Can Research be Taught?

CDEN/C²E²-09

6th Conference on Canadian Design Engineering Network and the Canadian Congress on Engineering Education

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Contents

- Introduction
- What is Research?
- Prerequisites for Research
- Getting a Research Idea
- How to Search?
- A Metric for Research
- Conclusion

Introduction

- Undergrad.

Introduction

- Undergrad. → Courses

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- Undergrad. → Courses → Linear & Predictable

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- Graduate Work

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- Graduate Work→ Thesis

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  - Carrier Advancement, $$$

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- Graduate Work→ Thesis → Irregular & Random
- Motivation for gradate school?
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- Challenges will Occur
  - Shock
  - Surprise!

Introduction …

- Some may discontinue the program.

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- Others will get Assistance:
  - Advisor
  - Senior Peers
  - Counseling

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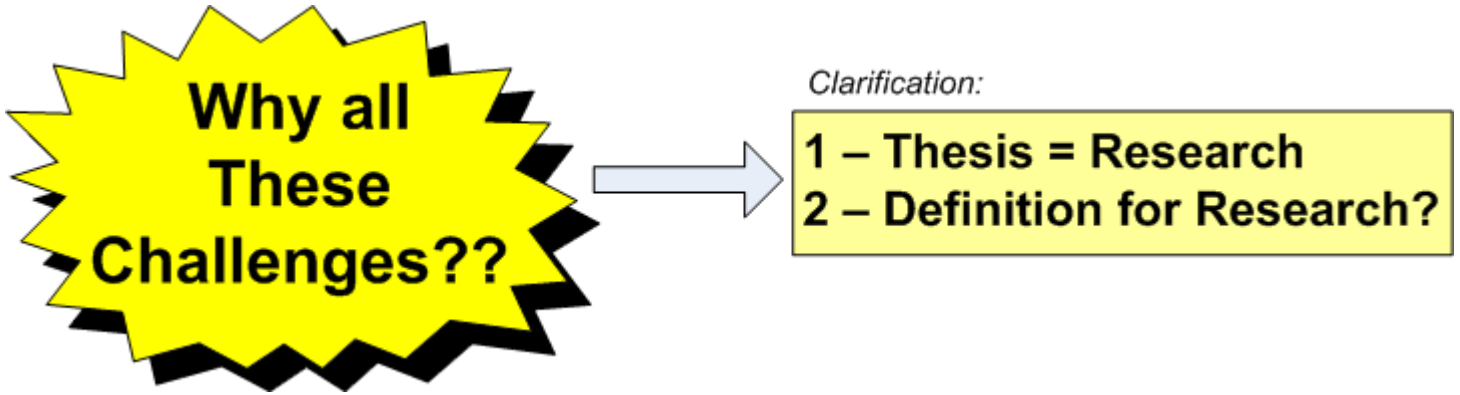

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What is Research?

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What is Research? …

- "research" → Novel contribution to knowledge!
- What is "Engineering Research"?
- Our definition:

"uncovering of an original, practical and efficient: principle, model, or gadget"

What is Research? …

Ask a Question

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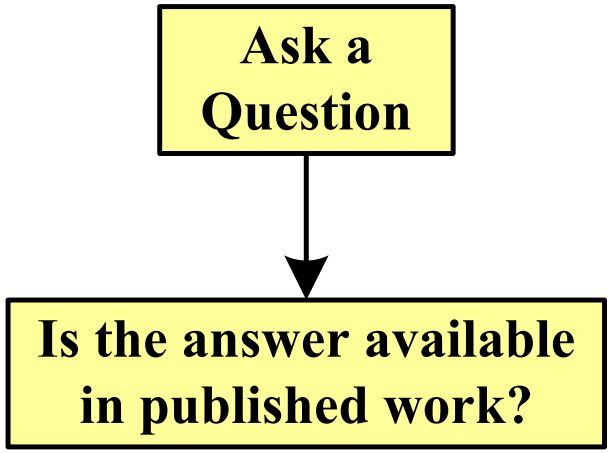

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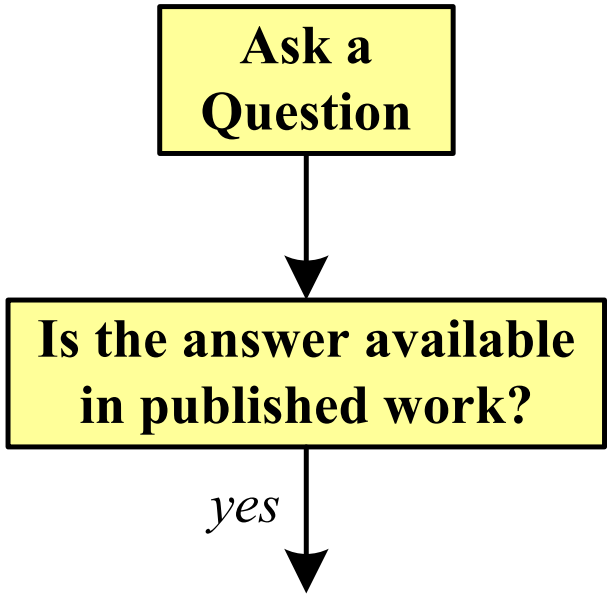

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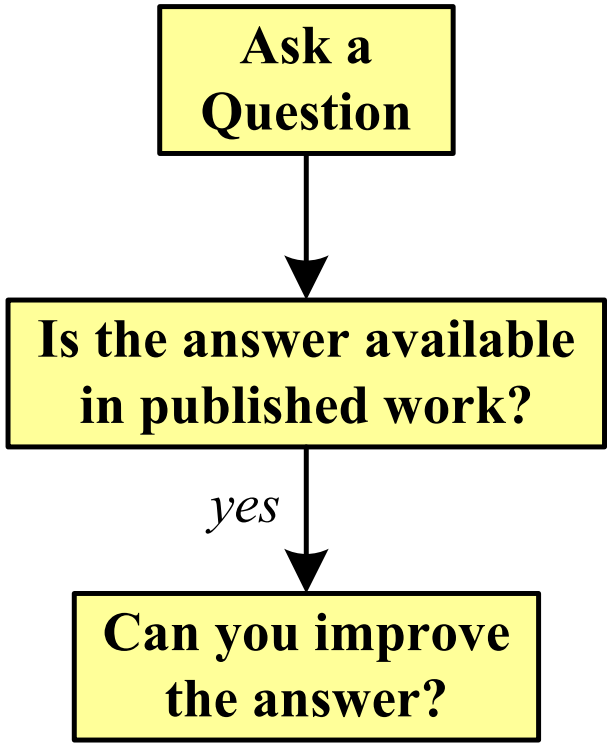

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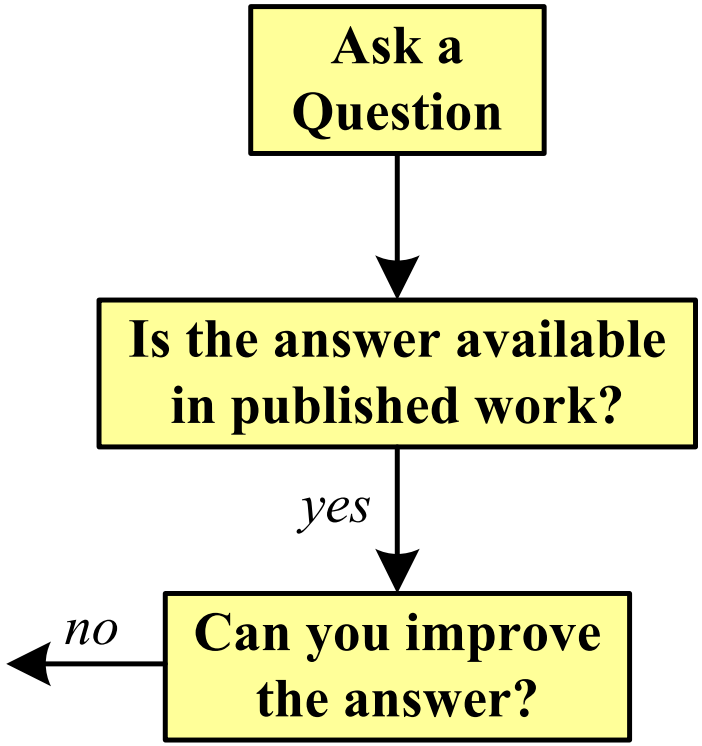

