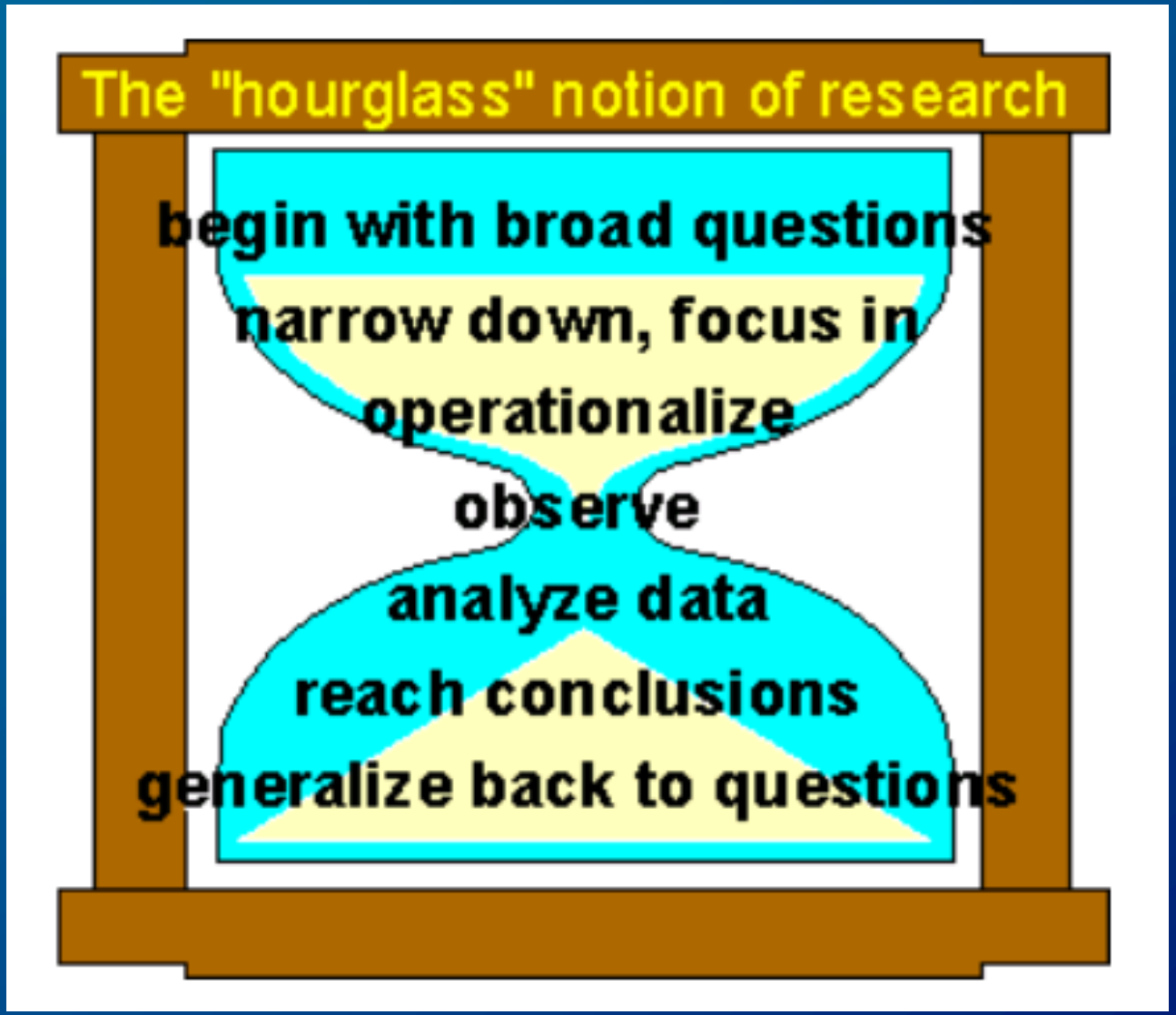
CISC-810: Research Foundations

Pengcheng Shi, PhD
PhD Program in Computing and Information Sciences

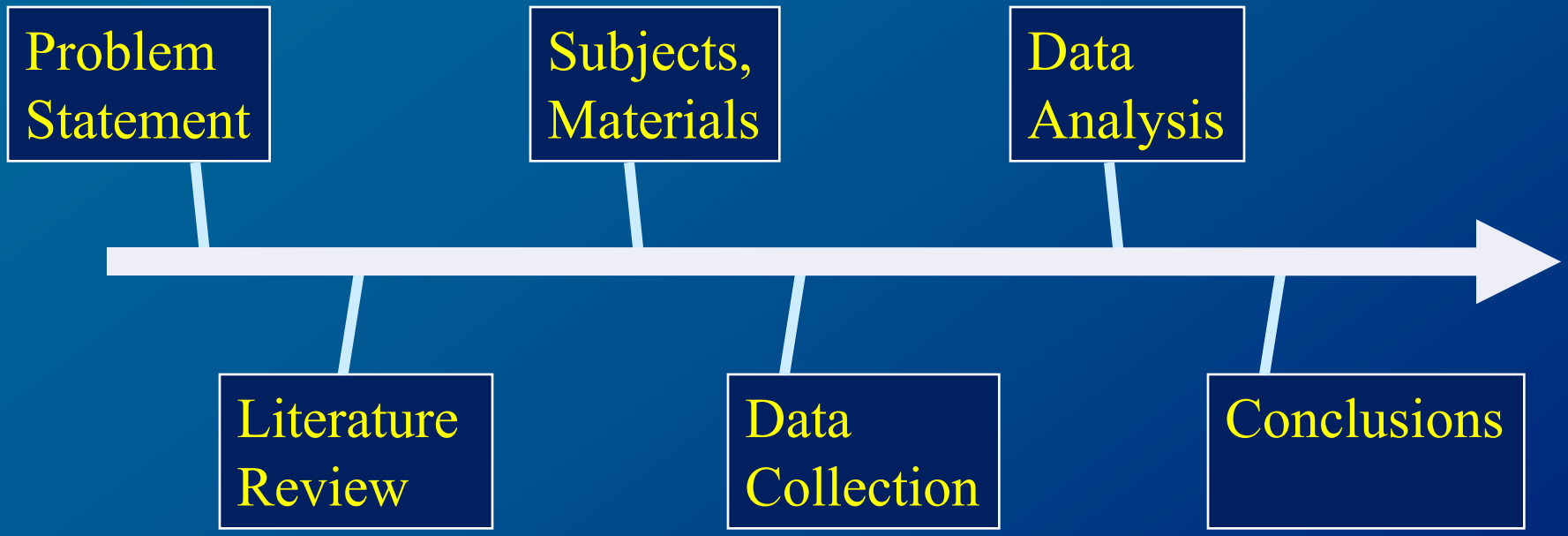
Research: a creative process

- Not procedural
- Not linear, although often reported in a linear fashion
- Starts and stops, jumps, intuitions, changes

