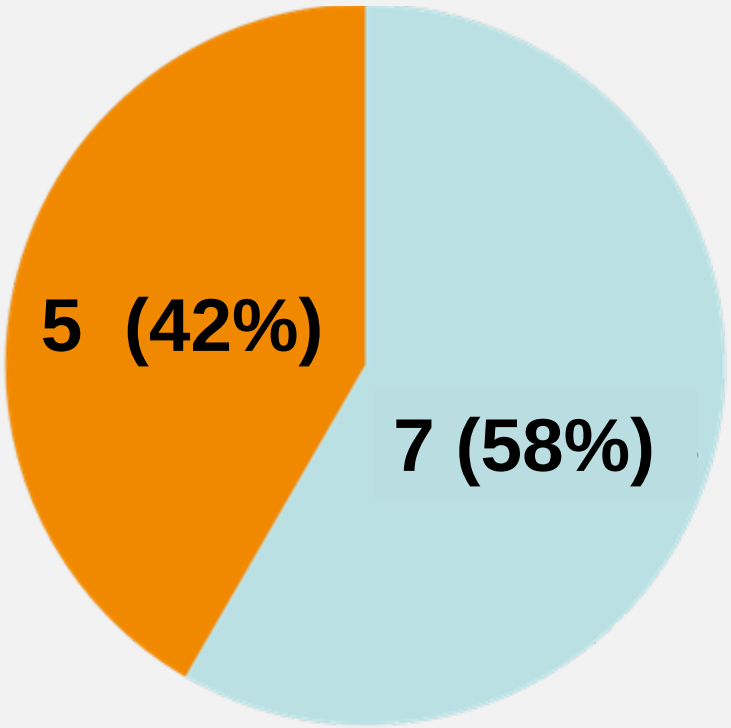
Results – American Universities

- Max: 8, Avg: 4.0



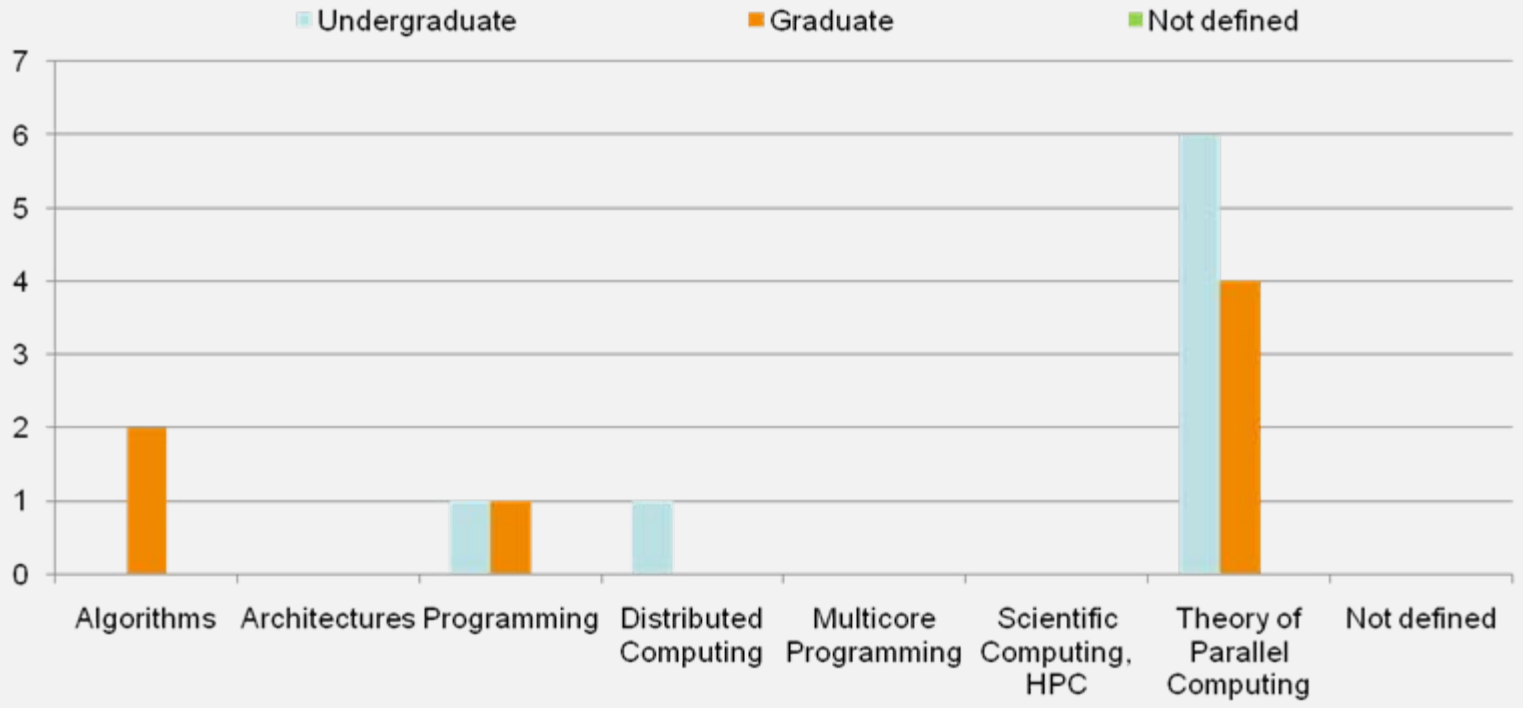
Results – U.K. Universities

