Data Structures and Algorithms
Lecture 0

Steven Guan

Menu

- About the lecturer
- What is CPT 102 about?
- Course organisation:
  How does the course work?
- Overview of Course
  Data Collections, Data Structures, Algorithms

People

- **Participants:**
- **YOU**
- **Lecturers:** Steven Guan ; Kok Hoe WONG
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- Room SD431 Email: kh.wong@xjtlu.edu.cn
- **TA in charge: Qiao Yuan; TAs:** TBA

About the lecturer - Steven Guan

- BSc Math, TsingHua
- MSc, PhD (Computer Science, University of North Carolina at Chapel Hill
- ***Xi’an Jiaotong-Liverpool University (Jan. 08-now)***: Professor, Department of Computer Science & Software Engineering.
- ***Brunel University***: Tenured Professor and Chair in Intelligent Systems, School of Engineering & Design.
- ***National University of Singapore:*** Associate Professor, Department of Electrical & Computer Engineering; Supervisor, IT & e-Education Team; Supervisor, Printed Circuit Board Facilities.
- ***La Trobe University, Australia:*** Lecturer, School of Computer Science & Computer Engineering.
- **Research**: Machine Learning/AI, Big Data Analytics, Personalisation, Security, Electronic/Mobile Commerce, Multimedia, and Networks
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About the lecturer – Kok Hoe Wong

- Ph.D. in 3-D imaging
- Worked for several renowned Multi-National Corporations (MNCs) before embarking into academia the last 10 years.
- His forte is in software engineering, project management, teaching and academic management.
- He has extensive experiences in architecting and managing enterprise-level IT projects, working with stakeholders from different parts of the world. Upon his arrival in China in 2007, he has progressed from being a Senior Lecturer to Vice President at a local institution, overseeing a successful Sino-Foreign partnership with Staffordshire University, UK.
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What is CPT102 About?

- **More about basics of organising, accessing, managing data and the algorithms to manipulate them**

- Touches upon foundations of designing and building programs (why?)
- Programs with **collections** of data
  - Different kinds of data
  - Different kinds of collections
  - Data structures for implementing collections
  - Algorithms for dealing with collections
- Programs with algorithms for access, control, i/o, etc.
- Analysing programs, algorithms, and data structures (efficiency, correctness).

Programming Background

- You should have some programming background

Learning in CPT102

Multiple resources:

• Lectures, , Q&A, Revision	Go to them
• Tutorials, Help Sessions	Prepare & attend
• Labs & Assessments	Prepare and attend them
• Text Book	Read it
• Personal exploration	Do it
• Study groups	Form one or join one
• TA consultation/TA Help Meetings	By appointment with TA

- Developing **self-study & problem solving** skills is important for **lifelong learning**

Lectures / Tutorials /Help Sessions

- There are Tutorials in weeks 3-6 & 10 (delivered by Dr Wong, timetable to be confirmed by him: 10am in SA169 or online on Wednesdays
- The remaining tutorial timeslots will not be used.
- Lectures & tutorials are resources for your learning
  - SLIDES ≠ TEXTBOOK ≠ module contents
  - **Attendance is crucial for your survival**
- Goals:
  - Provide a framework / background for your learning
  - Provide explanations / demonstrations / interactions to help your understanding

Labs

- We have 3 lab sessions which are scheduled during the lab timetable slots for CPT102 students in groups at **prescribed lab venues** in Weeks 5, 6, 7
- These labs are hosted by our TAs and supervised by Dr Wong. There will be no labs during the other lab timeslots

- 2 Online Quiz Assessments dates to be confirmed by Dr Wong.

Personal TA Help Meetings

- Each week we will allow booking of up to 5 TA help meetings with our TAs by email appointment.
- Each help meeting can be booked via LM for individual student or a group of students who need help in his/her/their study
- Each help meeting will last no more than 0.5 hour (max)
- Meeting place is upon your arrangement with the TA assigned for the meeting
- **Booking is to be made via LM.**

- First Come First Served in general, while priority will be offered to group meeting requests and we will reserve at least one session/week for repeating students

Tutorials, Q&A, Practical Assessments, Revision

- Integrated closely with our lectures & learning
- Review & Enhance learning
- Can also be used to develop your data structure related problem solving skills
- Goals:
  - Solve problems
  - Practice knowledge learnt from the lecture/tutorial materials
  - Prepare & attend assessments

Text Book

- **Data Structures and Algorithm Analysis in Java, 3rd edition (英文影印版) have been shelved in Library 9th Floor. Call Number is EN/QA76.73.J38./W45/18.**

- Complements the lectures and assignments, (but we do not follow text closely, why?).

