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Department of Computer Science
University of Pretoria

Programming Languages
COS 333

Practical 1: Research Assignment

February 26, 2024

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1 Objectives

This practical aims to achieve the following general learning objectives:

- Provide experience in independent research, focusing on topics related to programming language theory;

- Give superficial exposure to some of the more esoteric topics related to programming languages, which are not the primary focus of the course, or the prescribed material (including esoteric programming languages, domain-specific programming languages, and multi-paradigm programming languages);

- Provide some introductory experience in the use of the LaTeX typesetting system;

- Provide some introductory experience in the use of some special-purpose programming languages.

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2 Plagiarism Policy

Plagiarism is a serious form of academic misconduct. It involves both appropriating someone else's work and passing it off as one's own work afterwards. Thus, you commit plagiarism when you present someone else's written or creative work (words, images, ideas, opinions, discoveries, artwork, music, recordings, computer-generated work, etc.) as your own. Note that using material produced in whole or part by an AI-based tool (such as ChatGPT) also constitutes plagiarism. Only hand in your own original work. Indicate precisely and accurately when you have used information provided by someone else. Referencing must be done in accordance with a recognised system. Indicate whether you have downloaded information from the Internet. For more details, visit the library's website: `http://www.library.up.ac.za/plagiarism/`.

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3 Submission Instructions

The following submission requirements must be adhered to for this practical. Marks will be awarded for adherence to these guidelines (see Section 6):

3.1 Document

The final research report must be compiled using the LaTeX typesetting system. Documentation related to the LaTeX system is available from this practical's folder on the course site [5]. The Informatorium Linux installations include the commonly used teTeX implementation of LaTeX. The MikTeX system is available for free download, if you prefer to use Windows (see `https://miktex.org/`).

You must include a list of references for the sources you consult. All references must be cited at the appropriate location within each question. Because your references will be marked (see Section 6), ensure that

there are sufficient (do not make unsubstantiated statements, unless they are clearly your own opinion) and that each is complete and correct. You may reference online sources. Note that this does not mean you must include a reference for every question (questions that ask for your opinion, for example, do not require a reference). You will receive marks for managing your references with BIBTEX. Documentation for BIBTEX is also provided on the course ClickUP page [6].

3.2 Upload

There is a separate upload slot for a PDF of your research questions report, the LATEXsource for your research questions report, and each of the practical tasks. Upload your practical-related files to the appropriate assignment upload slots on the course ClickUP page. Multiple uploads are allowed. The deadline is **Monday, 11 March 2024, at 12:00**.

- You are required to submit only your research questions PDF to a Turnitin assignment upload slot. Submissions will not be permanently uploaded to the Turnitin archive. Submission to Turnitin is required in order to receive a mark for your answers to the research questions.

- You must also upload the LATEX and BIBTEX source for the research questions report in a single zip archive. You must include a compiled PDF file, and the complete LATEX and BIBTEX source.

- For your PostScript implementation, submit only the source file (that is, not a compressed archive). For the Snap! implementation question, upload a single zip archive containing your saved program file (which will be an XML file). It must be possible to run your submissions with only the files you upload.

The reports will be assessed offline by the tutors. If in-person classes have started by **Monday 11 March 2024**, the implementation questions will be assessed during the practical sessions of that week. If in-person classes are still suspended by this date, the implementation questions will be assessed offline by the tutors.

4   Research Questions   [Total: 30]

Answer the following questions. Your answers should be as complete and clear as possible. Provide only information relevant to the question, and be as concise as possible. Overly verbose and lengthy answers will probably disadvantage you during the marking process:

1. The LATEX typesetting system is based on TEX. It is interesting to note that TEX is Turing complete. **Briefly explain** what the Turing completeness of TEX implies, and **briefly describe** one advantage and one disadvantage associated with the Turing completeness of TEX. [3]

2. **Explain** what an esoteric programming language (or *esolang*) is. [2]

3. The general consensus is that esoteric programming languages are little more than amusing diversions for computer science researchers. **Argue** for and against this viewpoint. [5]

4. Choose any two (2) esoteric programming languages. **Describe** each language in terms of its designer(s), year of initial design, the general syntactic and semantic characteristics, and whether the language is Turing complete or not. [10]

5. Bash is a shell used by most modern Linux distributions. **Briefly describe** one reason that Bash can be considered a programming language, and one reason why it cannot be considered a programming language. [2]

6. Consider ALF, which is a multi-paradigm programming language. **Identify** the paradigms that ALF combines. [2]

7. Consider the Visual Logic software used for teaching program design. **Briefly describe** the software in terms of the syntax and semantics it uses to support program design, and **provide** one advantage and one disadvantage associated with the approach used by Visual Logic to support teaching program design. [5]

8. **Explain** what the purpose of the Dr. Memory tool is. [1]

5   Implementation Questions   [Total: 10]

Implement each of the following programs. For each question, include at least one comment at the top of the program, that details the complete set of steps for executing the program:

5.1   PostScript   [5]

PostScript is a programming language commonly used as a page description language [3]. In Linux, programs such as `ghostview`, `kpdf` and `evince` can be used to interpret PostScript files. Documentation on how to use PostScript is available on the course ClickUP page [1][2].