- **12** lectures



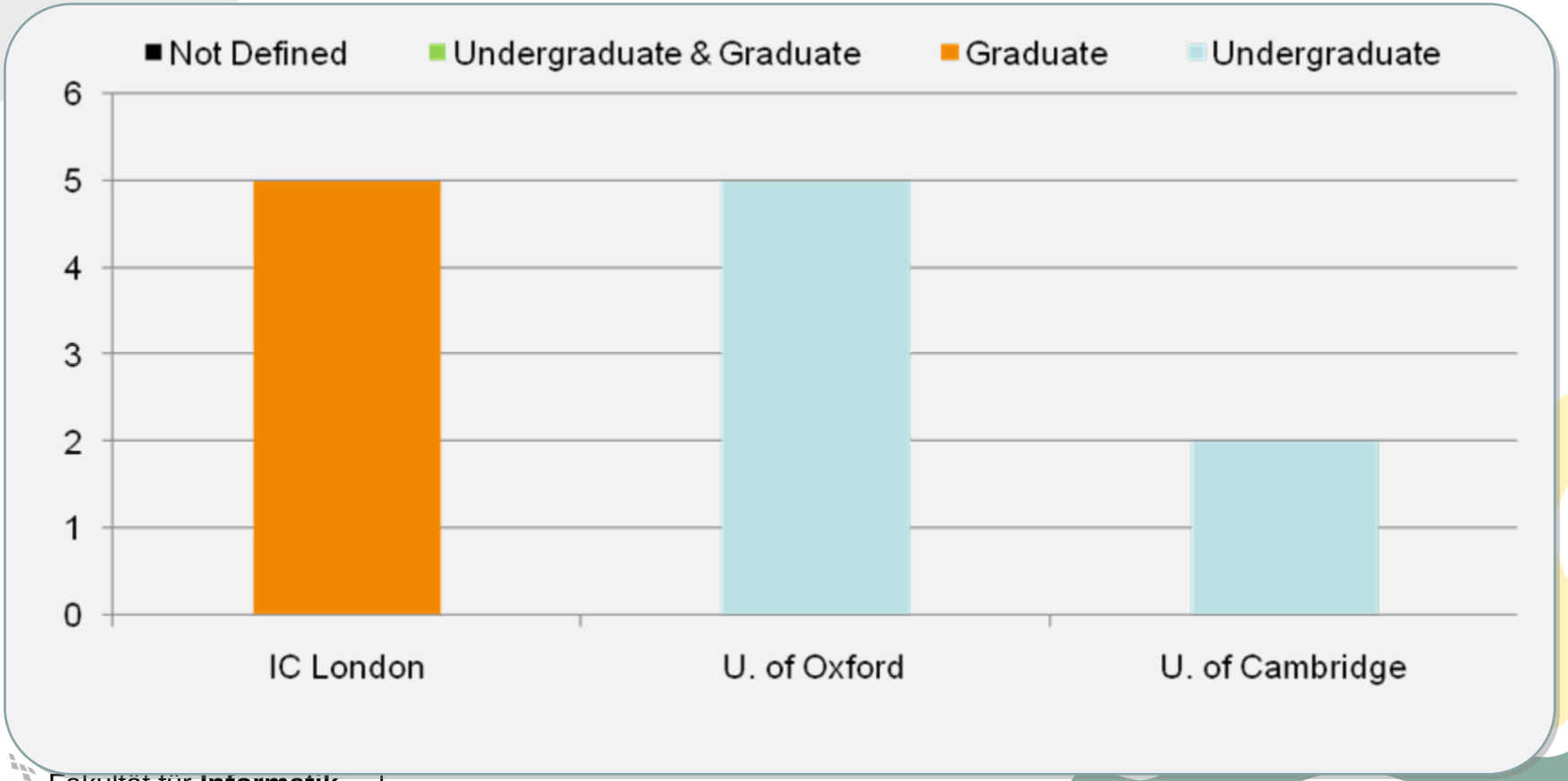
Results – U.K. Universities

- **12** lectures
- Main category „Theory of Parallel Computing“



