Applied Software Development Project

Writing the Methodology

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What Should You Include in Your Research Methodology?

- **Title of research project** ✓
- **Abstract** ✓
- **Table of Contents** ✓
- **Introduction** ✓
- **Research Question and Rationale** ✓
- **Literature reviews or Related Material** ✓
- **Research Method and Specification** ✓
- **Proposed Research Implementation and Evaluation** ✓
- **Research timeline** ✓
- **Potential problems and remedies (If Applicable)** ✓
- **Conclusions** ✓
- **References** ✓
- **Appendix** ✓

Agenda

- Research Report: Area of Interest

- Research Report: Algorithms in Energy Optimizations

- Research Report: Planning for Research

- Proposed Approach: Focus on your Research Area

- Proposed Approach: Purpose/ Objectives

- Research Methodology: Design Algorithms

- Research Methodoly: Presentation of Algorithm

- Research Methodology and Specification: Deductive Coding

- Research Methodology and Specification: Equipment, code and tools

- Research Methodology and Specification: Summary (6 - 8 pages)

Research Report
Area of Interest

- Virtualization

- Distributed computing

- Algorithm optimization

- Transaction and other processing systems

- Resource allocation & Scheduling

- Service discovery & Scalability

- IT Systems and Architectures

- On-demand Task scheduling

- Energy efficient scheduling etc. in large scale environments

- Big data analytics

Research Report
Algorithms in Energy Optimizations

- Bhabani Shankar, Prasad Mishra, Himansu Das, Satchidananda Dehuri, Alok Kumar Jagadev, Cloud Computing for Optimization: Foundations, Applications, and Challenges, ISBN 978-3-319-73675-4, 2018 Springer.

Table 1.1 Literatures of nature inspired algorithms in energy optimization

Developed strategy	Optimization algorithm	Purpose	Year	Reference
–	Multi objective PSO	Identification of power models of enterprise servers	2014	[41]
Smart VM overprovision	Mixed integer linear programming	Solving the energy efficiency problem	2017	[42]
–	Convex predictive optimization	Energy efficient resource utilization	2017	[43]
Dynamic backlight scaling optimization	–	Minimization of energy consumption	2014	[44]
–	Generic optimization	Cost optimality	2014	[45]
–	Improved PSO	Optimization of energy in virtual data centers	2013	[46]
–	SLA based optimization	Minimization of energy cost	2012	[47]
–	Immune Clonal optimization	Energy efficiency	2014	[48]
–	PSO	Virtual machine allocation	2014	[49]
ACO-VM placement	ACO	Effective use of physical resources	2014	[50]

Research Report
Planning for Research

- Focus on your research question that you have already written.

- Define what is to be evaluated or measured - what system, what properties of the system that will be used for the research.

- Sketch/ Draw a computational experiment or trial:

  - To get output to be used as evidence in the research report/ paper.

  - To gather information for your own learning.

- Brainstorm **different ways of investigating** the research question.

- Consider simple preliminary investigations, or case studies, before embarking on a large-scale implementation.

- Search for definitive experiments - small differences are not convincing.

- Distinguish exploratory work from substantial and confirming experiments.

Research Report
Planning for Research

- Do you need to plan a controlled computational experiment, or are case studies sufficient for your research?

- Which operating system will be used to perform your experiment and/ or which cloud computing environment you would like to use?

- Will a payment be required for the computational experiment?

- What instructions are considered as special for the computational experiments?

- What kind of architectures/ OS/ and hardware will be preferred to use?

- Can you achieve all objectives with a planned experiment?

- Are you aware of the relevant ethical guidelines?

Proposed Approach
Focus on your Research Area

- Serverless Computing: Current Trends and Open Problems

- Big Data Analytics in Cloud: A Streaming Approach

- Resource Procurement, Allocation, Metering, and Pricing in Cloud Computing

- Dynamic Selection of Virtual Machines for Application Servers in Cloud Environments

- Improving the Energy Efficiency in Cloud Computing Data Centres Through Resource Allocation Techniques

- Performance Modelling and Optimization of Live Migration of Virtual Machines in Cloud Infrastructure

- Analysis of Security in Modern Container Platforms

- Importance of Cryptographic techniques in Cloud Computing

Proposed Approach
Purpose/ Objectives

- The big question may consider the following points:

  - A major purpose of investigations is to establish facts (observations) on which a hypothesis might be based.

  - Another purpose of investigations is to establish the validity of, or to confirm a hypothesis.

  - What allows us to use some finite set of investigations to assert that a theory is established, that is, to assert that something can for all practical purposes be regarded as true?

  - What allows us to claim that a certain experimental design is good, or sufficient, or superior to the alternatives?

Research Methodology

Design Algorithms

- **Presentation of Algorithm**

- When an algorithm is presented in a computer science research paper

  – Purpose or details of the algorithm

  – Number of program steps involved

- You must demonstrate that the algorithm is a worthwhile contribution: for example, show that given appropriate input, it terminates with appropriate outcomes;

- Show, by a combination of proof and experiment, that it meets some claimed performance bound.

Research Methodology
Presentation of Algorithm

- As part of a description of an algorithm, a reader would expect to find of some or all of the following:

    - The steps that make up the algorithm.

    - The input and output, and the internal data structures used by the algorithm.