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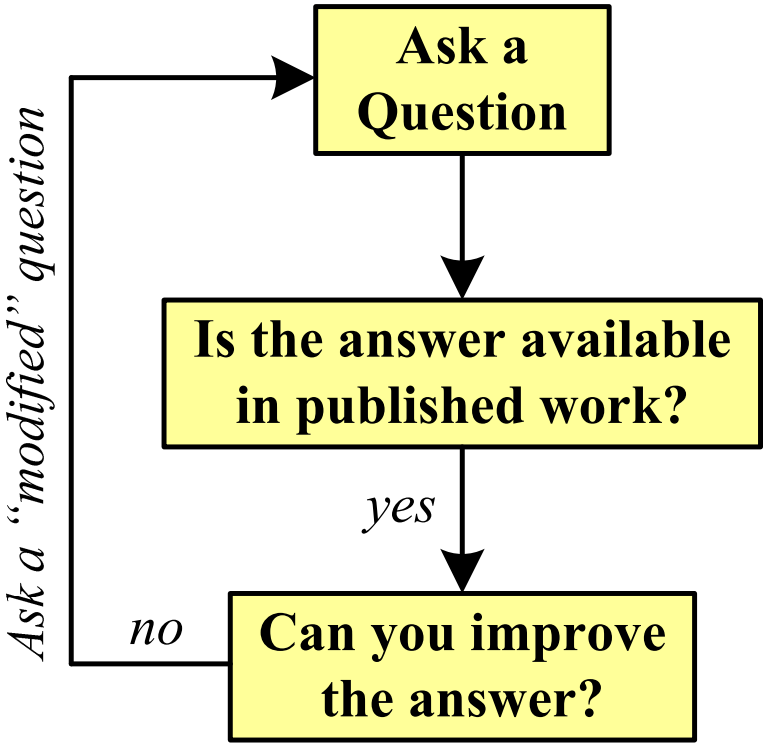

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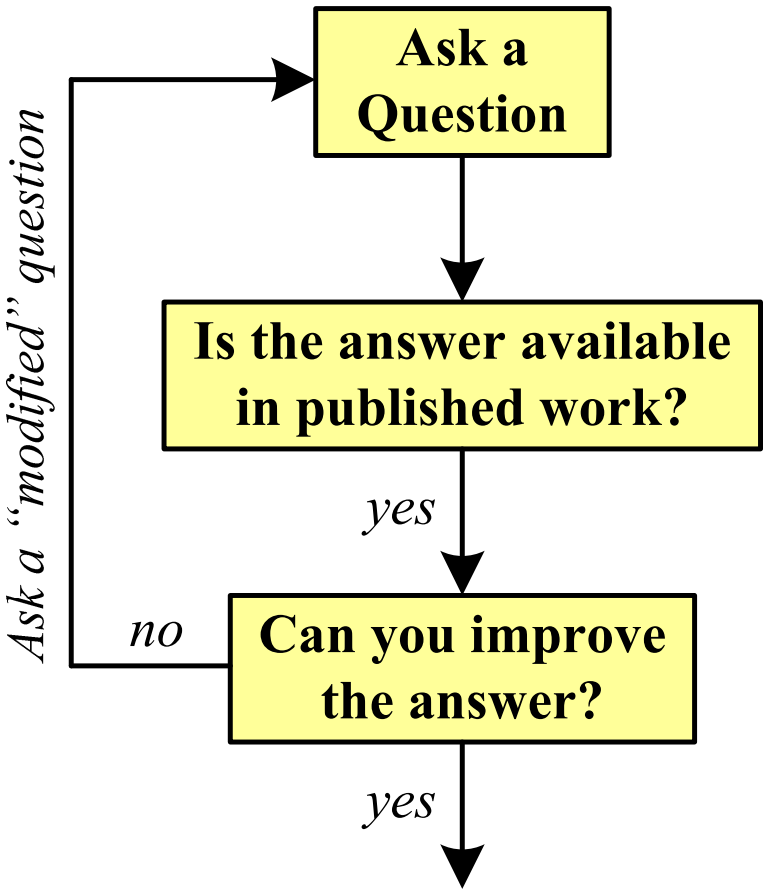

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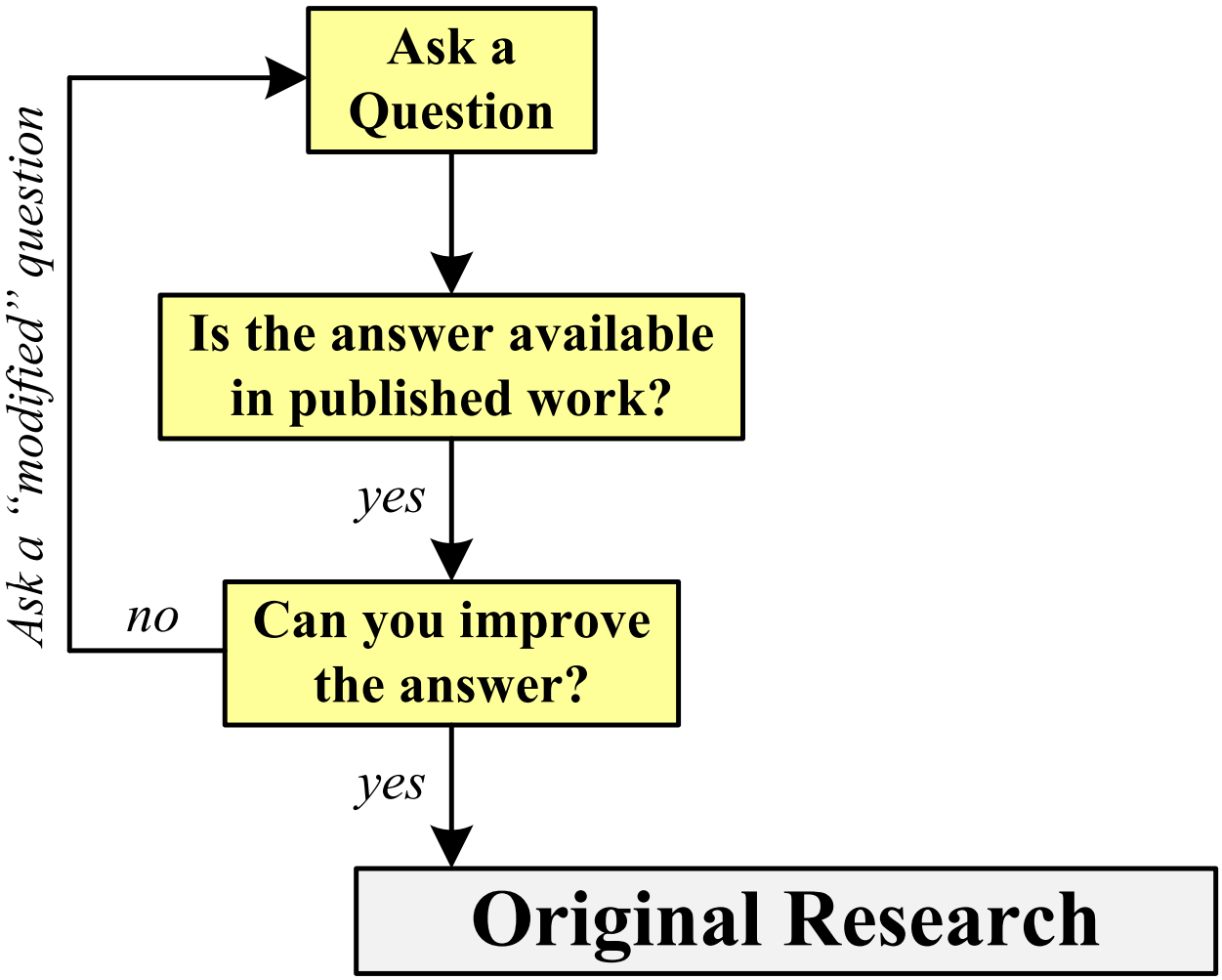