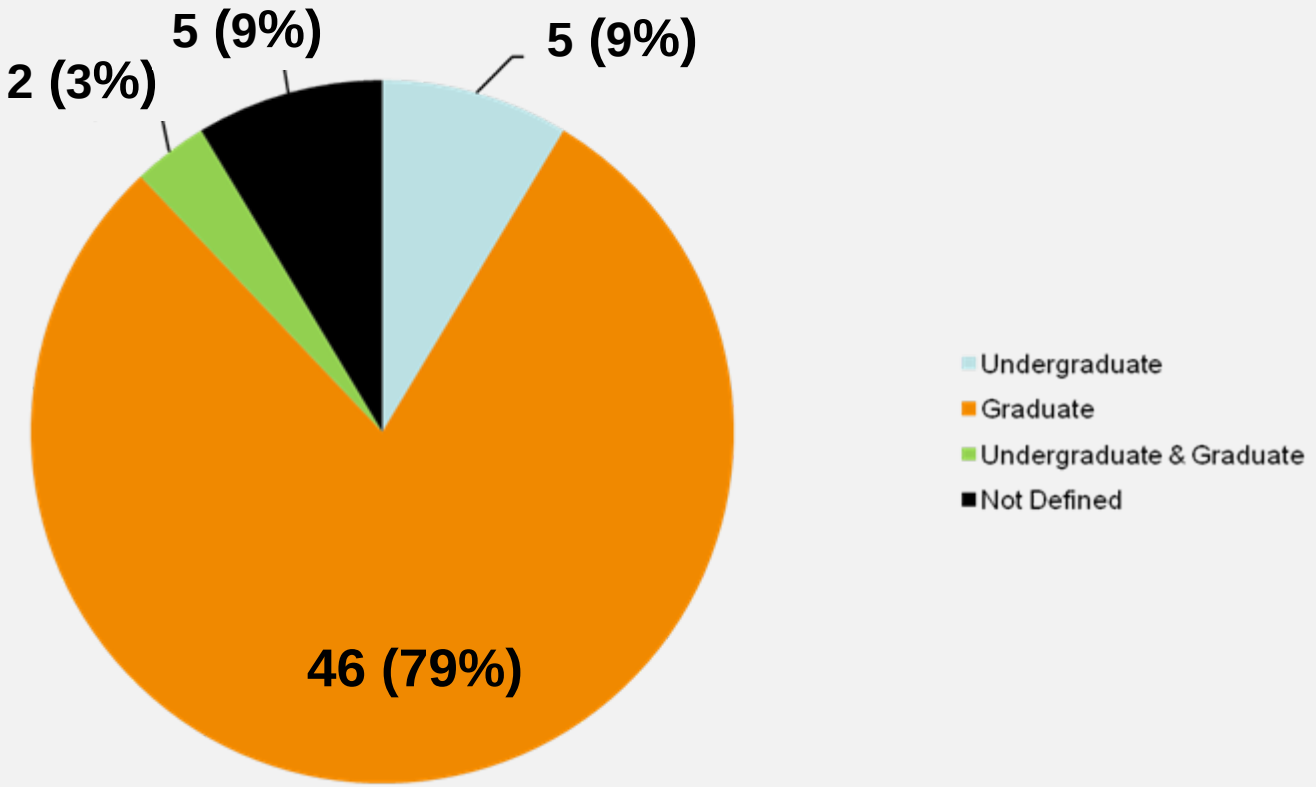
Results – U.K. Universities

- Max: 5, Avg: 4



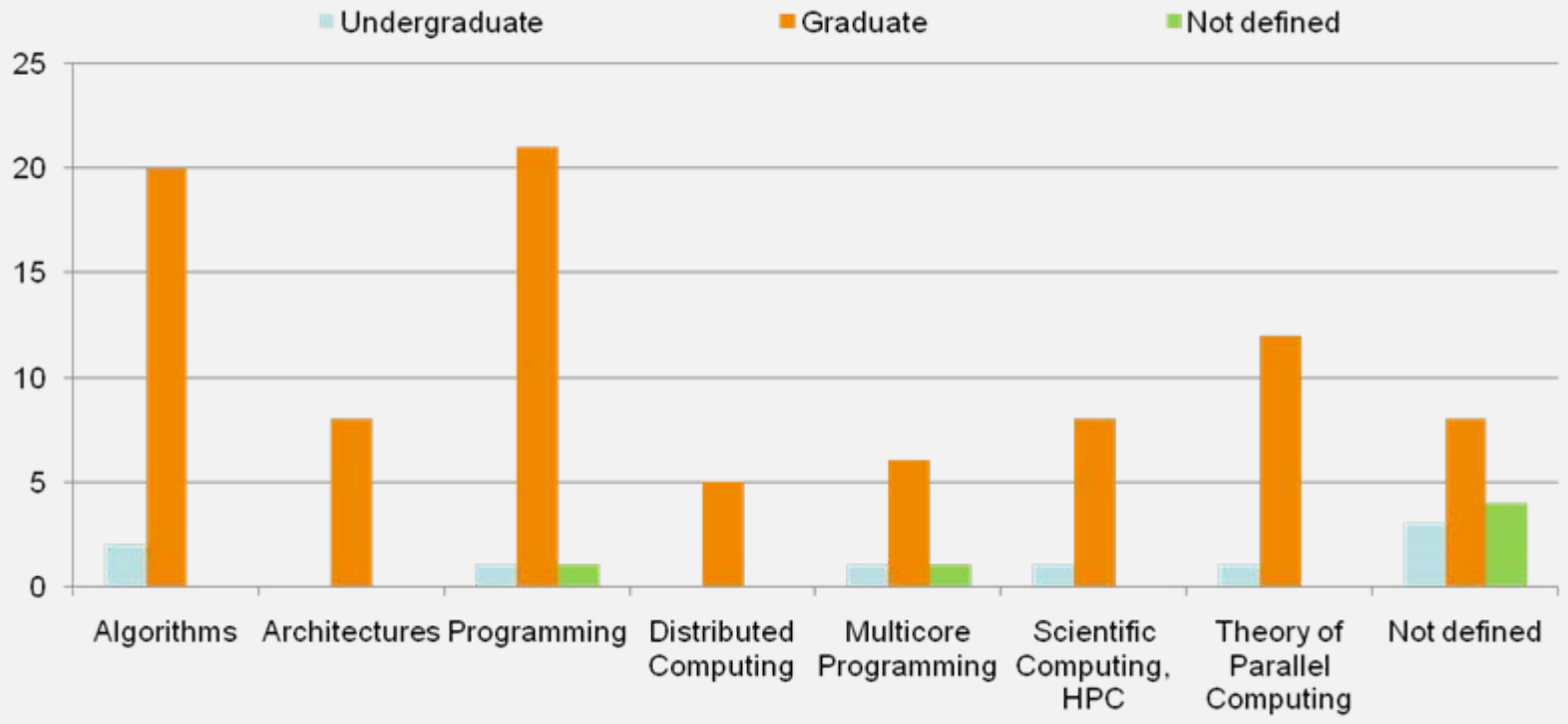