Web resources

- Read the Course Website under LM
    - regularly!
- Copies of lecture slides and assignments

Assessment

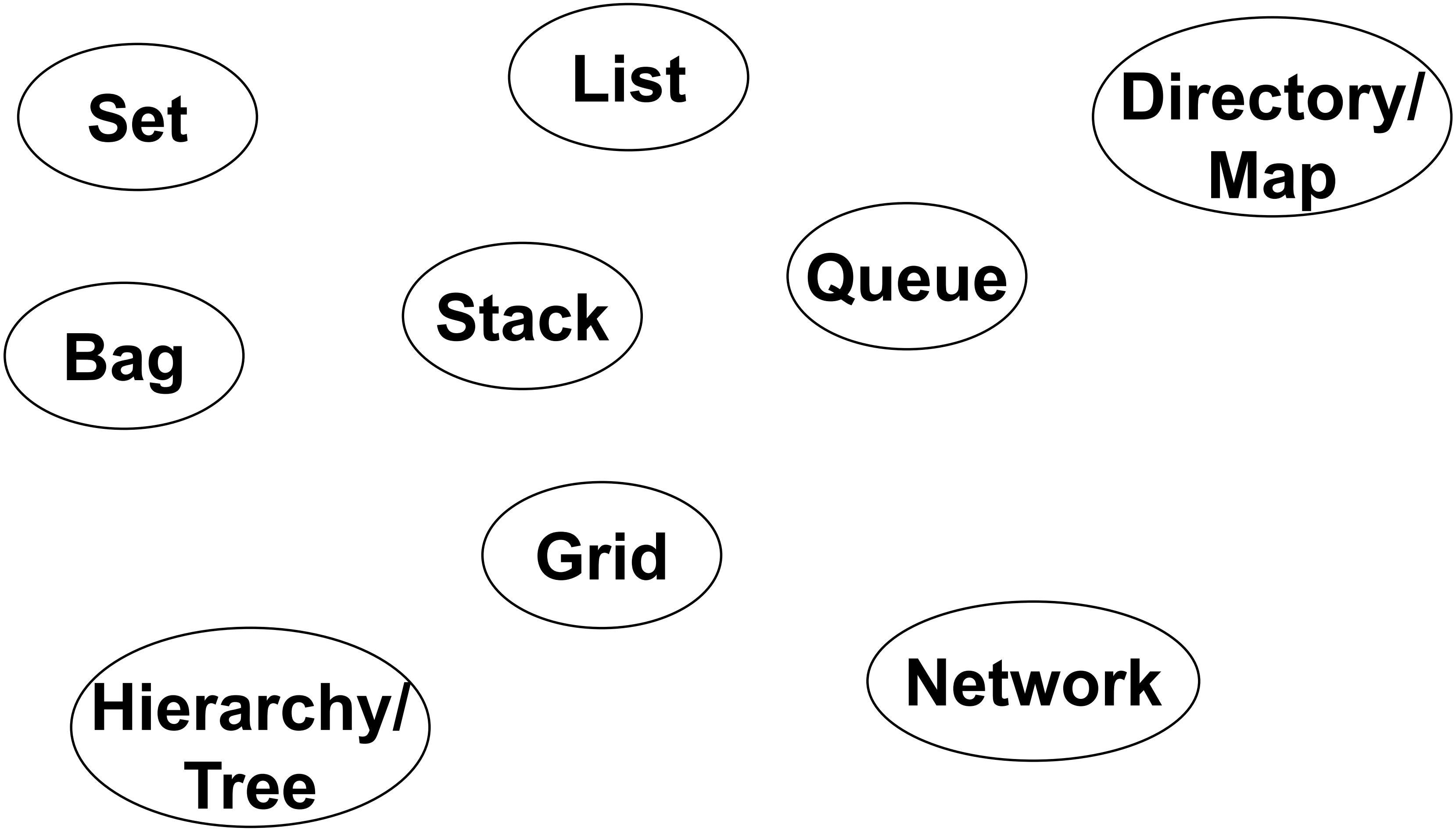
• Assessments: 2	20%
• Exam: 2 hours	80%

