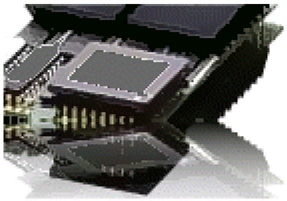
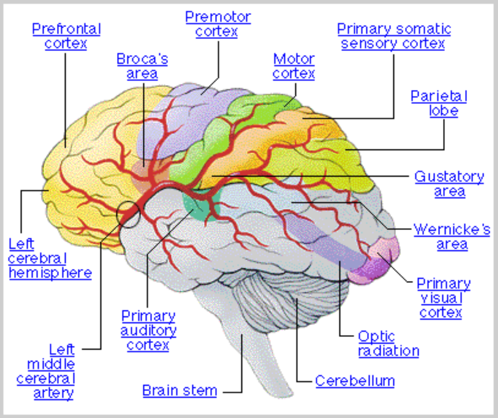


Brock University
Department of Computer Science

COSC 3P93: Parallel Computing



Fall 2024 D2 Instructor: **Vlad Wojcik** Support: **Mubashir Murshed**

Course Plan Lecture Room TH248

INSTRUCTOR:

Wlodzimierz ("Vlad") WOJCIK, vwojcik@cogeco.ca, Office: J213; Teaching Assistant: Mubashir Murshed

TIMES AND LOCATIONS:

Lectures and Seminars: Room TH248, Tuesdays and Fridays 4 PM to 5:30 PM. Mode of delivery is Lecture, face-to-face. All students are expected and required to attend lectures. To pass the course, all students must take tests and final exam and to submit seminar posters.

Office Consultation Hours: Tuesdays and Fridays 3 PM to 4 PM (Just before lectures). Room J328. Students unable to make these consultation hours are asked to contact the Instructor via e-mail, in order to make alternate arrangements.

Test Locations as per course plan (link above)..

COURSE OBJECTIVE:

To familiarize students with basic ideas pertaining to parallel computation. We will depart from the standard architecture of the von Neumann-type digital computer. A number of parallel computing architectures will be discussed, including SISD, SIMD, MIMD and data flow machines. Multiprocessor organizations: arrays, meshes of trees, hypercubes. Biological inspirations for multiprocessor configurations. Issues of dynamic and static machine reconfigurations. Concepts of diameter, bandwidth, and bisection width of the multiprocessor configuration. Parallel algorithms and their performance estimation: big O, Theta and Omega notations. Introduction to the theory of parallel languages with some exposure to Ada 2012.

TOPICS COVERED:

Origins of parallelism, classification of algorithm designs, characterization of performance. Pipelined computers: selection and comparison, case studies. Processor arrays, switching networks, case studies. Parallel languages: general principles, parallel constructs, vectorizing compilers, issues of portability. Some exposure to parallel programming language (Ada 2012) and parallel computing hardware. Parallel algorithms: general principles, recurrences, parallel approach to data structures and computational structures. Future trends: technology, design limitations, future supercomputers.

PREREQUISITE:

COSC 2P13 (minimum 60%). NOTE: In case of any discrepancies, the University Calendar prevails.

LECTURE NOTES, TRANSPARENCIES, ETC.:

- The modeling Process: **A Meta-Model**
- Measures of Parallelism: **Basic Concepts**
- Parallel Computers: **A Taxonomy**
- Parallel Computers: **Memories**
- Parallel Computers: **Interconnect Architectures**
- Parallel Computers: **Programming Methodology**
- Parallel Computers: **Benchmarking**
- Parallel Computers: **Programming Tools**
- Parallel Languages: **Compositional C++**
- Process Algebras: CSP:
  1. **The Transputer**
  2. **Occam 2**
  3. **Network Configuration**
  4. **Software Development Cycle**
  5. **Transputer Memory Management**
  6. **Transputer Network Conrol**
  7. **Occam 2 Transformation Rules**

REFERENCES AND RECOMMENDED READING:

- ***Introduction to Ada***: Set of PPT slides, courtesy of late **Robert Dewar**
- J. Barnes: ***Programming in Ada 2012***, Addison-Wesley 2014, ISBN 9781107424814.
- T.G. Mattson, B.A. Sanders, B.L. Massingill: ***Patterns for Parallel Programming***, Addison-Wesley 2005, ISBN 0-321-22811-1.
- S.H. Roosta: ***Parallel Processing and Parallel Algorithms***, Springer Verlag 2000, ISBN 0-387-98716-9
- I. Foster: ***Designing and Building Parallel Programs,*** Addison-Wesley Publishing, 1995, ISBN 0-201-57594-9
- M.A. Smith: ***Object Oriented Programming in Ada 2005***
- R. Riehle: ***Ada Distilled: An Introduction to Ada Programming for Experienced Computer Programmers***, AdaWorks Software Engineering 2002
- Quentin Ochem, ***Ada for Java or C++ Developer***, AdaCore 2013.
- J. Barnes: ***Programming in Ada 2012***, ISBN 9781107424814.
- Wikibook: ***Ada Programming***.
- C. Xavier, S.S. Iyengar: ***Intro. to Parallel Algorithms***, Wiley 1998, ISBN 0-471-25182-8
- H.F. Jordan, G. Alaghband: ***Fundamentals of Parallel Processing***, Prentice Hall 2003, ISBN 0-13-901158-7.
- A. Grama, A. Gupta, G. Karypis, V. Kumar: ***Introduction to Parallel Computing***, Addison-Wesley 2ed., 2003, ISBN 0-201-64865-2.
- B.M. Brosgol: ***Ada-Java comparison***, 2000
- Peter S. Pacheco: ***An Introduction to Parallel Programming*** (1st Edition). Publisher: Morgan Kaufmann; 1 edition (2011). ISBN-10: 0123742609 & ISBN-13: 978-0123742605.

- Victor Eijkhout, Robert van de Geijn, and Edmond Chow: ***Introduction to High Performance Scientific Computing*** (2nd Edition). Publisher: Lulu; 2 edition (2015). ISBN: 9781257992546.
- Michael McCool, James Reinders, and Arch Robison: ***Structured Parallel Programming: Patterns for Efficient Computation***. Publisher (imprint): Morgan Kaufmann; First Edition (2012). eBook ISBN:9780123914439. Paperback ISBN: 9780124159938.
- Blaise Barney: ***Introduction to Parallel Computing***, Lawrence Livermore National Laboratory. On-line.

USEFUL NOTES AND PROGRAMMING EXAMPLES:

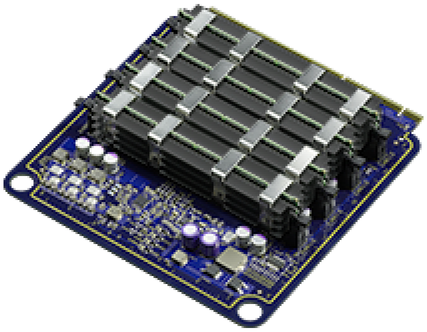
- Refresher on **Semaphores**
- **Tasking in Ada**
- Use of **Attributes in Ada**
- **Garbage collection in Ada**: programming example

SEMINARS:

- Vlad Wojcik on **Scene Segmentation**

Seminar topic suggestions:

- Cluster Connectivity: Quadrics, Myrinet, Infiniband, Dolphinics, etc ... (several seminars possible here)
- Hottest Processors of the Day ...
- Parallel Programming Approaches with one of: UNIX, MPI, Open MP, PCN, PVM, Linda (including C-Linda and/or FORTRAN-Linda), CHARM ...
- Parallel Programming Languages (select one of): Occam, OpenCL, Modula-2, Modula 3, Java, Fortran M, High Performance Fortran, Compositional C++, Data-flow programming in VAL, Functional programming in SISAL, Data parallel programming with C*, Data parallel programming with Fortran 90 ...
- AI and Parallel Processing
- Selected Parallel Search Algorithms
- Selected Parallel Graph Algorithms
- Parallel Programming Approaches with UNIX
- Measuring Computational Performance
- Parallel Computing with MPI
- OSCAR (Open Source Cluster Application Resources)
- Cluster Management (IPMI, etc.)
- Cluster Booting Issues (PXE, etc.)
- Other (please suggest...)



MARKING SCHEME:

- Two Tests @ 20% = 40%
- One Seminar (Two cooperating students delivering): 20%
- Final Exam 40% (you must score at least 40% here to pass the course!)

CAUTION: The Department reserves the right to scan submissions using electronic means, in order to ensure the originality of students' work.

NOTES:

In case a given mark is perceived unjust or unclear by a student, s/he is encouraged to see the instructor to discuss the issue. Depending on the case s/he is able to make, a mark can be modified. The deadline to contact the instructor on these matters is one week after the mark has been issued. Marks not disputed within this period will be considered final.

PENALTIES:

Possible lateness in assignment submission is counted in days, each period of a day ending at 4 PM. The penalty for late submission is 25% up to three days (or a part of a day). After that period the penalty is 100%.

While honest cooperation between students is considered appropriate, the Faculty of Mathematics and Sciences considers **plagiarism** and other forms of academic misconduct as grave offenses. For clarification on these issues you are directed to Section VII, "Academic Misconduct" in the "Academic Regulations and University Policies" entry in the University Calendar, to view a fuller description of prohibited actions, and the procedures and penalties.

Information on what constitutes academic integrity is available on **Brock University Academic Integrity** Website.

Instructor: Vlad Wojcik
Revised: 20 September, 2024 9:16 AM