Results – German Universities

- **58** lectures



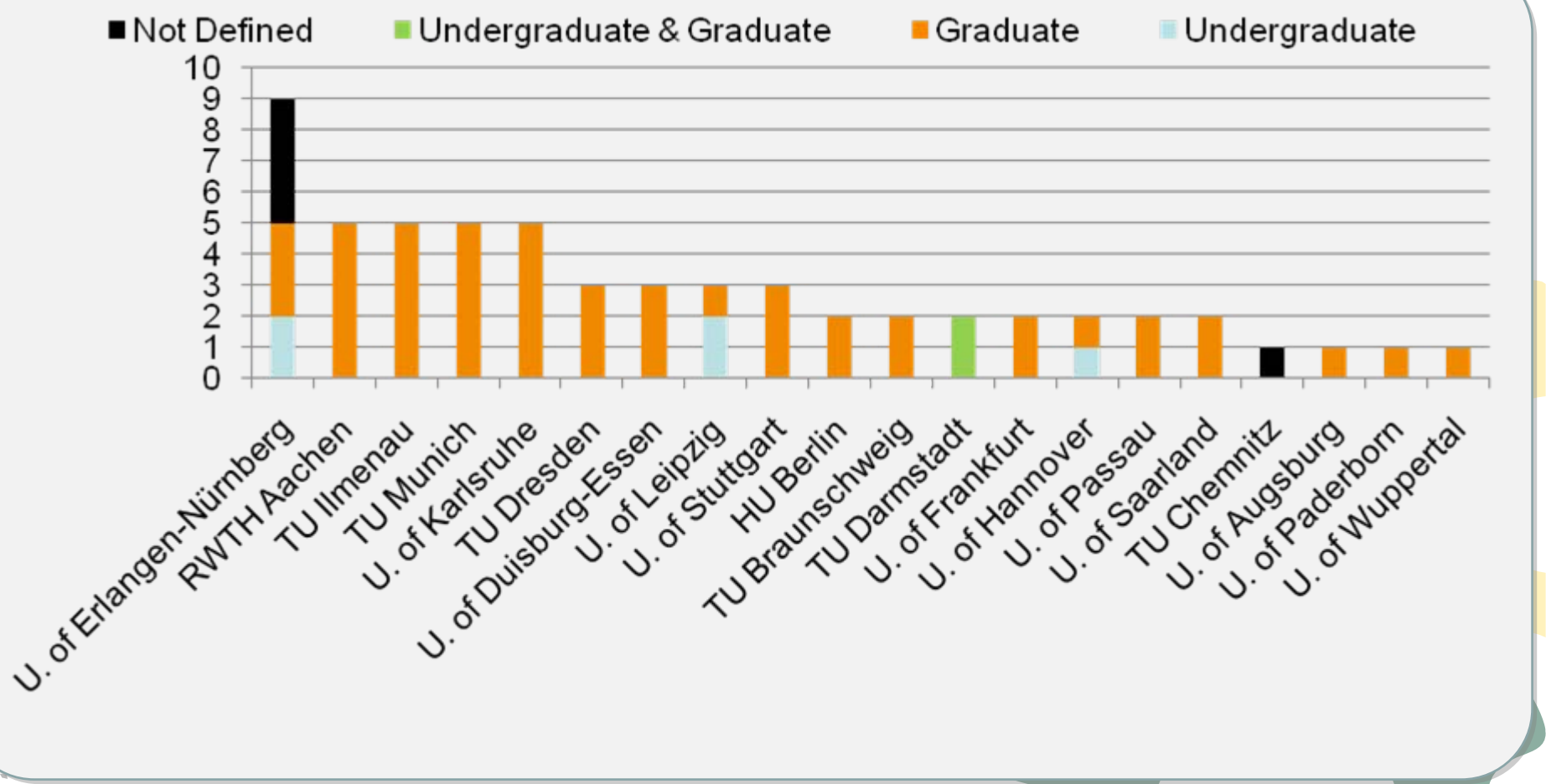
Results – German Universities

- **58** lectures