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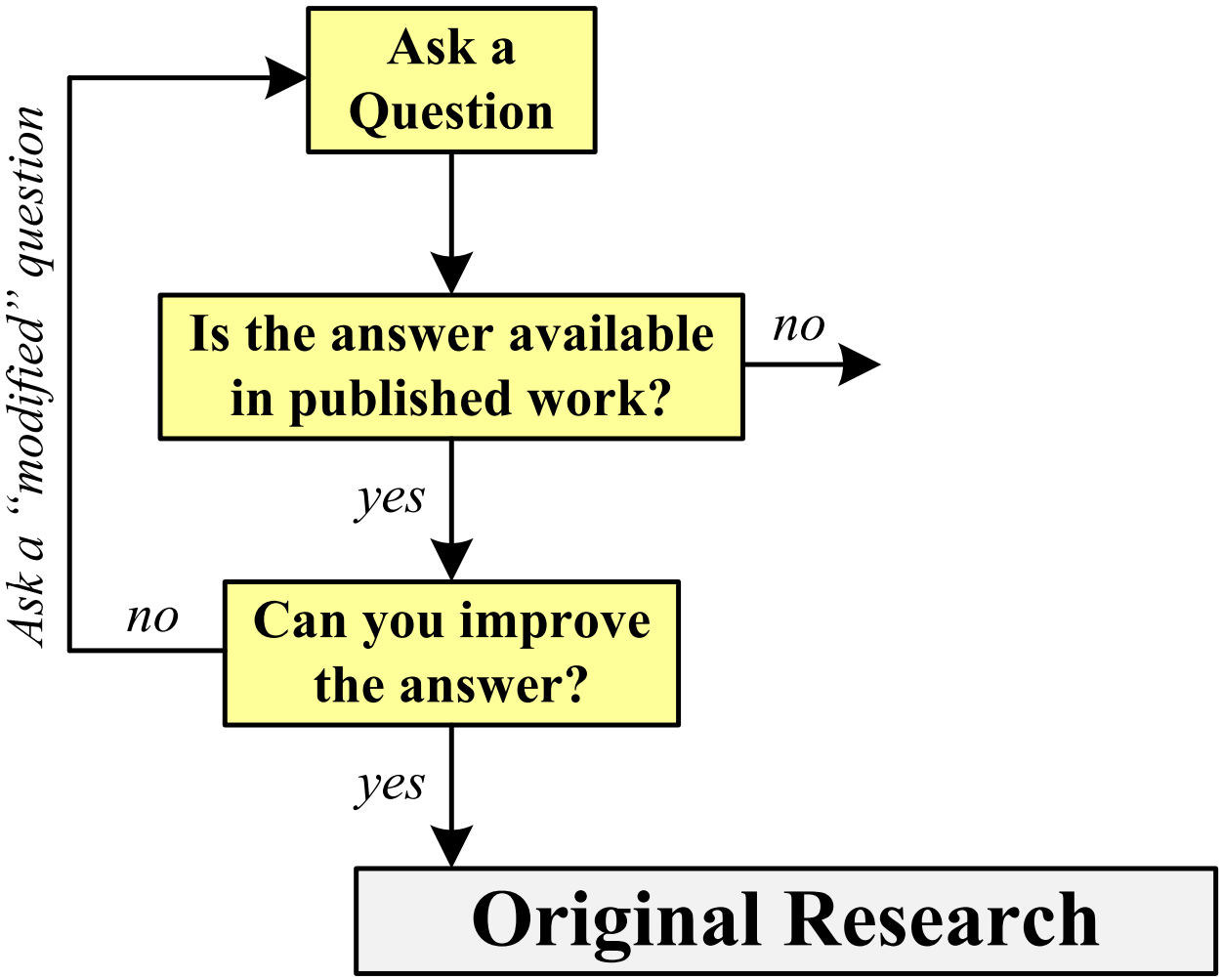

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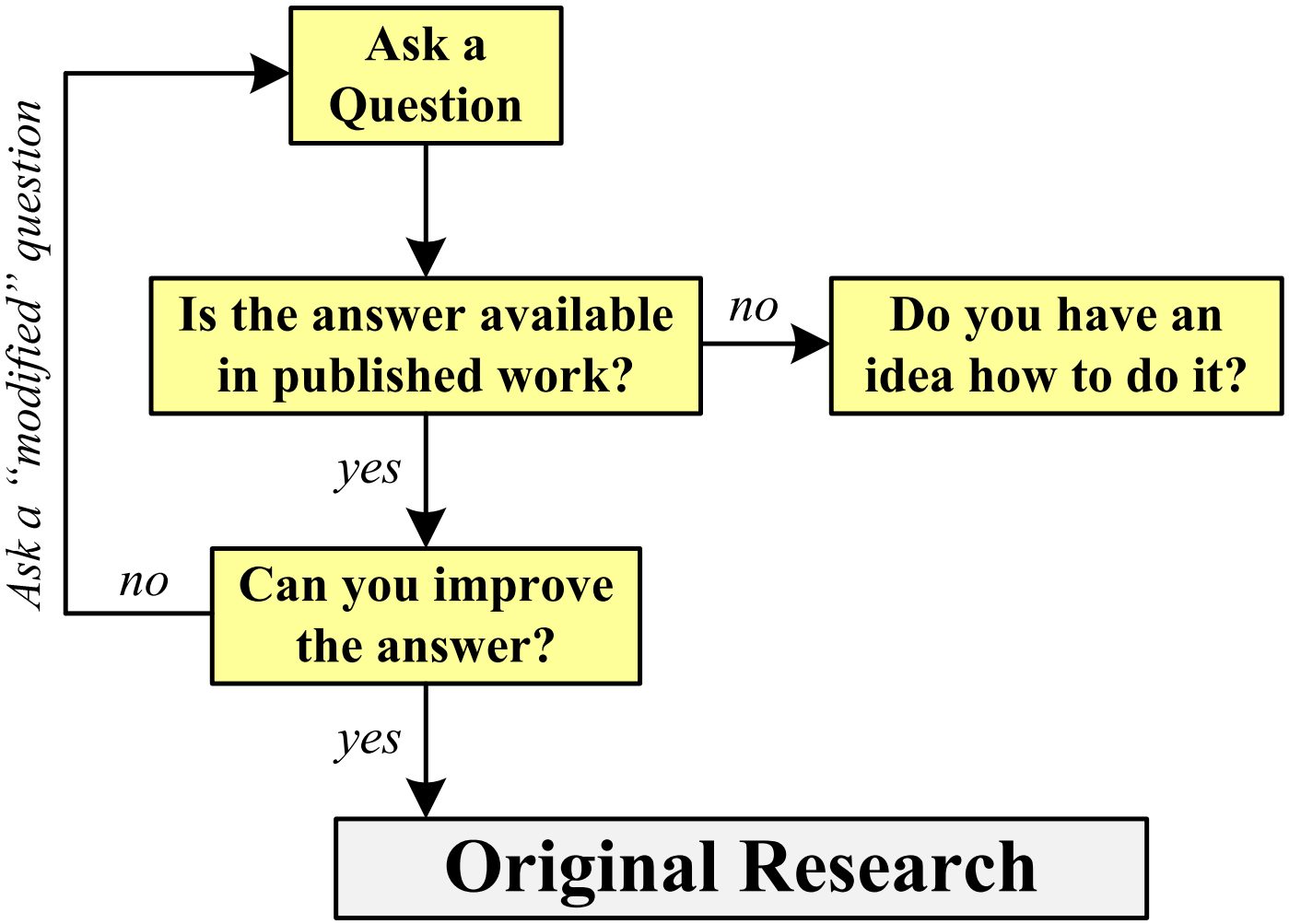

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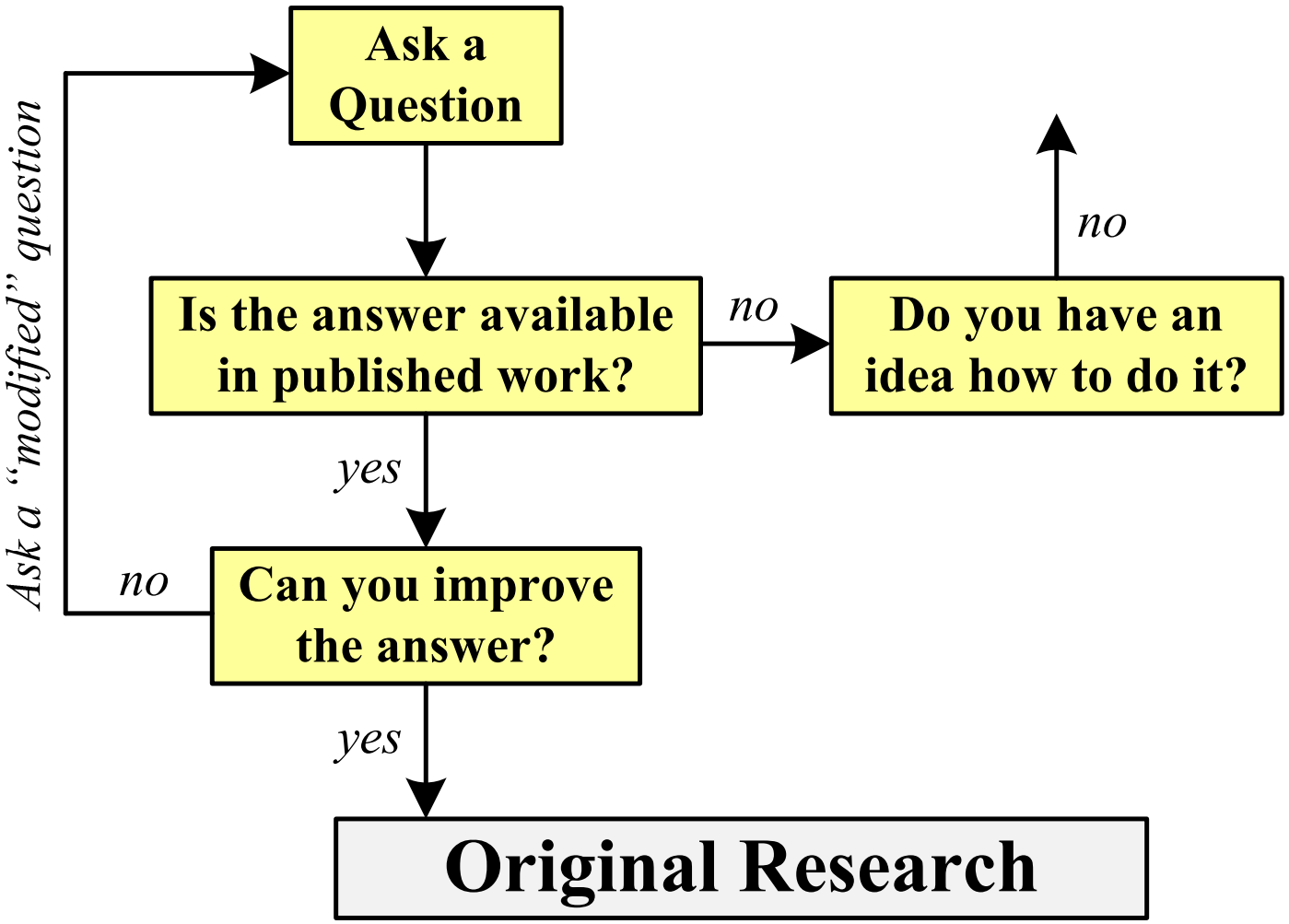

