

## Introduction



- Beijing Normal University Zhuhai (BNUZ) is located at the south of China
- The Department of Software Engineering currently has an enrollment of 508 students and 21 faculty members
- Bachelor's Degree of Engineering in three specialization areas, including Commercial Software Development, Mobile Software Development, and Software Testing, is offered
- The NSF/IEEE-TCPP Curriculum Initiative on Parallel and Distributed Computing (PDC) is integrated into department-wide undergraduate multi-semester core courses.

## Preliminary Survey

Terms	Percentage of knowing the topic
PDC	60
Multicore	100
Shared Memory	55
Distributed Memory	33
Multithread	25
Speedup	0
OpenMP	0
MPI	0

- ✓ The left table is the PDC terms survey to freshmen
- ✓ Students were asked whether they heard about the related terms listed in the table

Terms	Percentage of Positive Answers		
	0	1	2
Hadoop	19	76	5
Multicore	0	88	12
Shared Memory	0	55	45
Distributed Memory	0	80	20
Go Programming Language	8	92	0
Speedup	95	5	0
OpenMP	0	100	0
MPI	0	100	0

- ✓ The left table is the PDC terms survey to juniors
- ✓ Students were asked to rate their knowledge on the PDC terms listed in the table
- ✓ Level 0 represents not heard. Level 1 represents simply knowing, and level 2 represents knowing well

## Early Adopting Courses

Course Name	Integrated PDC Topics
Introduction to Computer Programming	<ul style="list-style-type: none"> <li>Algorithms: Time (K), Space/Memory (K), Time vs. Space (K), Sorting (K)</li> <li>Architecture: Taxonomy (K), Multicore (K)</li> </ul>
Data Structures	<ul style="list-style-type: none"> <li>Algorithms: Asymptotics (K), Speedup (K), Divide &amp; Conquer (K), Recursion (K)</li> <li>Architecture: Shared vs. distributed memory (K)</li> <li>Programming: Language extensions</li> </ul>
Computer Algorithms	<ul style="list-style-type: none"> <li>Algorithms: Speedup (C), Time vs. Space (C), Divide &amp; Conquer (C), Recursion (C)</li> <li>Architecture: Shared vs. distributed memory (K)</li> <li>Programming: Message passing (C), Client-server (C)</li> </ul>
Operating Systems	<ul style="list-style-type: none"> <li>Architectures: Superscalar (C), Single vs. Multicycle (C), Muticore (C), Buses (C), Cache organization (C), Message passing (C)</li> <li>Programming: Deadlock (C)</li> <li>Cross cutting: Cloud/grid Computing (K), Web Search (C), Web Services (C)</li> </ul>

## Course Design Strategy

As the first effort, the inclusion of the PDC modules was gradual since PDC ideas were not systemically introduced before. We carefully designed the method of presenting PDC topics for each course with the hope that the integration will be performed with a very few reduction of coverage for existing material.

- **SE101** Introduction to Computer Programming  
There is a future trend period, which is vary each year. The design of this period for this school year was focused on PDC. The instructor changed the way of presenting the material of this period by scattering the PDC topics through several PDC topic related periods. An OpenMP project was used in this course and will be used in the course SE102.
- **SE102** Data Structures  
To make up the time for integrating PDC topics, we will reduce the time for illustrating the implementation of Hoffman algorithm and leave it as an assignment question.
- **SE303** Computer Algorithms

Most of the topics in this course were introduced in conjunction with the course projects. The instructor encouraged the students learning some PDC knowledge by themselves and selected course projects with some PDC features. In the course project presentation periods, the instructor covered the PDC topics in the format of giving the comments when the students presented the PDC related projects.

