RESEARCH METHODOLOGY

AIUB.

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CONTENTS

- Brief on the Course….
- Evaluation Criteria and Regulations…. Points to be noted!!
- Introduction to the Research & Research Methodology.

COURSE OUTLINE AND EVALUATION

I. Course Core and Title

CSC 4195: Research Methodology

II. Credit

3 credit hours (3 hours of theory per week)

III. Nature

Core Course for CS, CSE, CSSE, CIS

IV. Prerequisite

CSC 2105: Graduating Year

Course Description:

- Define and Comprehend research, research perspective and need to conduct research, validation of research.
- Comprehend basic building blocks of research (e.g., framework).
- Define and Explain different research methods.
- Define and Explain ethics, research ethics, and its integration in real life scenarios.
- **Analyze and Formulate Research proposal.**
- Evaluate and Design a research based on problem analysis.
- **Conduct research using Systematic Literature Review method and write a Scientific Article.**
- Comprehend the basics of scientific writing.
- LaTex: The tool to write scientific and Professional Documents.

OBE – Outcome Based Education.

CO – Course Outcome [Achievied from participating in courses and successfuly passing the evaluation].

PO – Program Outcome [Achieved at the point of Graduation].

12 Program Outcomes (POs)

- ✓ OBE certification (During Graduation).
- ✓ To be IEB accredited Engineer.
- ✓ To be Internationally (Washington Accord) accredited Engineer.

CO	CO Definition	Blooms Level	Blooms Learning Level			PO Map	Assessment Method
			C	P	A		
CO2	Determine and Demonstrate Ethical Constraints and Considerations in conducting Research.	3		P		8	Case Study
CO1	Formulate and Compose a Research proposal considering complex research activities, background studies, and following standard guidelines.	6		P		10	Project
CO3	Design and compose a Research article after conducting a mock research on a given topic by leveraging a research method.	6		P		10	Project

C: Cognitive; P: Psychomotor; A: Affective; S: Soft-skills (CT: Critical Thinking, TS: Teamwork)
*The numbers under the 'Level of Domain' columns represent the level of Bloom's Taxonomy each CO corresponds to.
** The numbers under the 'PO Assessed' column represent the PO each CO corresponds to.

PO8	Apply ethical principles and commit to the professional ethics, responsibilities and the norms of the engineering practice.
PO10	10.1 Communicate effectively about complex engineering activities with the engineering community and with society at large. Can give and receive clear instructions.
	10.2 Can comprehend and write effective reports, design documentation, make effective presentations.

EVALUATION CRITERIA

Marks distribution [Mid and Final]:

- Class Assignment (30%).
  - 3 + 3 Quizzes.
- Term Project and Viva (70%).

Mandatory Evaluations:

- Mid Term Project.
- Final Term Project.

Mandatory Evaluations:

- Mid Term Project:
  - Writing a comprehensive research proposal.
- Final Term Project:
  - Writing a research paper.

EVALUATION - SUMMARY

Must Participate and Pass:

- Mid Term project.
- Final Term Project.

Bonus marks are applicable for commitment, sincerity, honesty, dedication, attitude, & performance.

Academic honesty and sincerity:

- Rules are uniform and equal to all irrespective of Gender, Cast, and Track records.
- No compromise on ethical standpoint – applicable to faculty also!
- Missing online assessment may be reimbursed with appropriate proof.
- Unethical means in passing the course will be evaluated to 0 and resulted in dropping the course – Teacher reserves the sole authority to decide with proper evidence !

EVALUATION - RULES

Term Projects:

- Group of 3 people.
- Must be submitted and passed to pass the course.
- Must be written in **LaTeX**.
- Must comply all the requirements.
- Must be submitted within given deadline.
- **Plagiarism** is checked with professional tool (iThenticate) and must be over the threshold level. Otherwise it's a FAIL.