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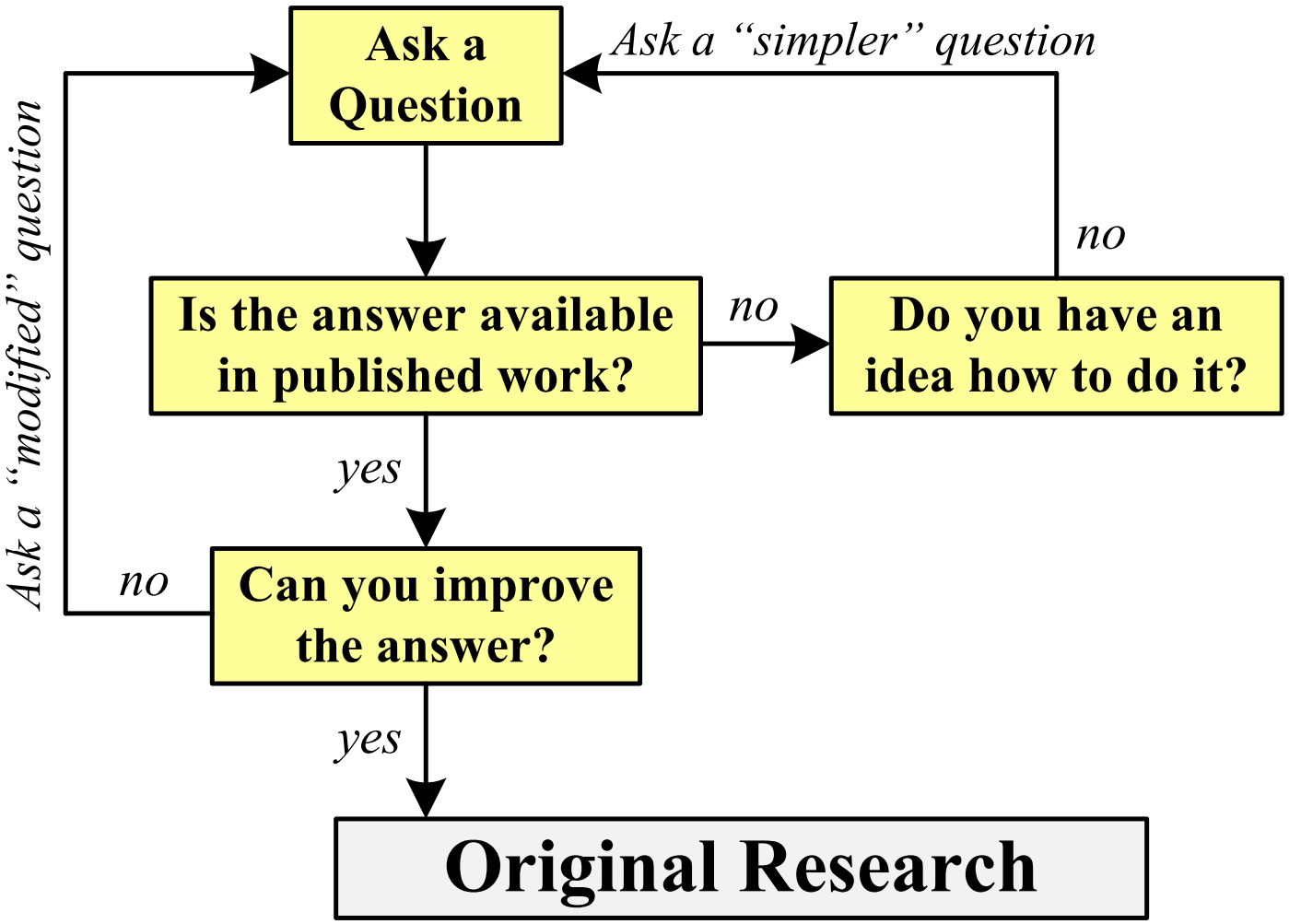

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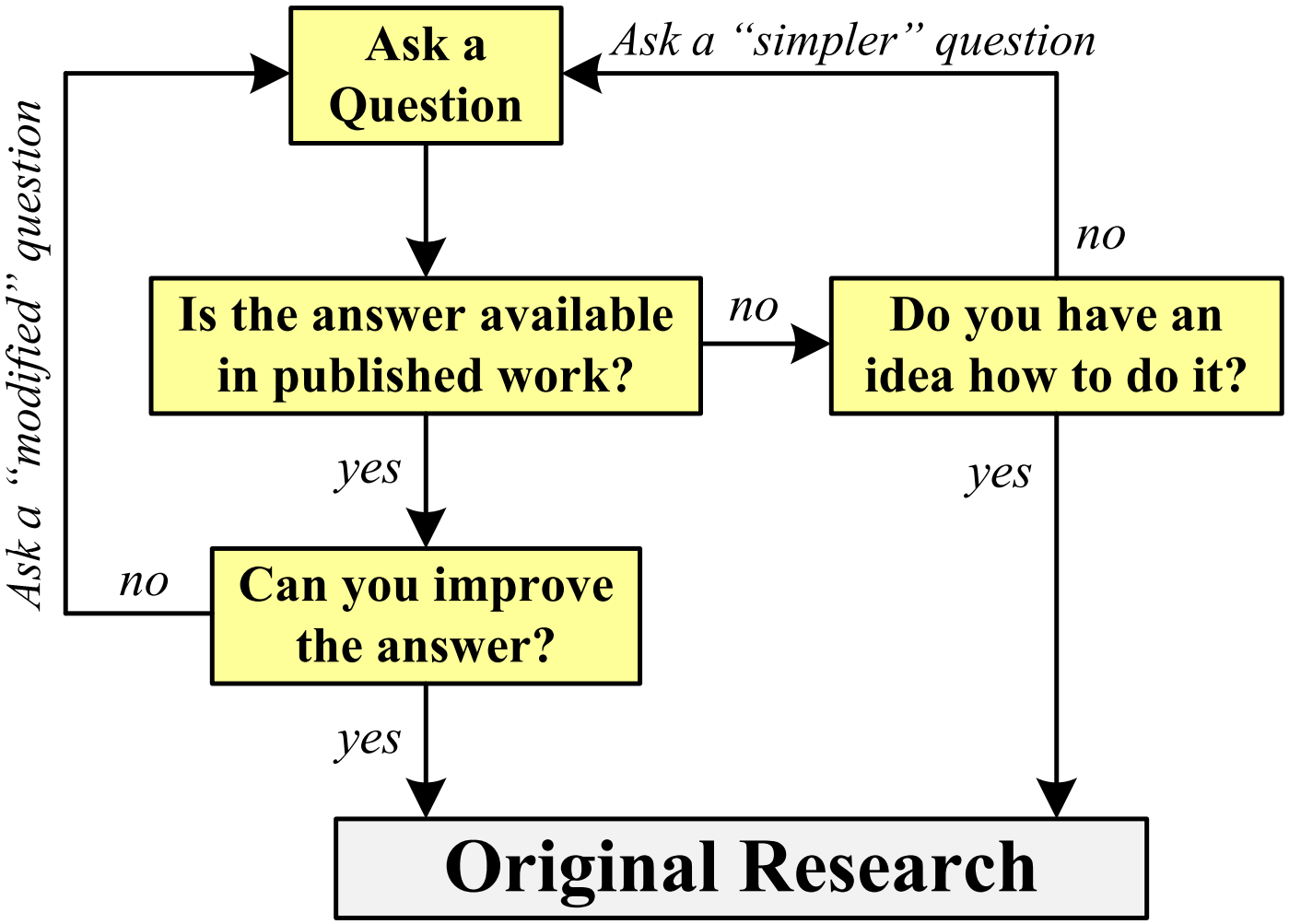