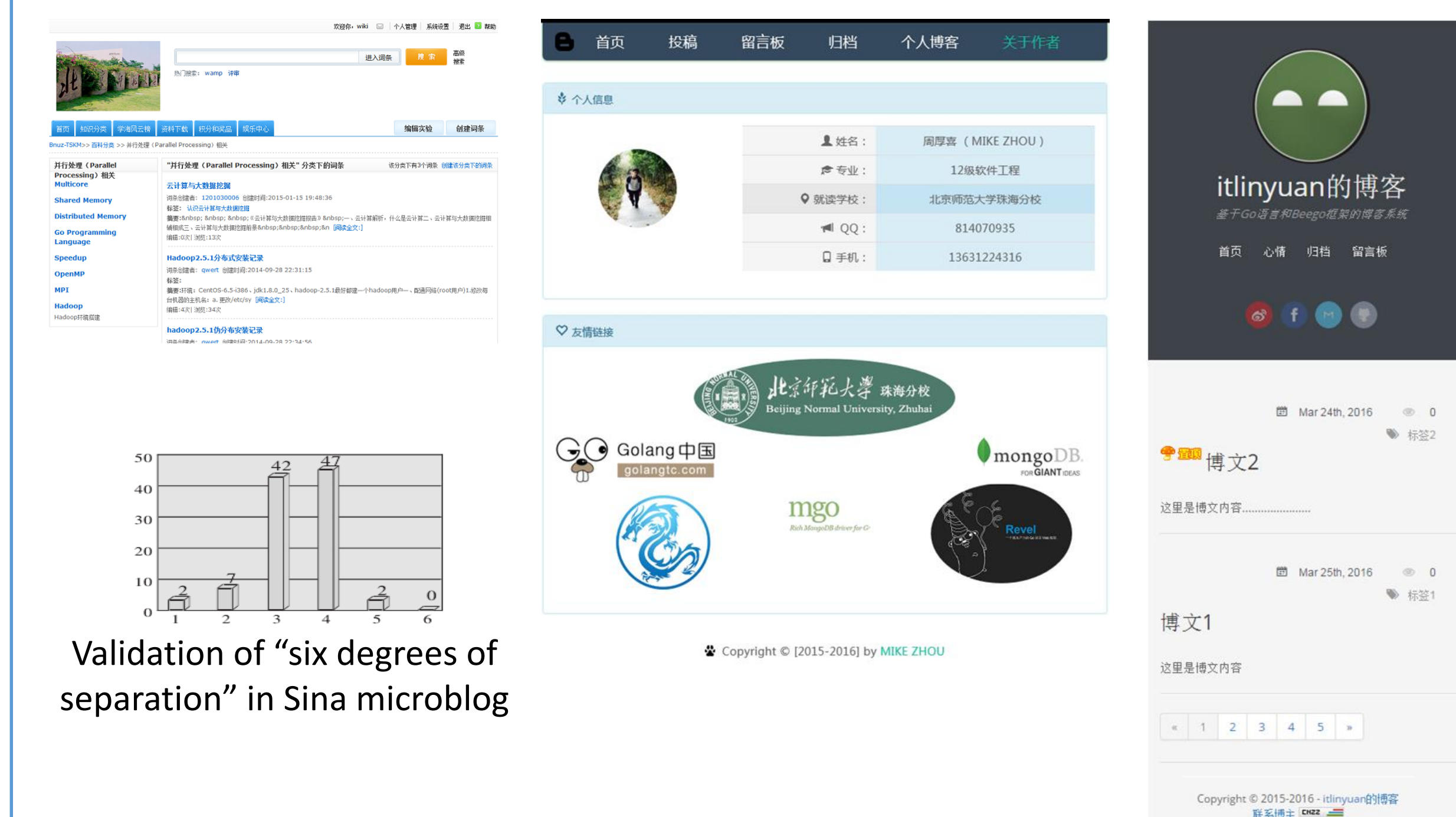
- **SE304** Operating Systems  
This course adopted the similar approach as that in SE303. However, the time spent on the PDC topics included some extracurricular activities, since the instructor encouraged students to form study groups. A course wiki platform based on HDWiki was built together by the instructor and students. Learning experiences were posted and shared in the form of wiki entries.

## Activities

Date	Activities	Operated By	Status
Jan. 2015	Preliminary training for instructors in BNUZ	Feng Gu	Finished
Feb. 2015	Identifying PDC topics covered in each course	Wei Lu, Wen Yu, Wei Sun, Hongyu Xiao, Feng Gu	Finished
Feb. 2015 – Aug. 2015	Revising course materials to cover desired PDC topics	Wei Lu, Wen Yu, Wei Sun, Hongyu Xiao	Finished
Aug. 2015	Starting to develop teaching and evaluating strategies	Wei Lu, Wen Yu, Wei Sun, Hongyu Xiao	Finished
Sept. 2015	Survey on Freshmen and Juniors	Hongyu Xiao and Wei sun, respectively	Finished
Sept. 2015 – Jan. 2016	Implementing PDC modules in SE101, SE303 and SE304	Hongyu Xiao, Wen Yu and Wei Sun, respectively	Finished
Jan. 2016	Evaluating efforts put on SE101, SE303 and SE304	Wei Lu, Wen Yu, Wei Sun, Hongyu Xiao	Finished
Mar. 2016 – June 2016	Implementing PDC modules in SE102	Wei Lu	On Going
July 2016	Evaluating efforts on SE102	Wei Lu, Wen Yu, Wei Sun, Hongyu Xiao	Planned
July 2016 – Aug. 2016	Summarizing experience; adjusting PDC topics; revising teaching and evaluating strategies; upload course materials to CDER resource site	Wei Lu, Wen Yu, Wei Sun, Hongyu Xiao	Planned

## Evaluations

- ❑ SE101 was evaluated by including the PDC topics in the final exam
  - The result shows that over 90% of the students understood the basic PDC concepts
- ❑ SE102 will be evaluated by assignments and the final exam
- ❑ SE303 and SE304 were evaluated by identifying the PDC related contents in their course projects
  - Most students mentioned PDC related techniques in their projects and about 30% of the students used PDC related techniques directly
  - Selected topics are personal blog systems (using Go, Beego and Revel), private cloud platform (using OpenStack), a social network analysis system (using Spark) and recommender systems (Using Hadoop and Mahout)



Validation of "six degrees of separation" in Sina microblog

OpenStack Network Deployment

Hostname	# of CPU	Memory (GB)	Hard disk (GB)	Tunnel (eth0)	Internet (eth1)	Storage (eth2)	Manager (eth3)
Controller Network	2	4	100	10.20.2.50	dhcp	WLAN	10.20.1.50
Compute	2	5	100	10.20.2.70	dhcp	10.20.3.70	10.20.1.70
Storage	1	2	100	10.20.2.80	dhcp	10.20.3.80	10.20.1.80

## References

- [1] Prasad et al. NSF/IEEE-TCPP Curriculum Initiative on Parallel and Distributed Computing-Core Topics for Undergraduates. <http://grid.cs.gsu.edu/~tcpp/curriculum/> (accessed March 23 2016).
- [2] Antony Mellor. Experiential learning through integrated project work: an example from soil science. Journal of Geography in Higher Education, 1991, 15(2):135-149.

## Acknowledgements

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