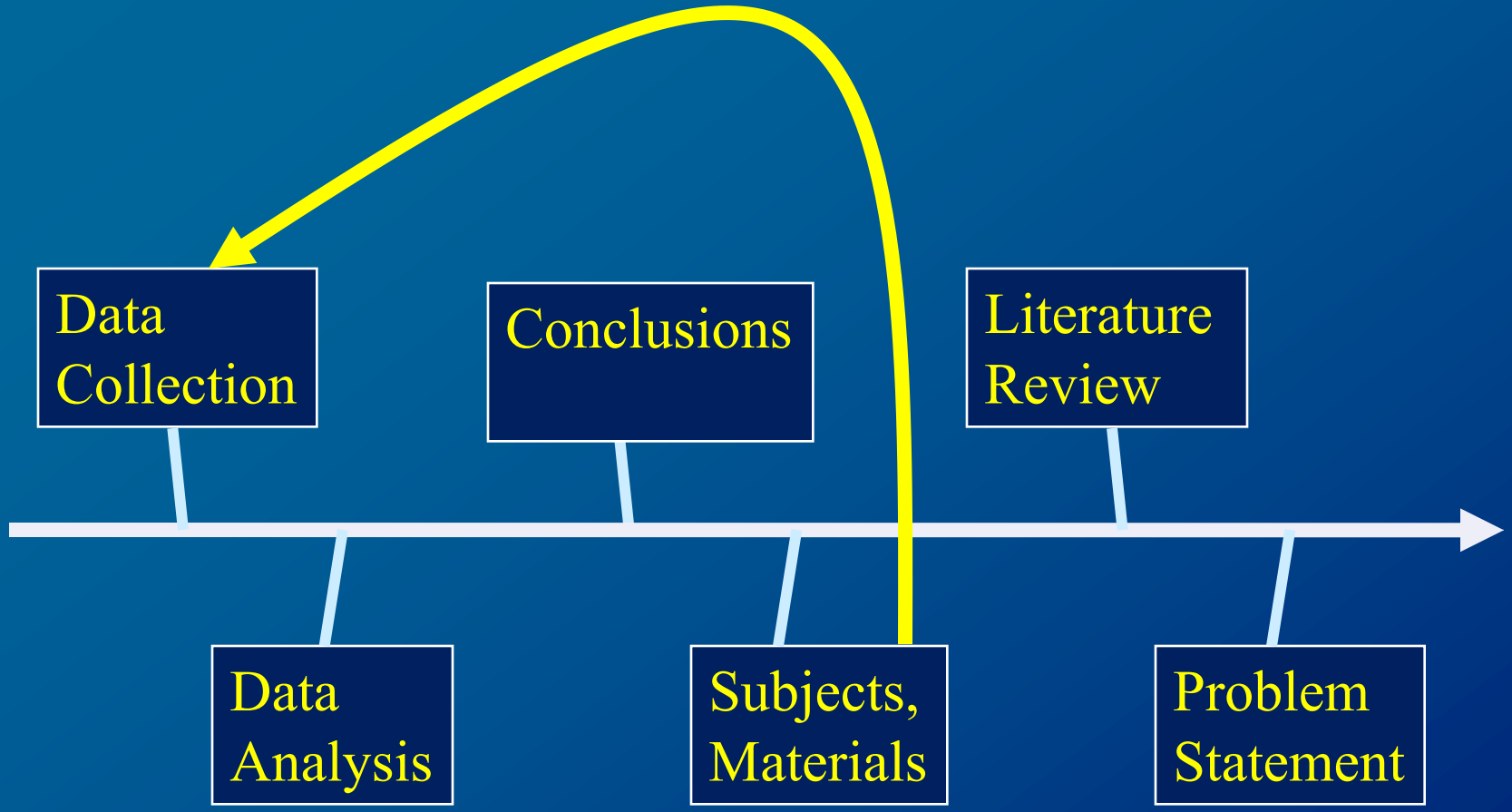
- Important: there is no perfect