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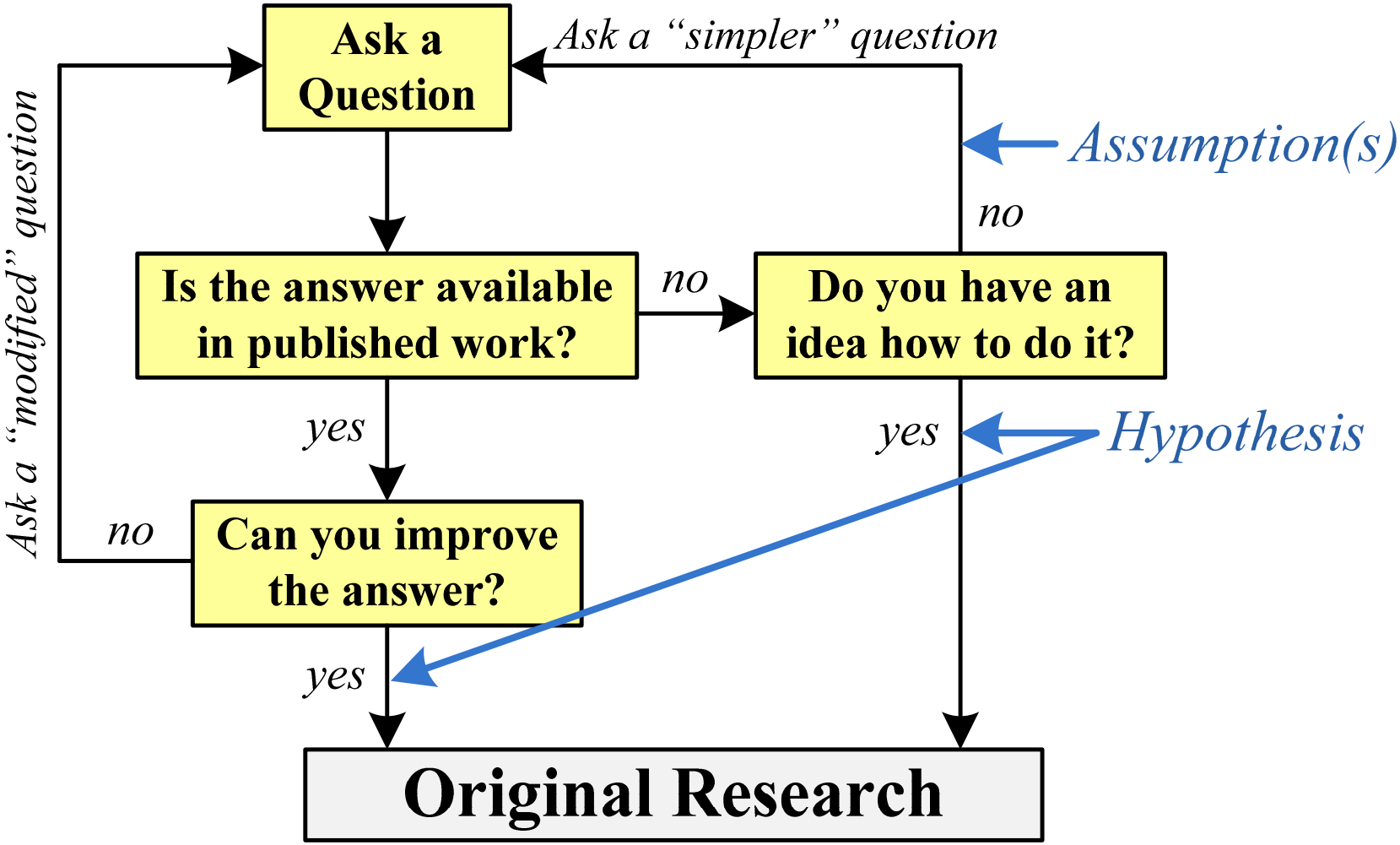

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- 1901 – 1954
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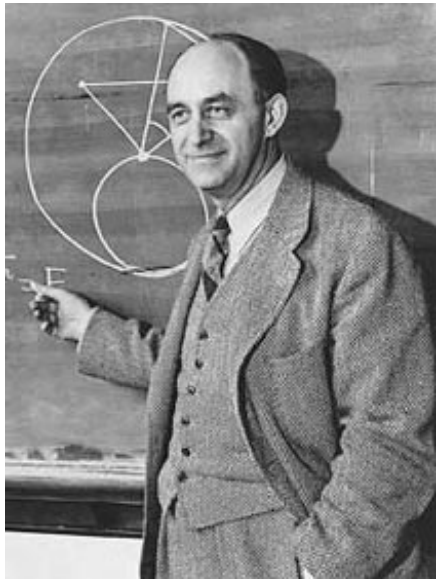

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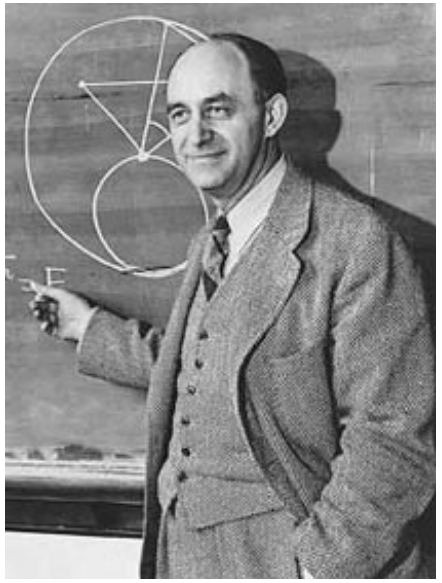

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- “*there are two possible outcomes: if the result confirms the hypothesis, then you’ve made a* ***measurement****. If the result is contrary to the hypothesis, then you’ve made a* ***discovery***”

What is Research? …

- Thus, Engineering Research is either:

- We Can Improve a known idea

OR

- We have a new idea all together

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- Otherwise, *generic* courses are recommended!

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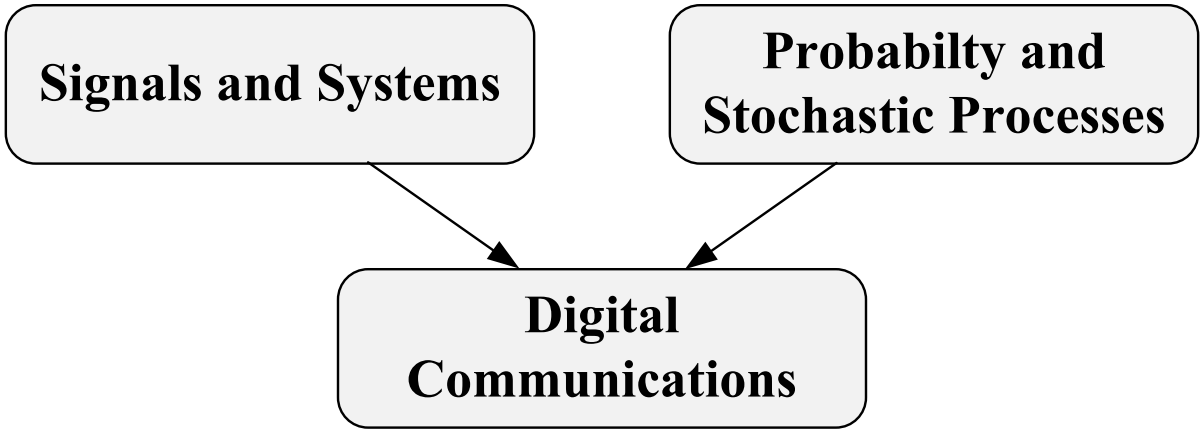