- Main categories „Algorithms“ and „Programming“



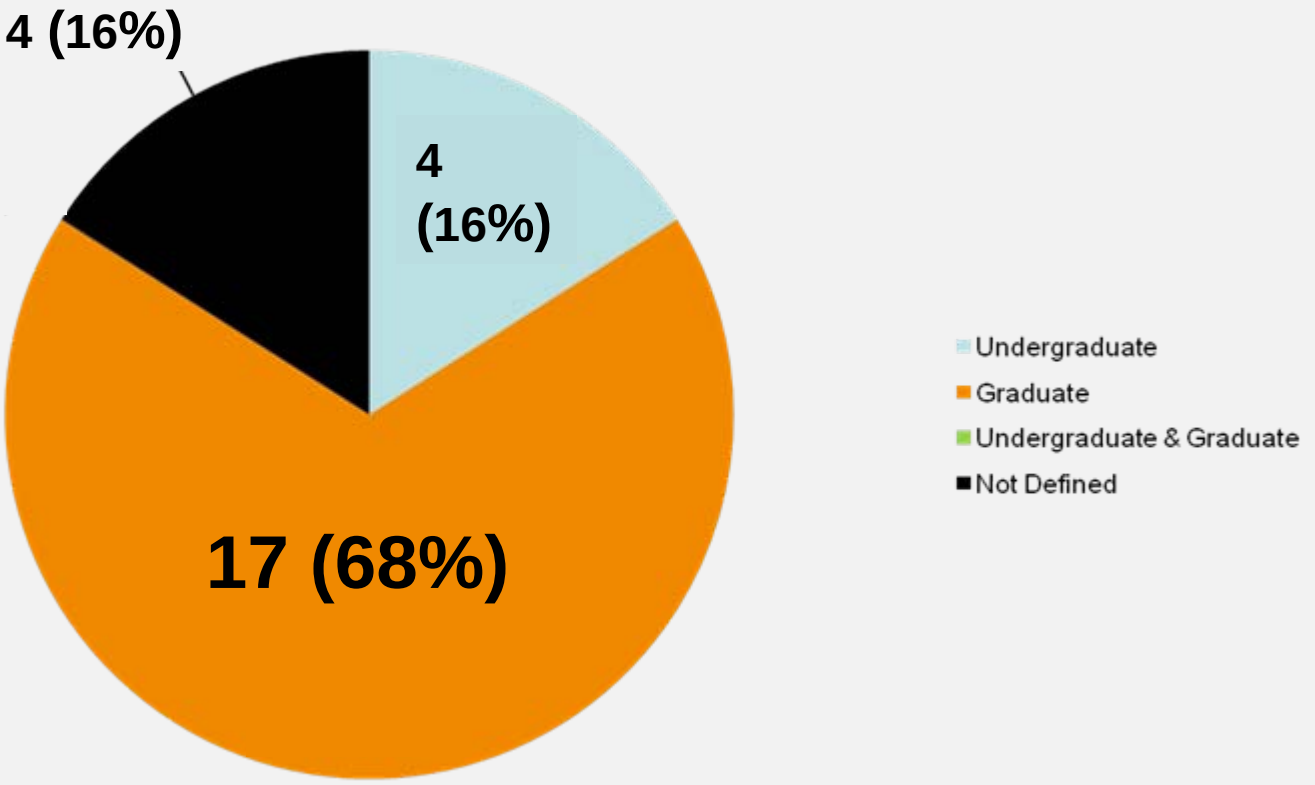
Results – German Universities

- Max: 9, Avg: 2.9