    - The scope of application of the algorithm and its limitations.

    - The properties that will allow demonstration of correctness, which might be formally expressed as pre- and post-conditions and loop invariants.

    - A demonstration of correctness.

    - A formal analysis of cost, for both space and time requirements.

    - Experiments confirming the theoretical results.

Research Methodology Presentation of Algorithm
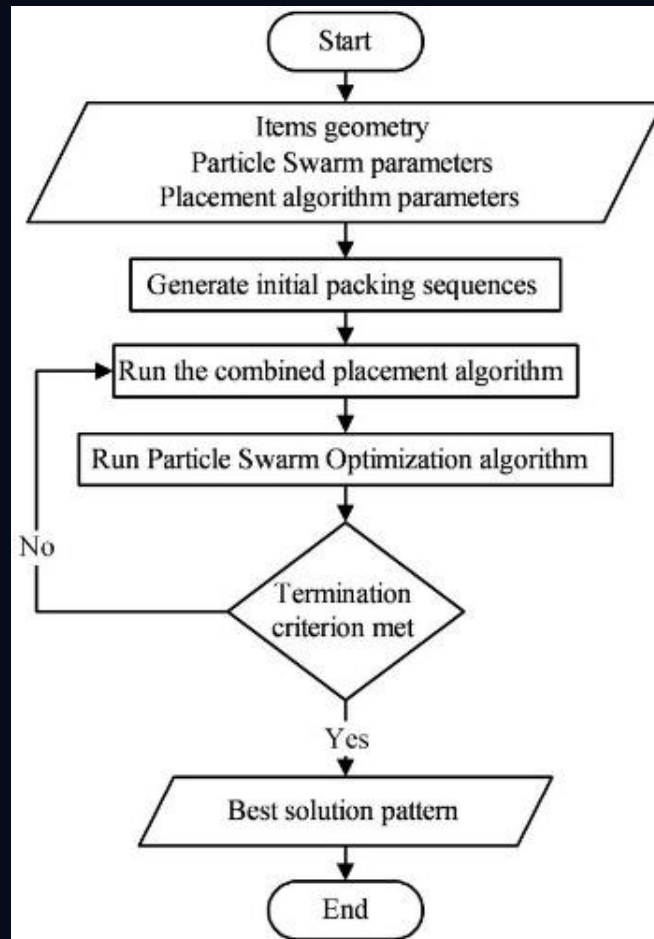
Algorithm 1 Pseudo-code for PSO

Inputs: size of the problem, size of the population;
Output: Optimized solution;
Description:

```
population  =  θ
s_g_optimal  =  θ
for (i = 1  to  size_of_population) do
S_velocity  =  Random_Velocity();
S_position  =  RandomPosition(size_of_population);
s_g_optimal  =  s_position ;
if Cost(S_s_best)  <=  Cost(S_g_best)
S_g_optimal  =  (S_s_best);
end
end
while: StopCondition ()  do
for  each  p  ε  population do
S_velocity  =  UpdateVelocity(S_velocity,  S_s_best,  S_s_best);
S_position = UpdatePosition(S_position, S_velocity);
if Cost(S_position) <= Cost(S_s_best)
s_s_best = s_position;
if Cost(S_s_best) < = Cost(S_g_best)
s_g_optimal = S_g_optimal;
end
end
end
end
return  P_g_best
```

Research Methodology and Specification
Deductive Coding

- When you have very specific and focused research questions, you may use "top-down" (deductive) coding process.

- First, construct **a coding scheme**.

- Then, find in the data the elements corresponding to the pre-constructed codes.

- Develop coding schemes based on theory, another study, and/or your research questions.

- Even deductive coding will require switching back and forth between inductive and deductive modes of coding.

- Be prepared to modify pre-constructed coding scheme in light of some emerging patterns.

Research Methodology and Specification
Equipment, code and tools

- You may need to trade off ease of implementation against realism of the result. Computational examples:

  - If you plan to measure algorithmic efficiency, implement in a suitable language.

  - Coding for a day followed by execution for a month is a lot less efficient than coding for five days followed by execution for 20 minutes . . . especially if you have to run again.

- Don't over-implement or invest in unnecessary effort.

  - Download code banks and use libraries.

  - Leave off unnecessary features.

  - Decompose into simple and separate pieces of code.

Research Methodology and Specification
Summary (6 – 8 pages)

- This section must:

- provide a specification to describe the techniques analysis methods that will eventually underlie the implementation (max 1 - 2 pages).

- furnish a complete analysis and design documentation in order to explain each of the major design decisions and choices to be made.

  - Consider using software engineering diagrams to illustrate your proposed approach e.g. **class and object diagrams, component diagrams, deployment diagrams, CRC cards, activity diagrams, communication diagrams, state-charts, and/or sequence diagrams (max 4 - 5 pages).**

- include a project plan which specifies the expected tasks to be carried out during the capstone project semester. It should have a Gantt chart with the related dependencies (max 1 page).

References/ Resources

- Student Research and Report Writing, From Topic Selection to the Complete Paper, Gabe T. Wang and Keumjae Park, WILEY Blackwell, 2016 John Wiley & Sons Ltd.

- Thanks to Horacio Gonzalez Velez for providing a presentation for this lecture.

- Some images used from Google Search Repository.