Data Structures

Data Collections

- What kinds of collections of data do we deal with in real life?
  - Book: a sequence of pages, or
    a sequence of chapters of paragraphs of words of letters
  - Phone book: set of (name – phone number) pairs
  - School transcripts
  - Index cards
  - Sales data
  - Customer profile
  - Weather maps
  - Criminal records

Standard types of collections



Set

List

Directory/ Map

Bag

Stack

Queue

Grid

Hierarchy/ Tree

Network

Tower of Hanoi

- The goal is to move all the discs from the left peg to the right one.
- http://www.mathsisfun.com/games/towerofhanoi.html
- Note the use of ‘**stack**’ in this game..

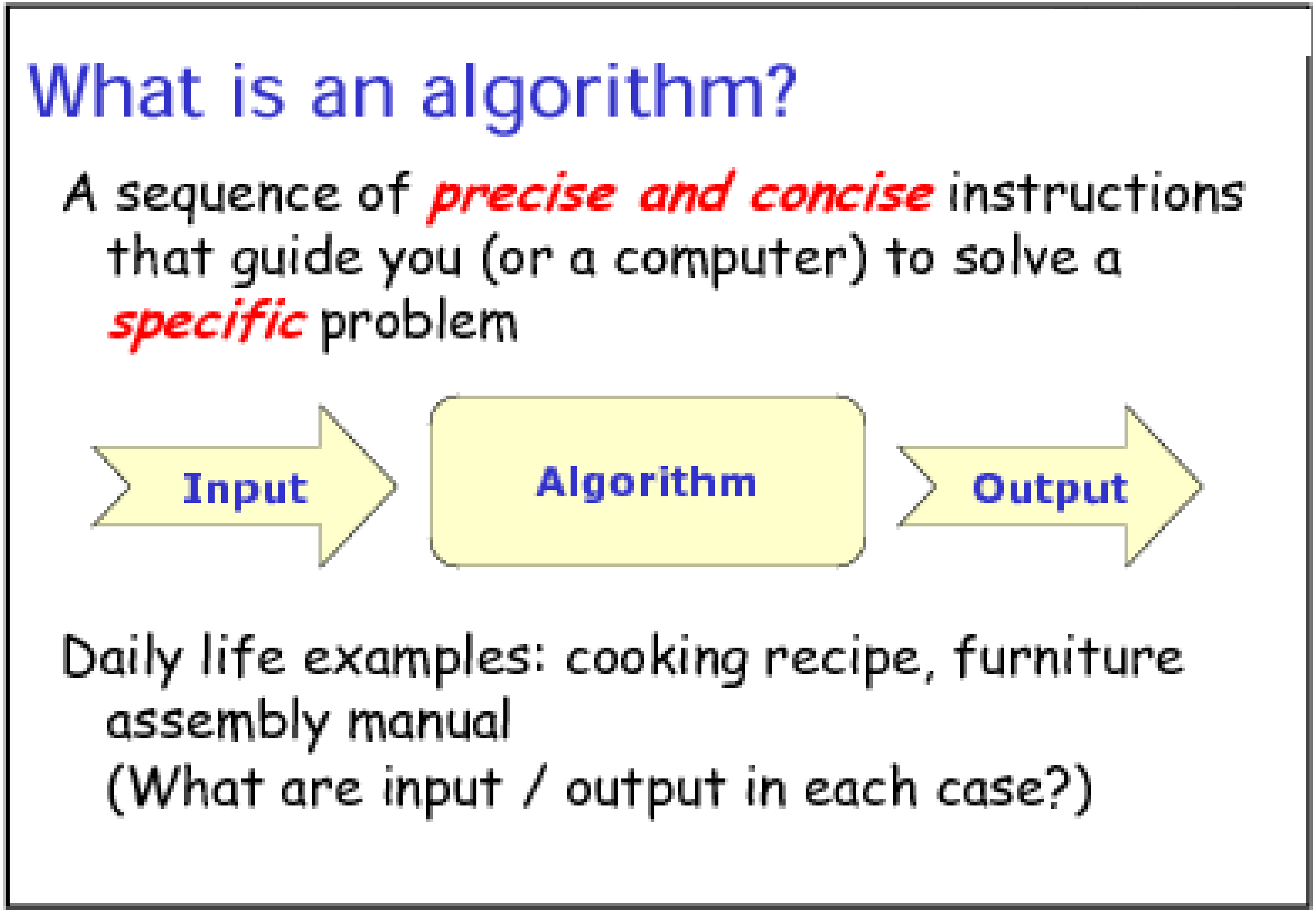
Collections: What’s the difference

- Different types of values
- Different structures
  - No structure – just a collection of values
  - Linear structure of values – the order matters
  - Set of key-value pairs
  - Hierarchical structures
  - Grid/table
  - ….
- Different access disciplines
  - get, put, delete anywhere
  - get, put, delete only at the ends, or only at the top, or at both ends…
  - get, put, delete by position, or by value, or by key, or …
  - ….
- Why these differences?

Q&A

- Name three typical type of data values in common data collections.
- Name three typical structures seen in common data collections.
- Name three typical operations seen in common data collections.
- Why do we learn data structure?
- Can we program data structure in Java?
- Can we program data structure in C?

Algorithms



What is an algorithm?

A sequence of *precise and concise* instructions that guide you (or a computer) to solve a *specific* problem

Input **Algorithm** **Output**

Daily life examples: cooking recipe, furniture assembly manual
(What are input / output in each case?)