MEET THE TEACHER ☺

- ✓ B.Sc (IUT), MSc (BUET, TUT), PhD (TUT).
- ✓ 18 years of tertiary level of teaching (AUST, TUT, AIUB, IUT).
- ✓ 6 years of professional Software Designing and Development (Lynax tech, TUT).

- ✓ 12 years of research and development.
  - ✓ European Space Egency (Finnish Geospatial Research Institute).
  - ✓ Tampere University of Technology.
  - ✓ Bangladesh University of Engineering and Technology.

MEET THE TEACHER ☺

- ✓ Software Engineering, Open Source Software, Software Architecture, Eco-system, Smart solution, IoT, Big data analysis and related.
- ✓ 30+ Publications (Journals, Book Chapters, Conferences, Technical Reports, Thesises).
- ✓ Reviewer of Journal and Conferences (IJOSSP, Journal of Navigation, Journal of Computer Science).
- ✓ Track Chair and TPE (ICWE2020, IST 2019, ICCA2020,..).
- ✓ Technical Evaluator (A2I), ACM Professional Member.
- ✓ 3 EU Projects, 2 Finnish National Projects, Funding for Graduate studies, Merit Schoarships and Research Grants.

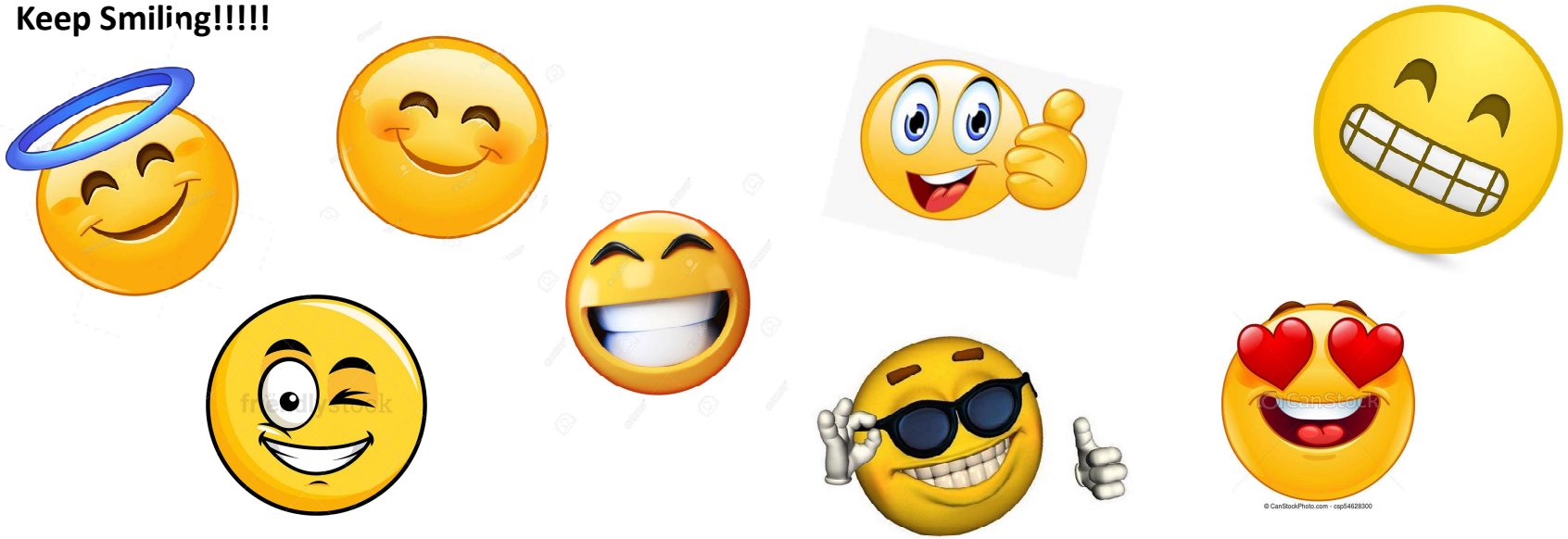
LIFE LONG TEACHINGS

- ✓ I am the BEST – discrete achievemets, self confidence, Fight against failures, Positive Attitude!
- ✓ Expressive, Explicit and Extrovert (**EEE**).
- ✓ Be Selfish till it does not affect others.
- ✓ Open and Accomodative (in a positive note).
- ✓ Self Criticizm (run this 24/7).
- ✓ Honesty, Dignity and Moral.