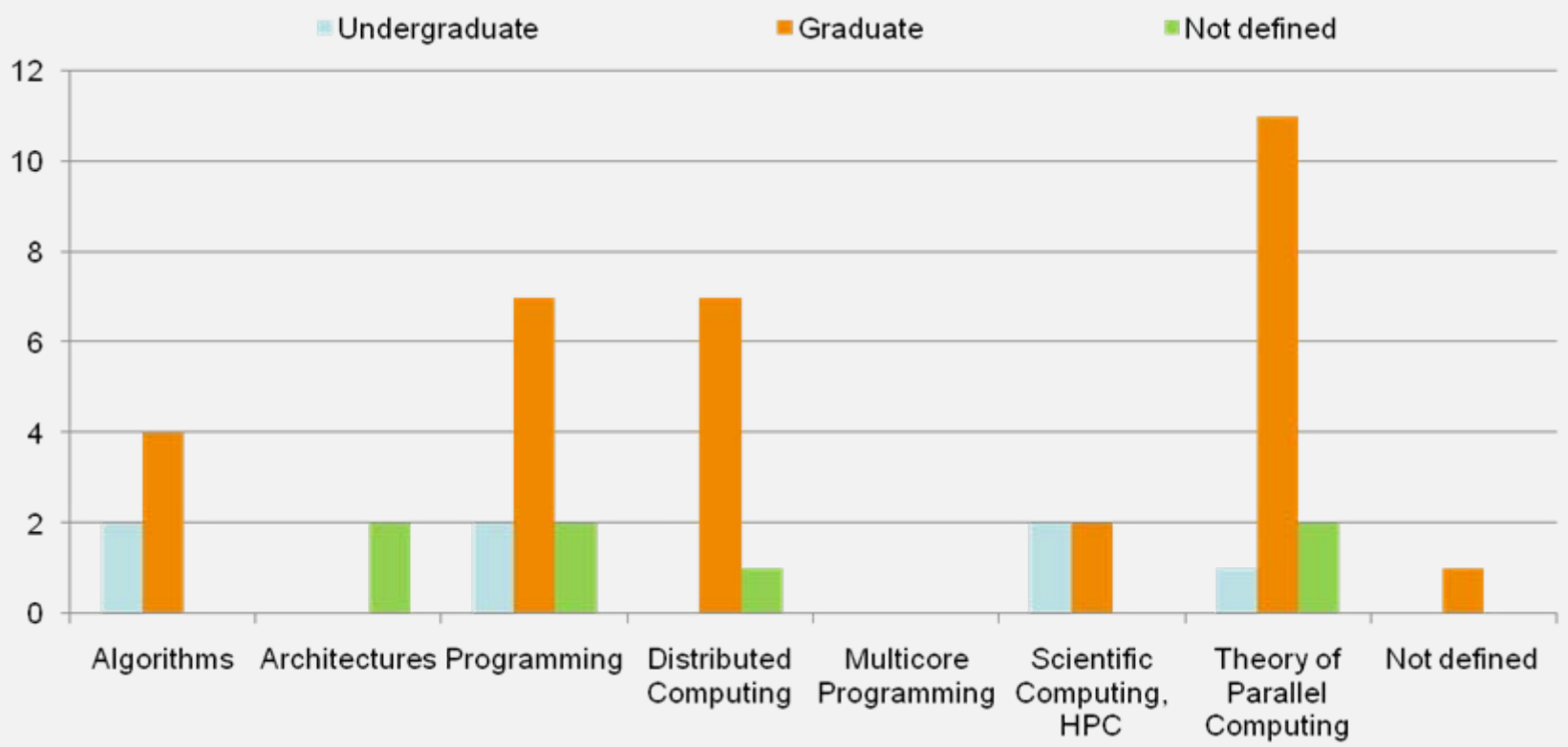
Results – Other Universities

- **25** lectures



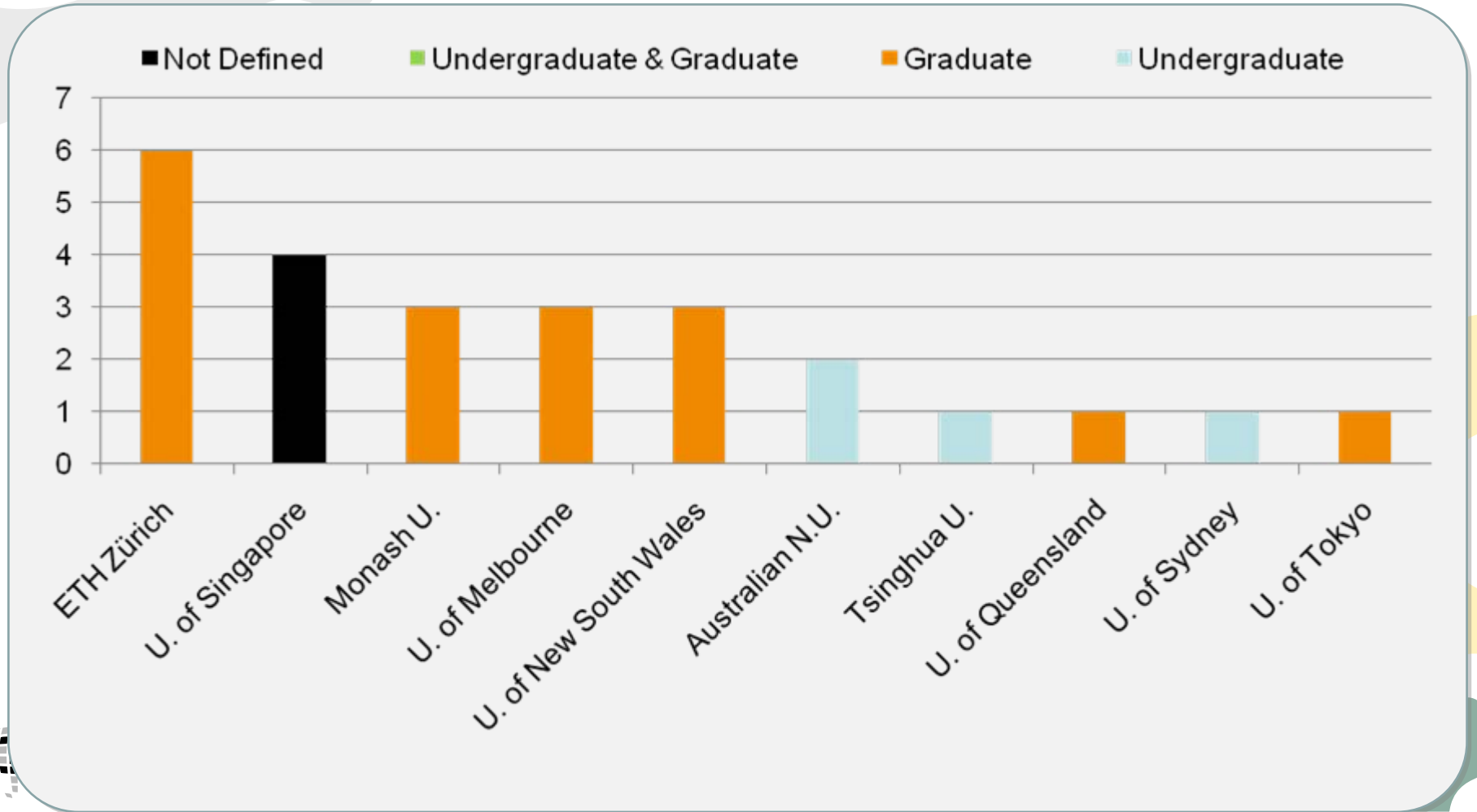
Results – Other Universities

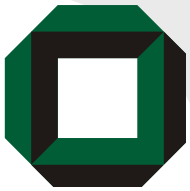
- **25** lectures
- Main categories „Programming“, „Distributed Computing“ and „Theory of Parallel Computing“