research process.



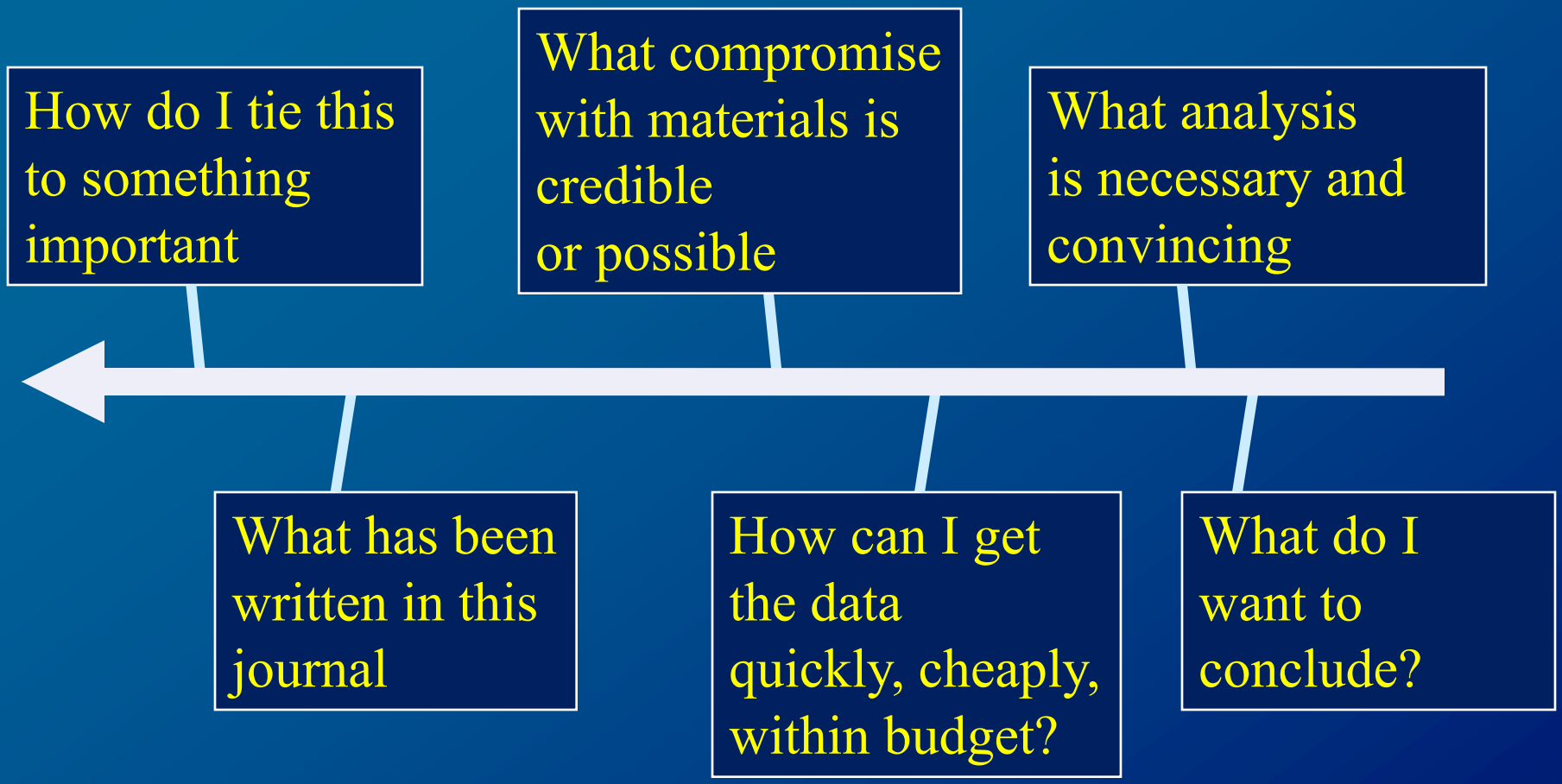
From Trochim, W.