Pasta with tomato sauce

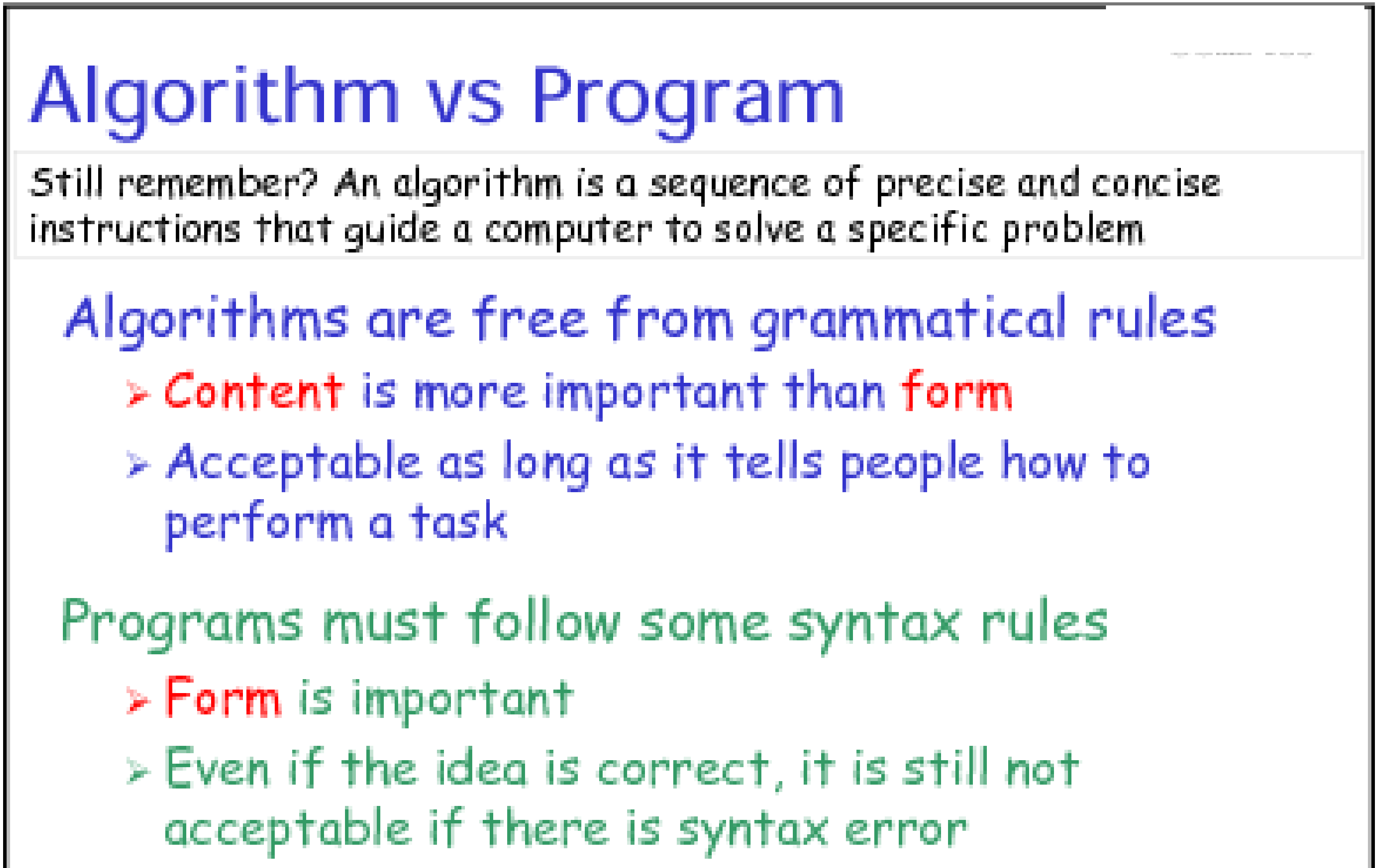
Recipe for Meaty Tomato Sauce

Ingredients

- 1 pound sweet Italian sausage, casings removed
- 1 pound hot Italian sausage, casings removed
- 1/2 pound ground beef
- 1 large onion, finely diced
- 1/4 cup minced garlic, or to taste
- 4 (14.5 ounce) cans diced tomatoes
- 2 (6 ounce) cans tomato paste
- 2 (14 ounce) cans tomato sauce
- 1/2 cup chicken broth
- 1/2 cup Cabernet Sauvignon (or other dry red wine)
- 1 table spoon dried Italian herb seasoning
- 1/2 cup chopped fresh basil
- 1 tea spoon salt
- 1/2 tea spoon ground black pepper, or to taste

Directions

- Heat a large skillet over medium-high heat and stir in Italian sausage, ground beef, onion, and garlic.
- Cook and stir until the meat is crumbly, evenly browned, and no longer pink, for 15 minutes.
- Use a potato masher to mash and blend the meat mixture every few minutes.
- Drain and discard any excess grease.
- Stir in diced tomatoes, tomato paste, tomato sauce, chicken broth, red wine, Italian seasoning, basil, salt, and black pepper.
- Transfer the sauce to a slow cooker and cook on low for 7 hours.



Algorithm vs Program

Still remember? An algorithm is a sequence of precise and concise instructions that guide a computer to solve a specific problem