Results – Other Universities

- Max: 6, Avg: 2.5



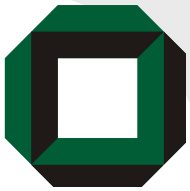


	Algorithms			Architecture/Hardware			Programming			Distributed Computing			Multicore			Scientific Computing			Theory of Parallel Computing			No Classification			∑ Courses per University
	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	
CalTech	2						1									1			2						3
Carnegie Mellon U.		2		1	1		1	1			1						1								4
Cornell U.	1	2			1		1	2		1	2					1	2								3
GaTech		4			1			2			2			2			4								8
Harvard U.																			1			1			2
MIT		1			2		1			1						1				4			1		7
Stanford U.		1			1			1			1									2					3
U. of Cal., Berkeley		2			2			1						1						4					5
UCLA					2			1		1						1			1	2					5
U. of Illinois		2			1		1	2			1						1			1					5
U. of Michigan					2			1			1														2
U. of Tennessee		1						1									1								1
U. of Toronto					1			2								1									3
∑ Undergraduate			3			1			6			3			0			5			4			1	
∑ Graduate			15			14			15			8			3			9			13			1	
∑ Not Defined			0			0			0			0			0			0			0			0	
∑ Courses			18			15			21			11			3			14			17			2	

Overview: American Universities

	Algorithms			Architecture/Hardware			Programming			Distributed Computing			Multicore			Scientific Computing, HPC			Theory of Parallel Computing			No Classification			∑ Courses per University
	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	
IC London		2						1												4					5
U. of Cambridge																			2						2
U. of Oxford							1			1									4						5
∑ Undergraduate			0			0			1			1			0			0			6			0	
∑ Graduate			2			0			1			0			0			0			4			0	
∑ Not Defined			0			0			0			0			0			0			0			0	
∑ Courses			2			0			2			1			0			0			10			0	

Overview U.K. Universities



	Algorithms			Architecture/Hardware			Programming			Distributed Computing			Multicore			Scientific Computing,			Theory of Parallel Computing			No Classification			∑ Courses per Universi
	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	
HU Berlin		2									1			1											2
RWTH Aachen		2						2									2						1		5
TU Braunschweig								1									1						1		2
TU Chemnitz									1						1										1
TU Darmstadt	1	1					1	1					1	1											2
TU Dresden		2			2			3									2								3
TU Ilmenau		2																		1			3		5
TU Munich		2			1			3			1						1			2					5
U. of Augsburg					1			1						1											1
U. of Duisburg-Essen		1																		2			1		3
U. of Erlangen-Nürnberg											1					1			1	1		1	1	4	9
U. of Frankfurt		2						2			1									1					2
U. of Hannover	1				1															1					2
U. of Karlsruhe		1			2			2			1			1						1					5
U. of Leipzig																						2	1		3
U. of Paderborn								1																	1
U. of Passau								1						1						2					2
U. of Saarland		1			1			1						1			1			1					2
U. of Stuttgart		3						2									1								3
U. of Wuppertal		1						1																	1
∑ Undergraduate			2			0			1			0			1			0			1			3	
∑ Graduate			20			8			21			5			6			8			12			8	
∑ Not Defined			0			0			1			0			1			0			0			4	
∑ Courses			22			8			23			5			8			8			13			15	

Overview German Universities

	Algorithms			Architecture/Hardware			Programming			Distributed Computing			Multicore			Scientific Computing, HPC			Theory of Parallel Computing			No Classification			∑ Courses per University
	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	U	G	N	
Australian N.U.	1						1									1			1						2
ETH Zürich		1						3			3						2			4					6
Monash U.								2			2									2					3
Tsinghua U.																							1		1
U. of Melbourne		2						1			2									2					3
U. of New South Wales		1						1												2					3
U. of Queensland																				1					1
U. of Singapore						2			1			1									2				4
U. of Sydney	1						1									1									1
U. of Tokyo		1						1									1								1
∑ Undergraduate			2			0			2			0			0			2			1			0	
∑ Graduate			5			0			8			7			0			3			11			1	
∑ Not Defined			0			2			1			1			0			0			2			0	
∑ Courses			7			2			11			8			0			5			14			1	

Overview Other Universities

Outlook

- The final document will be available for download soon: http://www.multicore-systems.org/separs
- Plan: provide regular updates in the future
- Feedback, requests for additions:
  - Contact: multicore-systems@ipd.uni-karlsruhe.de