No matter how big your are there is always someone bigger than you,
Until your **CREATOR**

LIFE LONG TEACHINGS

- ✓ **Keep Smiling!!!!!**



- ✓ Keep others interest first!!!

GETTING EXPOSURE BEING A RESEARCHER / PROFESSIONAL

- ✓ Google Scholar. (https://scholar.google.com/)
- ✓ Linkedin. (https://www.linkedin.com)
- ✓ ResearchGate. (https://www.researchgate.net/)
- ✓ Personal Website. (http://msyeed.weebly.com/)

SOFTWARE ENGINEERING

WHAT IS SOFTWARE ENGINEERING

1. The application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the application of engineering to software.

2. The study of approaches as in 1

IEEE Standard Glossary of Software Engineering Terminology, IEEE std 610.12-1990, 1990

WHAT IS SOFTWARE ENGINEERING

Software engineering is an engineering discipline that is concerned with all aspects of software production.

> Software engineers should adopt a systematic and organized approach to their work and use appropriate tools and techniques depending on the problem to be solved, the development constraints and the resources available.

Ian Sommerville, Software Engineering, 8th edition, 2006

RESEARCH

WHAT IS RESEARCH

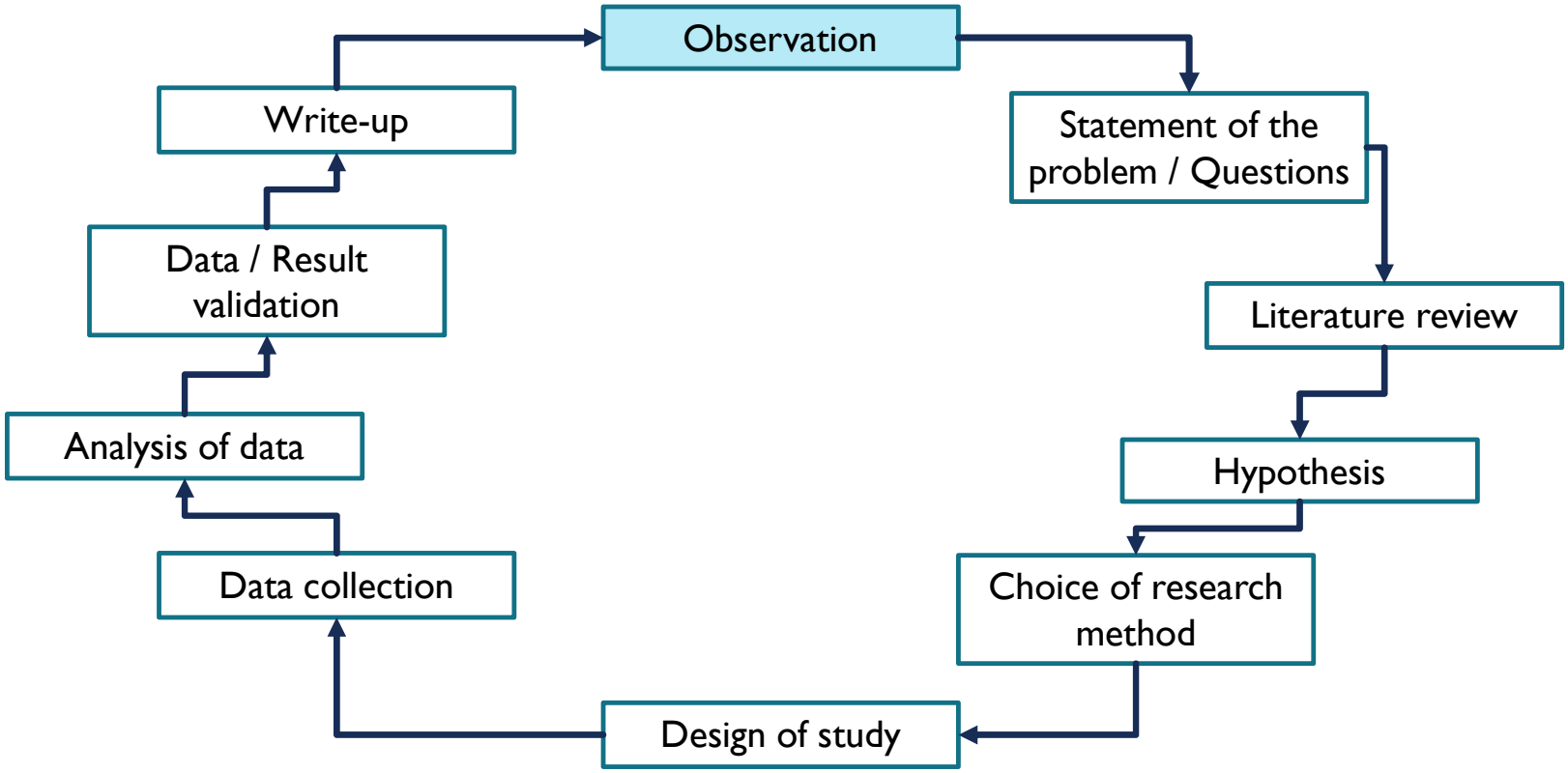
a. The systematic investigation into and study of materials, sources, etc, in order to establish **facts and reach new** conclusions.