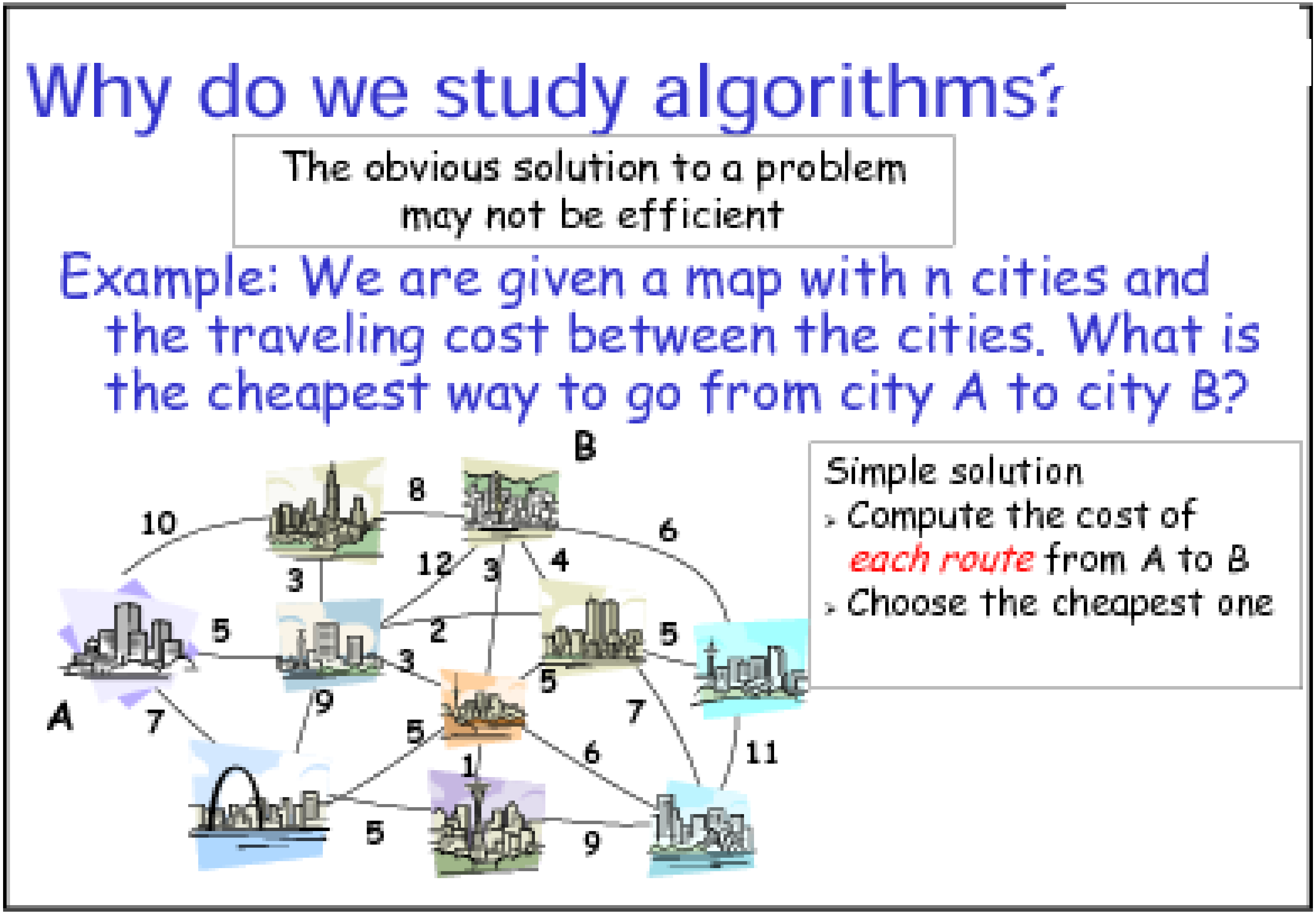
Algorithms are free from grammatical rules

- Content is more important than form
- Acceptable as long as it tells people how to perform a task

Programs must follow some syntax rules

- Form is important
- Even if the idea is correct, it is still not acceptable if there is syntax error