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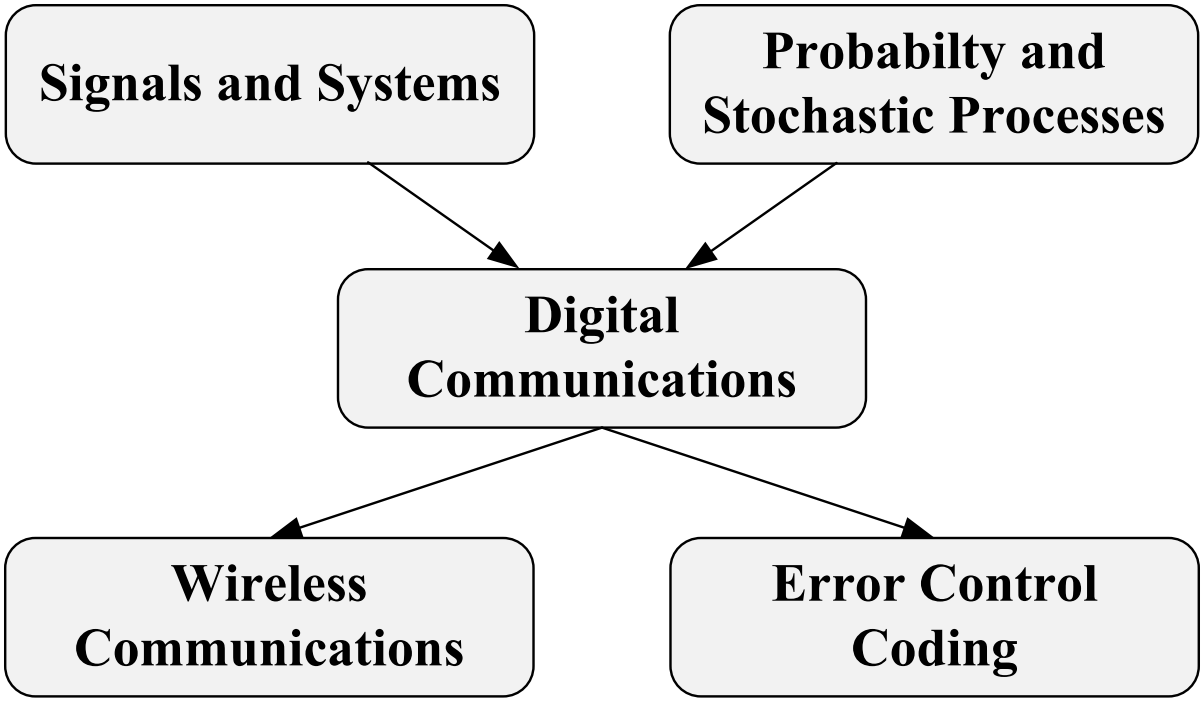

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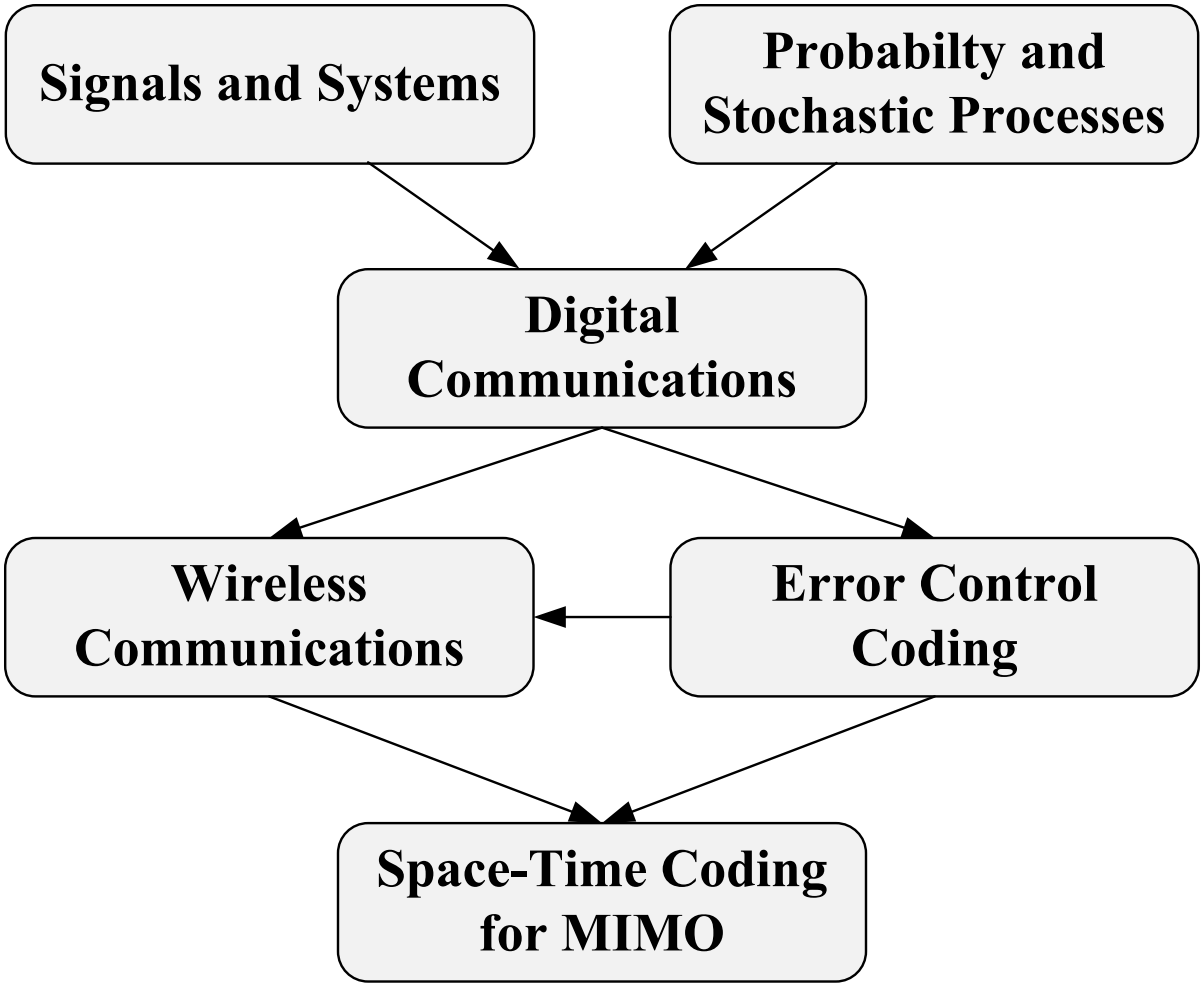

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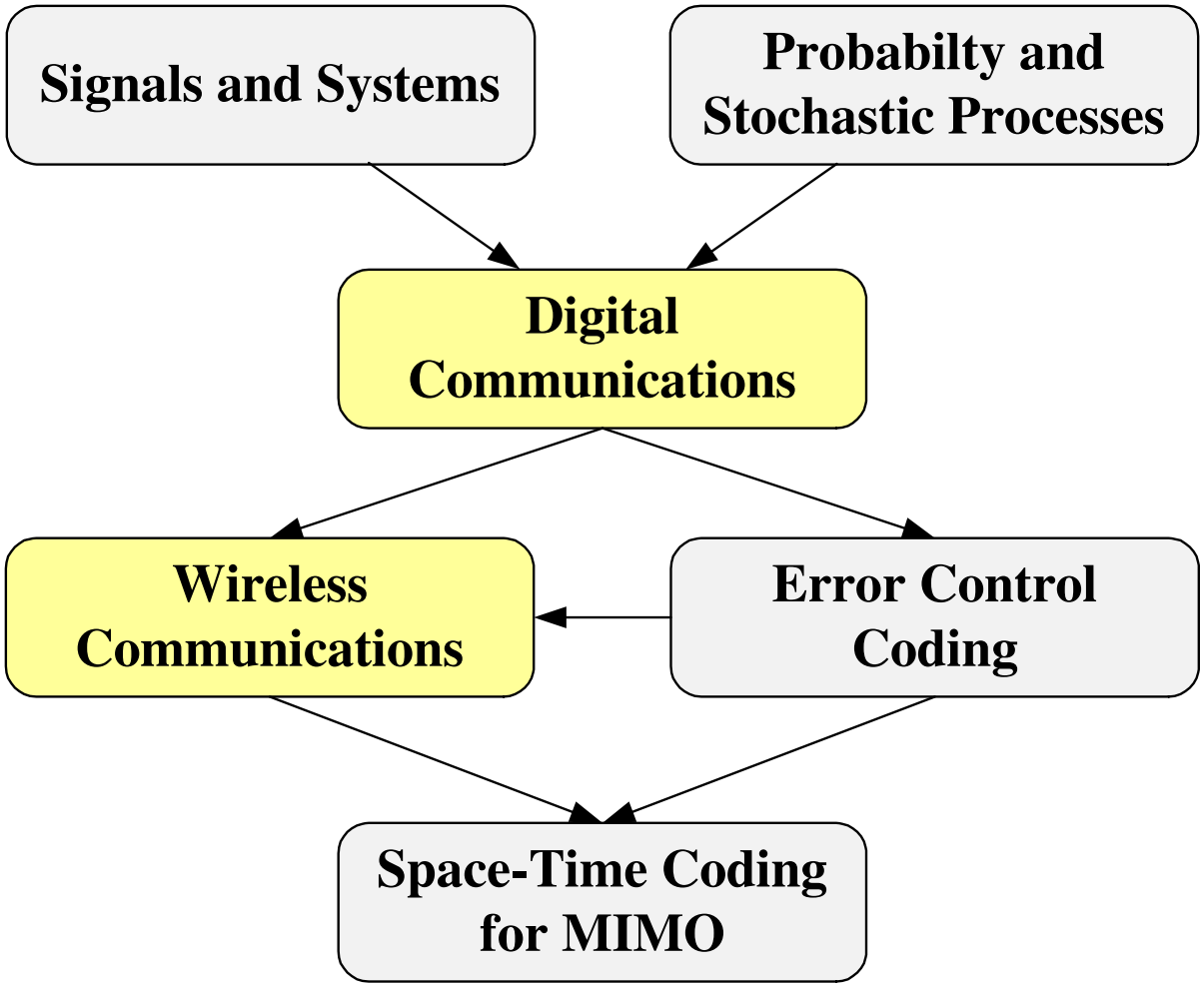