b. An endeavour to **discover new or collate old facts** etc by the scientific study of a subject or by a course of critical investigation. [Oxford Concise Dictionary]

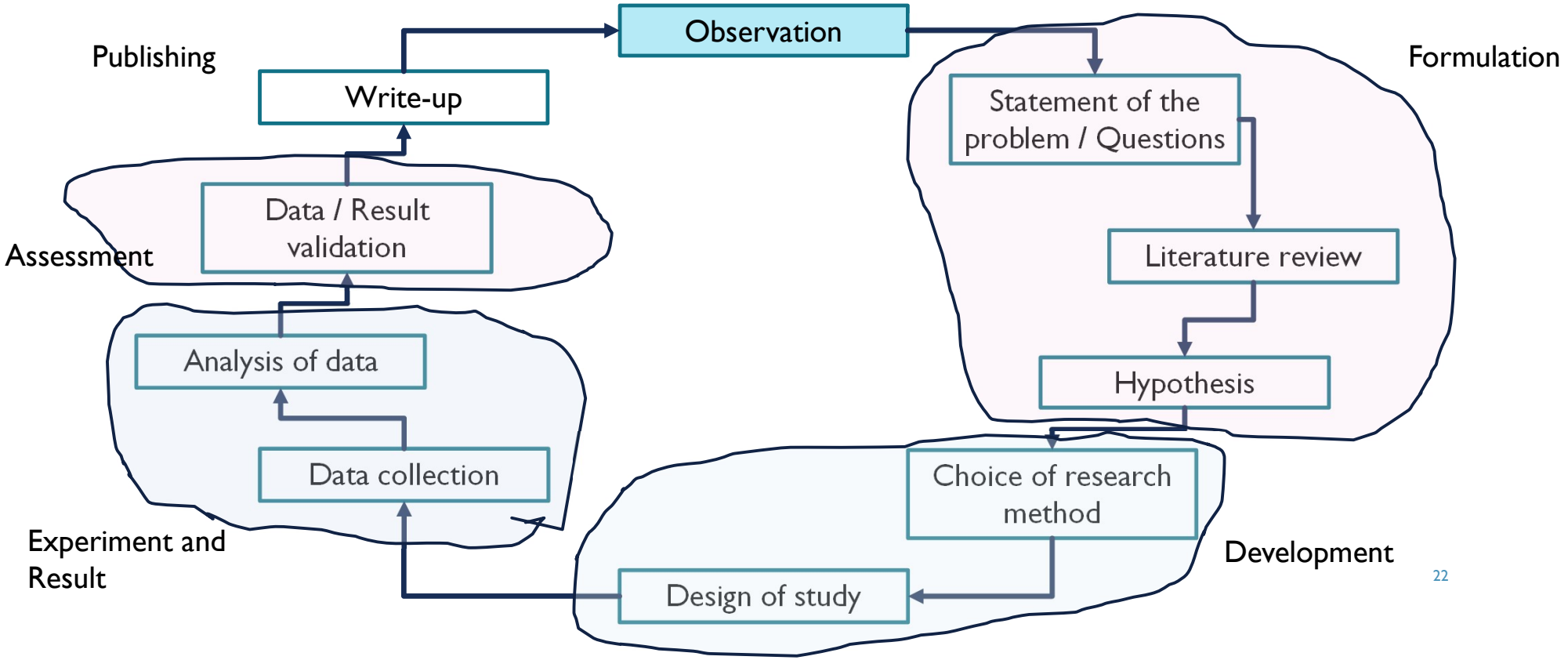
WHEN IS RESEARCH CONDUCTED

- Research is what we do when **we have a question** or a problem we want **to resolve**
- We may already think **we know the answer** to our question already (???)
- We may think the **answer is obvious**, common sense even (???)
- **But until we have subjected our problem to rigorous scientific scrutiny**, our 'knowledge' remains little more than guesswork or at best, intuition.

WHAT IS RESEARCH?



WHAT IS RESEARCH?



RESEARCH IN SOFTWARE ENGINEERING

WHAT IS SOFTWARE ENGINEERING RESEARCH

Engineering research – study methods, tools, etc. that can be used to solve practical problems

- May include invention of new methods, tools, etc. or improvement of existing ones
- But invention is neither necessary nor sufficient
- As opposed to basic research – study phenomena and try to find "the truth"

WHAT IS SOFTWARE ENGINEERING RESEARCH

- ✓ What kinds of questions are "interesting"?
- ✓ What kinds of results help to answer these questions, and what research methods can produce these results?
- ✓ What kinds of evidence can demonstrate the validity of a result, and how to distinguish good results from bad ones?

TYPES OF RESEARCH QUESTIONS

- ✓ Method or means of development
- ✓ Method for analysis
- ✓ Design, evaluation, or analysis of a particular instance
- ✓ Generalization or characterization
- ✓ Feasibility

TYPES OF RESEARCH QUESTIONS

Method or means of development

How can we do/create (or automate doing) X?

What is a better way to do/create X?

Method for analysis

How can I evaluate the quality/correctness of X?

How do I choose between X and Y?

Design, evaluation, or analysis of a particular instance

What is a (better) design or implementation for application X?

What is property X of artifact/method Y?

How does X compare to Y?

What is the current state of X / practice of Y?

TYPES OF RESEARCH QUESTIONS

Generalization or characterization

Given X, what will Y (necessarily) be?

What, exactly, do we mean by X?

What are the important characteristics of X?

What is a good formal/empirical model for X?

What are the varieties of X, how are they related?

Feasibility

Does X even exist, and if so what is it like?

Is it possible to accomplish X at all?