Algorithms will **terminate** while programs may not …



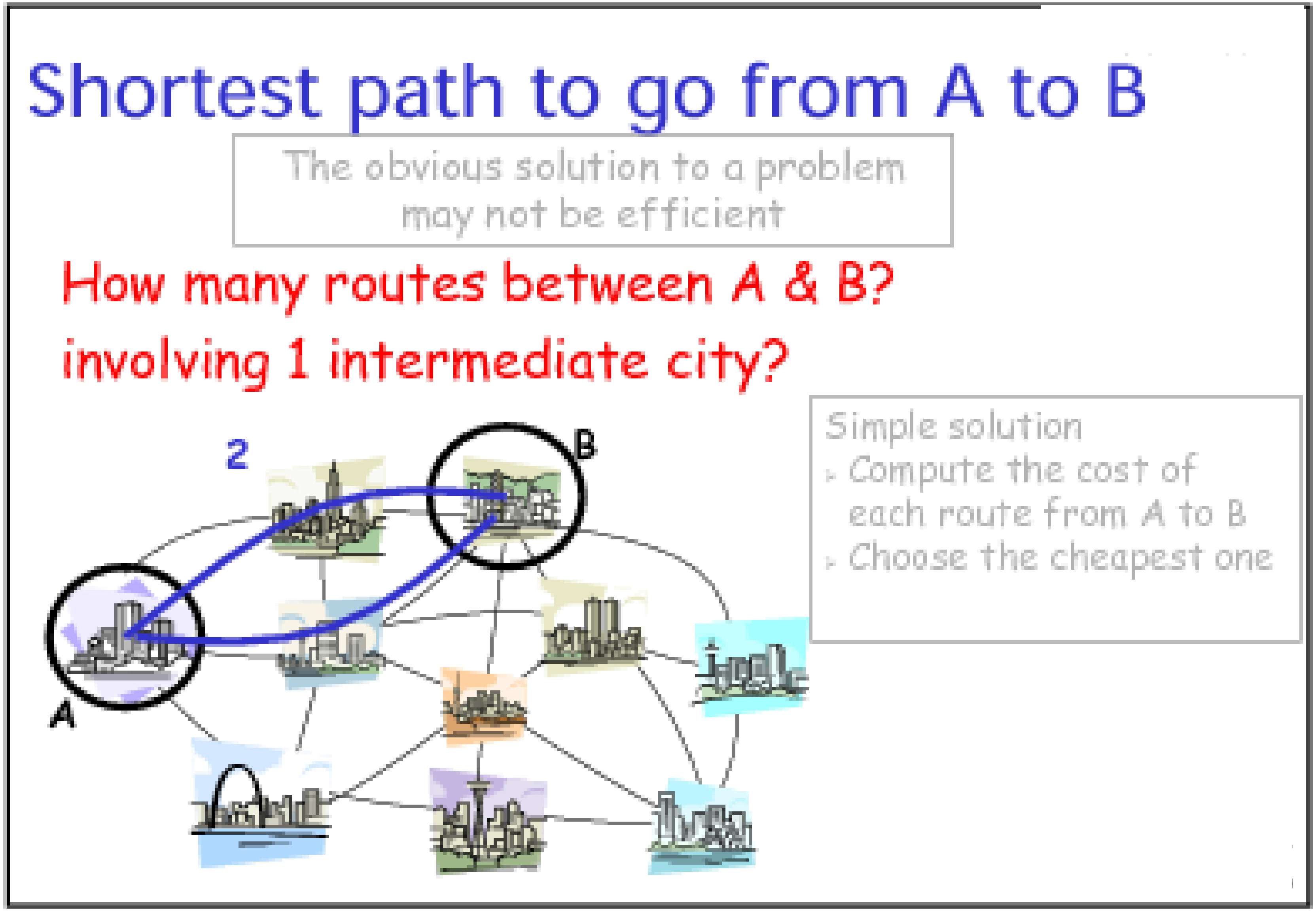
Why do we study algorithms?

The obvious solution to a problem may not be efficient

Example: We are given a map with n cities and the traveling cost between the cities. What is the cheapest way to go from city A to city B?