   Implement a PostScript 3 program that produces a circle of circles, where each second circle is filled. An example of the general form that your output should have is given, below:
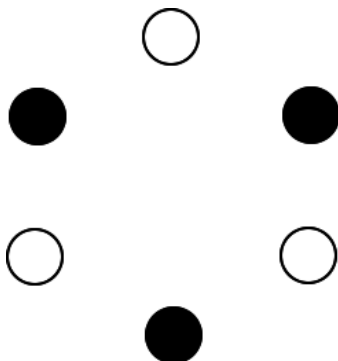
   Note that you **must** make use of a loop structure to print the circle. You **must** also make use of a conditional statement to determine whether a circle should be filled or not. If you simply draw each of the circles with different code, you will only receive partial marks.

   Save your PostScript program as a file named `task1.ps` and submit only this file to the appropriate upload slot on the course ClickUP page.

## 5.2   Snap!   [5]

Snap! is an educational programming language developed at the University of California, Berkeley [4]. Snap! uses a drag-and-drop web interface allowing a user to specify a program, and provides a cloud service to save programs. Snap! and its documentation are hosted at `http://snap.berkeley.edu/`.

   Implement a Snap! program to recursively draw a set of squares nested inside one another, similar to the following examples:
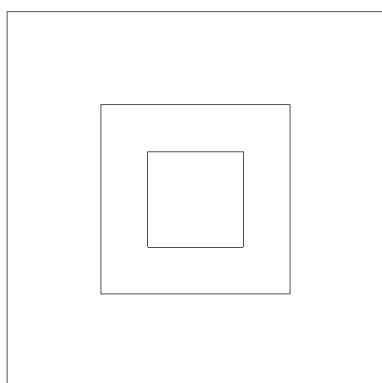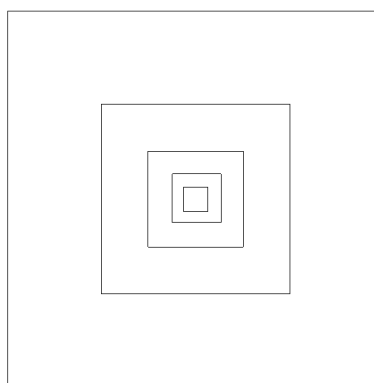
(a)   (b)

In the above examples, Figure (a) shows three squares nested inside each other, while Figure (b) shows five squares nested inside each other.

   Snap! uses the concept of a block to define a function. The block should accept two inputs (arguments). The first should specify the length of the outer square's sides, and the second should indicate how many squares

should be drawn. The block should draw each inner square with a side length that is half the length of its containing square. Include an example call to the block.

Note that you **must** use an iteration command to draw each square, and the procedure that draws the nested squares **must** be recursive. If you do not follow these guidelines, you will only receive partial marks.. Save your program in a file named `task2.xml` (Snap! allows programs to be stored online, but for submission purposes, save your program locally). Also note that ClickUP assignments do not allow XML file uploads, and you will therefore have to create a single zip archive named `task2.zip` containing the XML file. Submit this archive file to the appropriate upload slot on the course ClickUP page.

6 Marking

The marks for this practical will be allocated as follows:

Category	Mark Allocation
Research questions	30 marks
References	5 marks
Use of LATEX and BIBTEX	5 marks
Implementation questions	10 marks
TOTAL	**65 marks**

References

[1] Adobe Systems Incorporated. *PostScript Language Reference*, third edition, February 1999.

[2] Adobe Systems Incorporated. *PostScript Language Reference Supplement — Adobe PostScript 3 Version 3010 and 3011 Product Supplement*, 30 August 1999.

[3] Wikipedia, The Free Encyclopedia. PostScript. Online: `http://en.wikipedia.org/wiki/PostScript`.

[4] Wikipedia, The Free Encyclopedia. Snap! (programming language). Online: `https://en.wikipedia.org/wiki/Snap!_(programming_language)`.

[5] Tobias Oetiker, Hubert Partl, Irene Hyna, and Elisabeth Schlegl. The not so short introduction to LATEX 2_ε, version 6.2, 28 February 2018.

[6] Oren Patashnik. BIBTEXing, 8 February 1988.