TYPES OF RESEARCH RESULT

- ✓ Procedure or technique
- ✓ Qualitative or descriptive model
- ✓ Empirical model
- ✓ Analytic model
- ✓ Notation or tool
- ✓ Specific solution
- ✓ Answer or judgment
- ✓ Report

TYPES OF RESEARCH RESULT

Procedure or technique

- New or better way to do some task, such as design, implementation, measurement, evaluation, selection from alternatives,
- Techniques for implementation, representation, management, and analysis, but not advice or guidelines

Qualitative or descriptive model

- Structure or taxonomy for a problem area; architectural style, framework, or design pattern; nonformal domain analysis
- Well-grounded checklists, well-argued informal generalizations, guidance for integrating other results,

Empirical model

- Empirical predictive model based on observed data

Analytic model

- Structural model precise enough to support formal analysis or automatic manipulation

TYPES OF RESEARCH RESULT

Notation or tool

Formal language to support technique or model (should have a calculus, semantics, or other basis for computing or inference)

Implemented tool that embodies a technique

Specific solution

Solution to application problem that shows use of software engineering principles – may be design, rather than implementation

Careful analysis of a system or its development

Running system that embodies a result; it may be the carrier of the result, or its implementation may illustrate a principle that can be applied elsewhere

Answer or judgment

Result of a specific analysis, evaluation, or comparison

Report

Interesting observations, rules of thumb

VALIDATION TECHNIQUE

- Analysis
- Experience
- Example
- Persuasion
- Evaluation
- Blatant assertion

VALIDATION TECHNIQUE

Analysis - I have analyzed my result and find it satisfactory through
- … rigorous derivation and proof
- … data on controlled use
- … experiment

Experience – My result has been used on real examples by someone other than me, and the evidence of its correctness / usefulness / effectiveness is
- … narrative
- … data, usually statistical, on practice
- … comparison of this with similar results in actual use
- Example – Here's an example of how it works on
- … a toy example, perhaps motivated by reality
- …a system that I have been developing

VALIDATION TECHNIQUE

Persuasion – I thought hard about this, and I believe
- … if you do it the following way, …
- … a system constructed like this would …
- … this model seems reasonable
- If the original question was about feasibility, a working system, even without analysis, can be persuasive

Evaluation – Given the stated criteria, my result
- … adequately describes the phenomena of interest
- … accounts for the phenomena of interest
- … is able to predict … because …, or … gives results that fit real data …

VALIDATION TECHNIQUE

- **Feasibility** studies, pilot projects
- **Blatant assertion** – No serious attempt to evaluate result

SOFTWARE ENGINEERING RESEARCH

EXAMPLE SCENARIO

SOFTWARE ENGINEERING RESEARCH

Question	**Result/method**	**Validation**
Feasibility	Qualitative model	Persuasion
Characterization	Technique	Implementation
Method/means	System	Evaluation
Generalization	Empirical model	Analysis
Selection	Analytic model	Experience

SOFTWARE ENGINEERING RESEARCH - A COMMON PLAN

Question	**Result/method**	**Validation**
Feasibility	Qualitative model	Persuasion
Characterization	Technique	Implementation
Can X be done better? →	Build a system Y? →	Measure Y and compare to X.
Generalization	Empirical model	Analysis
Selection	Analytic model	Experience

SOFTWARE ENGINEERING RESEARCH - A COMMON PLAN BUT **BAD** PLAN

Question	**Result/method**	**Validation**
Feasibility	Qualitative model	Check if it works!
Characterization	Device a Technique	Implementation
Can X be done better?	System	Evaluation
Generalization	Empirical model	Analysis
Selection	Analytic model	Experience

SOFTWARE ENGINEERING RESEARCH – TWO MORE GOOD PLANS

Question	**Result/method**	**Validation**
Can X be done at all?	Qualitative model	Look it works!
Characterization	Technique	Implementation
Method/means	Build Y that does X	Evaluation
Is X always true of Y	Empirical model	Check proof
Selection	Formally model Y and prove X	Experience

EXERCISE

Build a electric car charging system that will maximize the conversion of kinetic energy to electric power to extend the battery life.