Simple solution

- Compute the cost of each route from A to B
- Choose the cheapest one



Shortest path to go from A to B

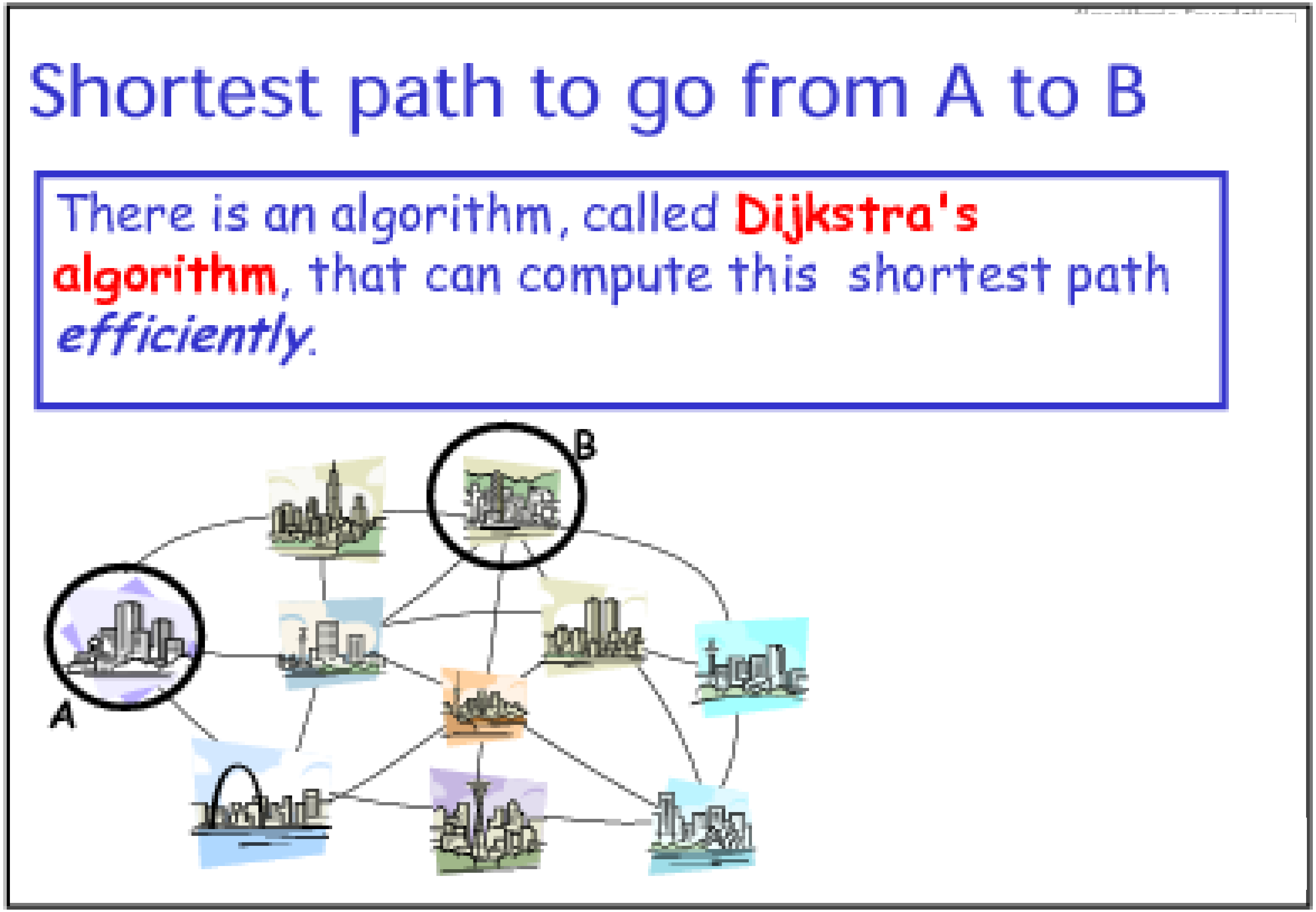
The obvious solution to a problem may not be efficient

How many routes between A & B?

involving 1 intermediate city?

Simple solution

- Compute the cost of each route from A to B
- Choose the cheapest one



Shortest path to go from A to B

There is an algorithm, called **Dijkstra's algorithm**, that can compute this shortest path ***efficiently***.

Our focus on algorithms

- Algorithms that create, access, manipulate data structures …
- Cost and performance analysis ..
- Performance refinement

Where are we going?

- Using the Java Collection Library
- Designing and Creating new Collection classes
- How to add, remove, search, sort, *etc.* **efficiently**
  - Fundamental data structures
  - Fundamental algorithms
  - Measuring efficiency of algorithms

Q&A

- Why do we insist an algorithm must terminate?
- Why do we insist an algorithm must be precise?
- Why instructions in an algorithm are written in a sequence?

- Write down an algorithm to start up IE Explorer on a computer.
  - Input: a computer equipped with Windows which is shut down
  - Output: a computer up & running with Windows IE Explorer

- Write down an algorithm to shutdown a computer safely from Windows.
  - Input: a computer equipped with Windows which is running under Windows
  - Output: a computer which is shutdown

- 1. Switch the computer into 'On' position
- 2. Wait til Windows coming up, click upon 'Start'
- 3. Choose 'IE Explorer' to run by clicking upon it

- 1. Close all running programs
- 2. Click upon 'Start', choose 'Shutdown' & click on it
- 3. Confirm 'Shutdown' by choosing 'Shutdown' & click on it in the dialogue box

Readings

- [Mar07] Read 1.1, 1.2, 2.1
- [Mar13] Read 1.1, 1.2, 2.1