The *linear* illusion of research



Other possibilities of being *productively lost*



In actual planning, we might very well start from the end – *backtracking*!

Essential Skills

- Analytic/Critical Thinking
- Creative Synthesis: big pictures and small details
- Statistics (maybe sometimes less universally required: *advanced mathematics*): data is the new KING!
- Writing and Presenting: you are what you can communicate
- Project/Time Management

Clarity of thought and precision of expression

We said…

- Finding, describing, framing to clearly and credibly answer a question (or set of questions)

Purpose of Research

- Gaining *understanding* of a phenomenon
- Add pieces to the puzzle of:
  - Description: what is happening
  - Explanation: formulate theories, rules
  - Prediction: do they hold, under what circumstances
  - Control: creating mechanisms to dictate a *desirable* outcome

Usually

- Gathering data in a specific situations (early) with the intent of generalizing to *other or all situations* (later)

Nomothetic

(relating to the study or discovery of general scientific laws)

- What makes that leap of faith sensible?
  - Logic (what claims can we make)
  - *Statistics* (probabilistic thinking)

Search for the *Truth*

- Almost always a *relative term*

- Truth is what is currently agreed upon by *experts*
- *Truth* is inevitably wrong to varying degrees
- *You can almost always do better* ☺

Consensus on the *Truth*

- A *game* of getting *experts* to agree with you
- Generally, you have to work within the existing system to be credible
- Why would people protect *un-truth*?
  - The age of fake news / alternative facts ☹

Every Question, Every Field is Different. But …

- CS, Gaming, IT, Security, SE, …
- Merging and splitting
- Things come and go out fashion: AI

How to best situate yourself for *your* opportunities regardless your field of interests

Paradigms

- *The Structure of Scientific Revolutions* Thomas Kuhn (1962):
  - Normal science: things move along incrementally
  - Revolutionary science: there are great changes in thinking and the *truth*
- Paradigm shift:
  - new way of seeing things
  - new questions and new approaches

Paradigm Shift

- Ptolemy – 100 AD, earth centric, but fairly accurate
- Copernicus – 1500, sun centered
- Galileo – early 1600's existence of Jupiter moons, contradicted Ptolemy
- Kepler – ellipsoidal orbits, accurate predictions
- Newton 1600 – physical laws / gravitation

Perhaps …

- Computer as a number crunching device
- Computer as a communications (bit-sharing) device
- Computer as a portal to information

- Computer as a ubiquitous component of everything …

Homework

- Reading: *Trochim & Donnelly*
  - Foundations:
    - Ethics in Research

Homework

- Cooking assignment #2:
  - Just like the last time, cook your favorite dish! However, this time, find a recipe (from anywhere) that is not your own.
  - Materials, recipe, *actual cooking process*
  - How does it taste? Good, bad, potential areas of improvement *according to your taste.*
  - Write it up.
  - Due date: September 1.