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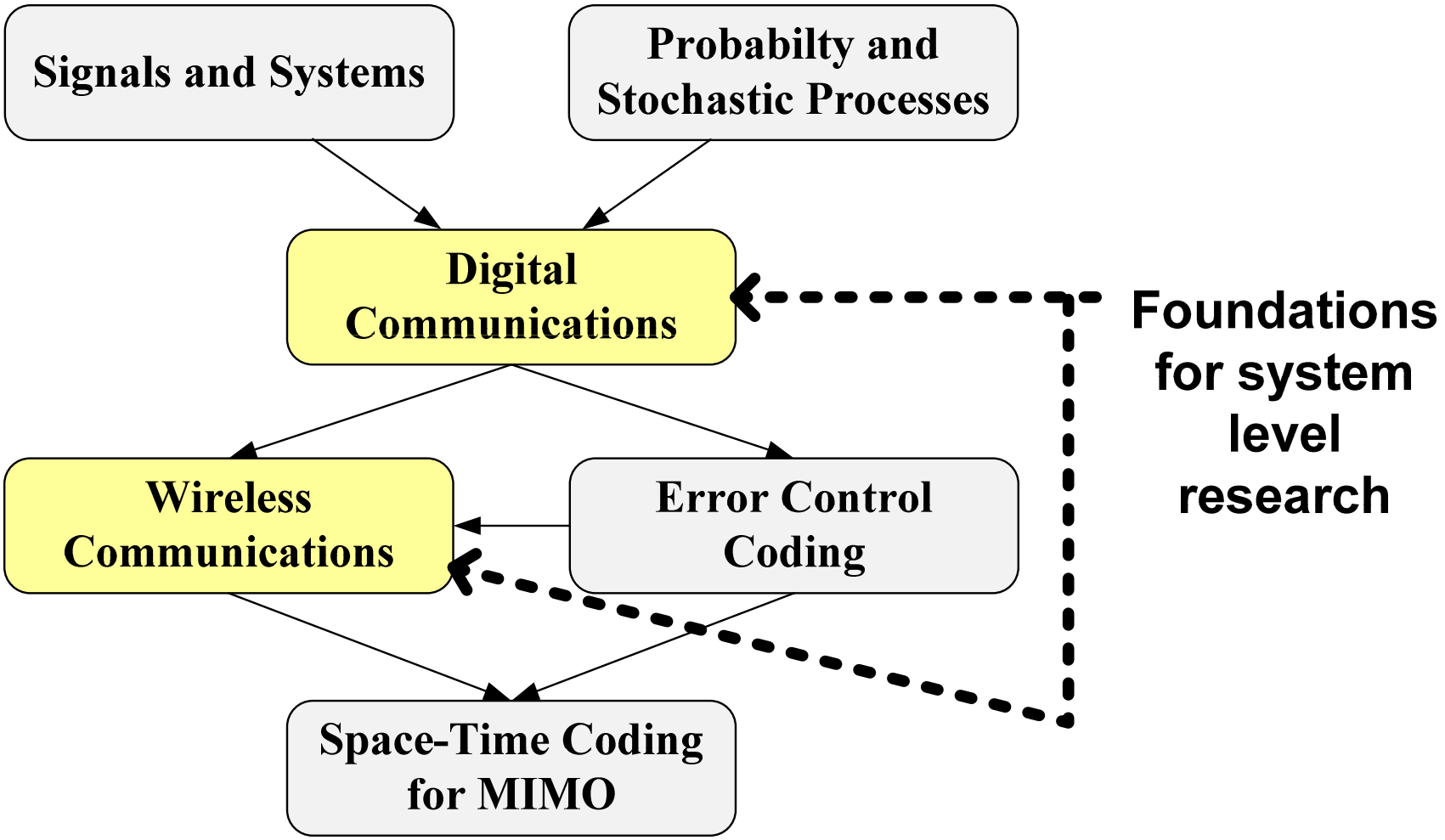

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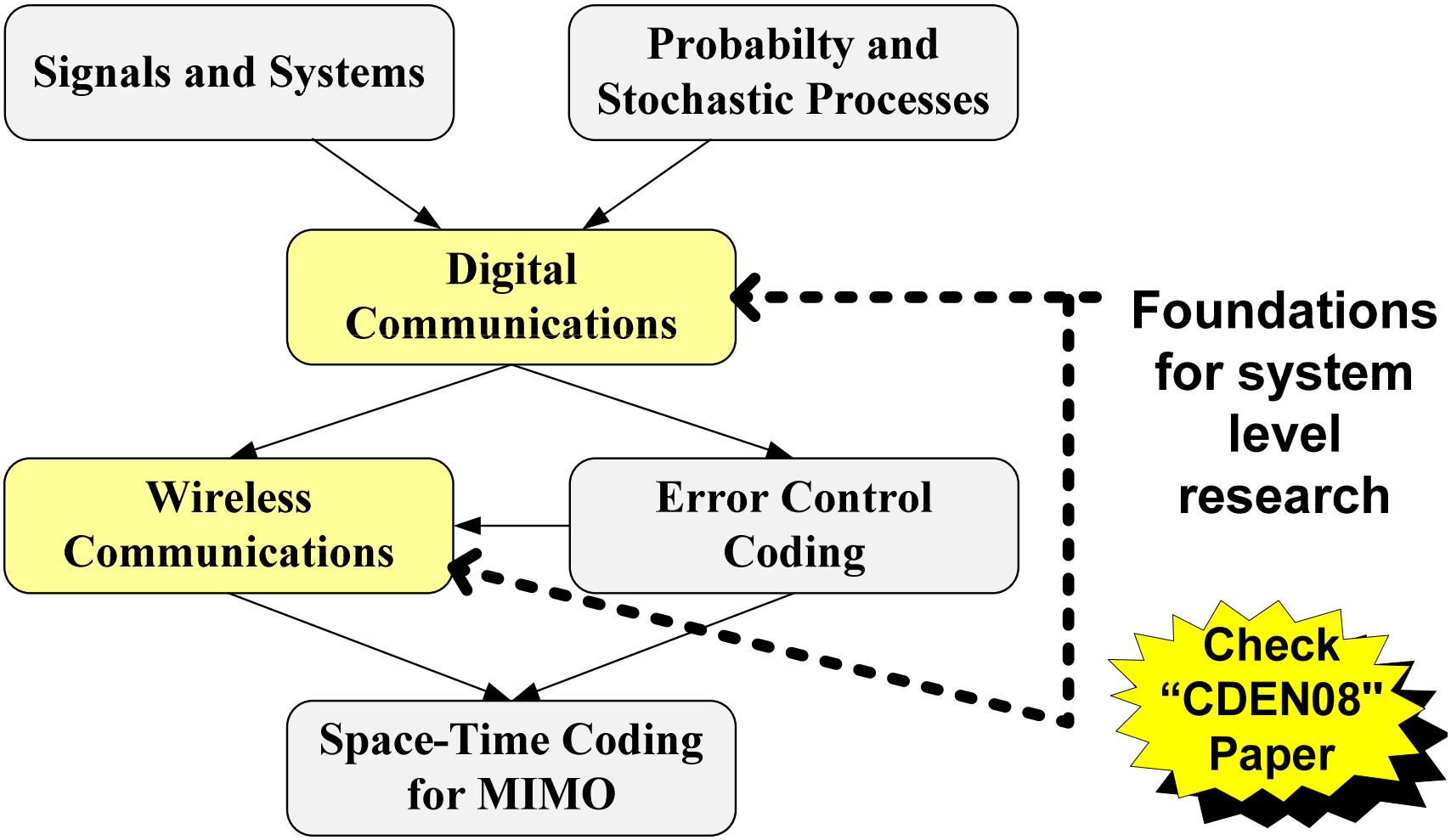

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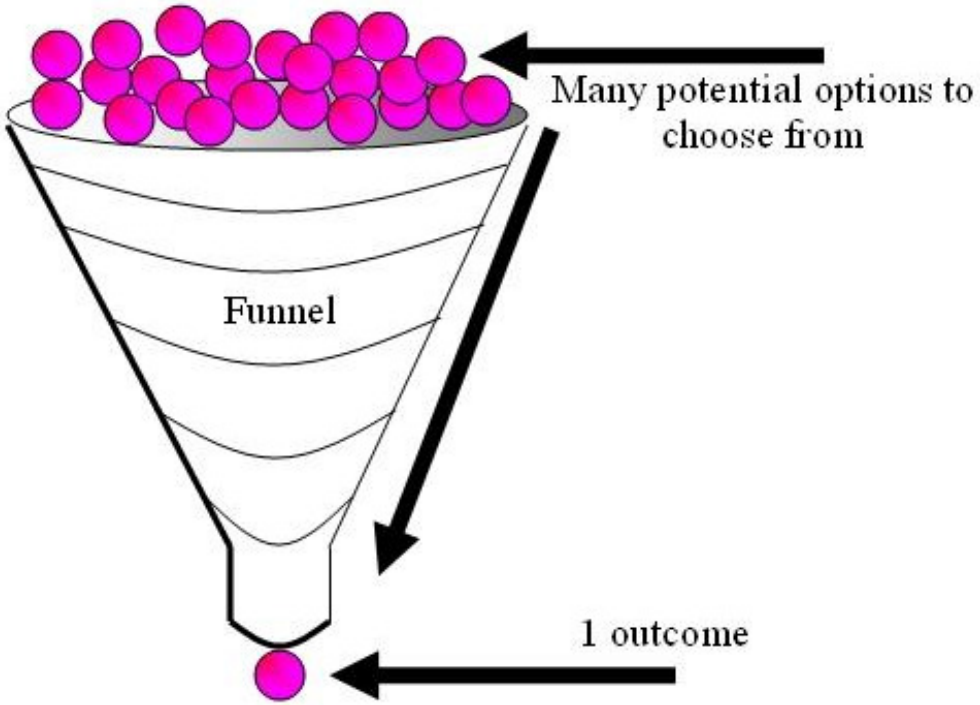
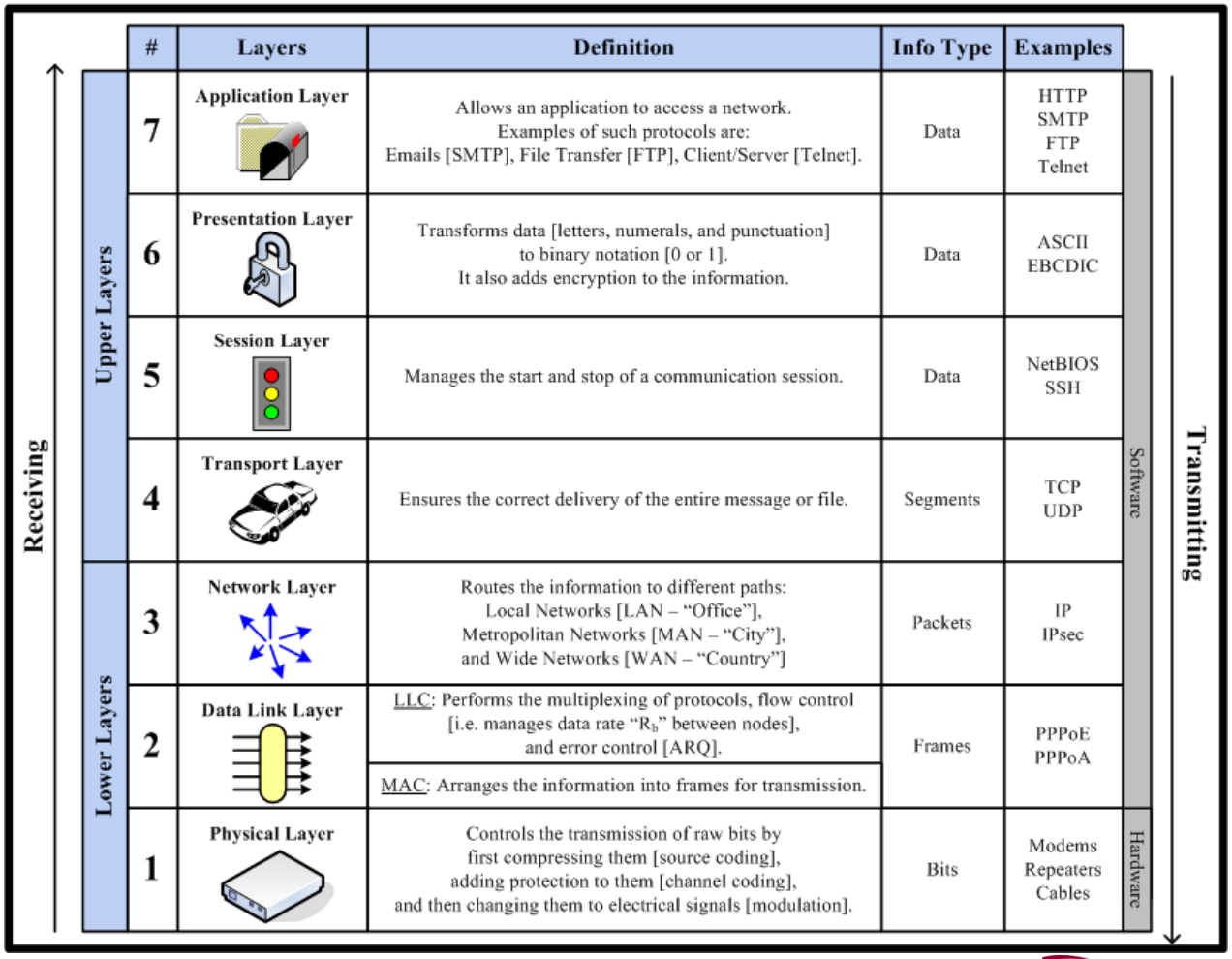


Getting a Research Idea …

- How to start this “big-picture” method?
- Find a: - Classification
  - Categorization
  - Dichotomy
  - Taxonomy
- In Telecom:
  - OSI Model
  - Standards
  - Channels, …

Getting a Research Idea …

OSI Model



#	Layers	Definition	Info Type	Examples	
7	Application Layer	Allows an application to access a network. Examples of such protocols are: Emails [SMTP], File Transfer [FTP], Client/Server [Telnet].	Data	HTTP SMTP FTP Telnet	Software
6	Presentation Layer	Transforms data [letters, numerals, and punctuation] to binary notation [0 or 1]. It also adds encryption to the information.	Data	ASCII EBCDIC	Software
5	Session Layer	Manages the start and stop of a communication session.	Data	NetBIOS SSH	Software
4	Transport Layer	Ensures the correct delivery of the entire message or file.	Segments	TCP UDP	Software
3	Network Layer	Routes the information to different paths: Local Networks [LAN – "Office"], Metropolitan Networks [MAN – "City"], and Wide Networks [WAN – "Country"]	Packets	IP IPsec	Software
2	Data Link Layer	LLC: Performs the multiplexing of protocols, flow control [i.e. manages data rate "R_b" between nodes], and error control [ARQ].	Frames	PPPoE PPPoA	Software
		MAC: Arranges the information into frames for transmission.			
1	Physical Layer	Controls the transmission of raw bits by first compressing them [source coding], adding protection to them [channel coding], and then changing them to electrical signals [modulation].	Bits	Modems Repeaters Cables	Hardware

Upper Layers / Lower Layers

Receiving ↑ Transmitting ↓

Getting a Research Idea …

Standards

Network	Technology Name	Standard
WPAN (~10+ m)	ZigBee – 2003	IEEE 802.15.4
	NFC – 2004	ECMA-340 ISO-18092
	RFID – 2003	ISO-18000-2 [LF] ISO-18000-3 [HF] ISO-18000-6 [UHF]
	Bluetooth – 1998	IEEE 802.15.1
	Infrared – 1993	IrDA
	UWB – 2002	ECMA-368 ISO-26907
WLAN (~30+ m)	Wi-Fi – 1999	IEEE 802.11a
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Parameters

Specifications of Wireless Systems
Systems Range [m]
Mobility of a Device [km/hr]
LOS Requirements [LOS, WLOS, NLOS]
Transmission Power [W] or PSD [W/Hz]
License Requirements [free or not?]
Operating Frequency [Hz]
Detection Method [coherent or not?]
Modulation Scheme [ASK, PSK, QAM, FSK, OFDM, ...]
Data Rate [bps]
Overall Bandwidth [Hz]
Number of Channels [#]
Channel Bandwidth [Hz]
Multiple Access Scheme [TDMA, FDMA, CDMA, OFDMA, ...]
Duplexing Method [TDD, FDD]
Performance [BER]
Network Topology [P2P, P2MP, mesh, ...]
Base Station Requirements [yes or no?]
Complexity [computation & hardware]
Acquisition or Synchronization Method
Source Coding [lossy or lossless]
Error Control Coding [BC or CC]
Spatial Diversity [SISO, SIMO, MISO, MIMO]
Cognitive Radio Capability [fixed or dynamic radio?]
Software Defined Radio [supported or not?]
IP Availability [yes or no?]

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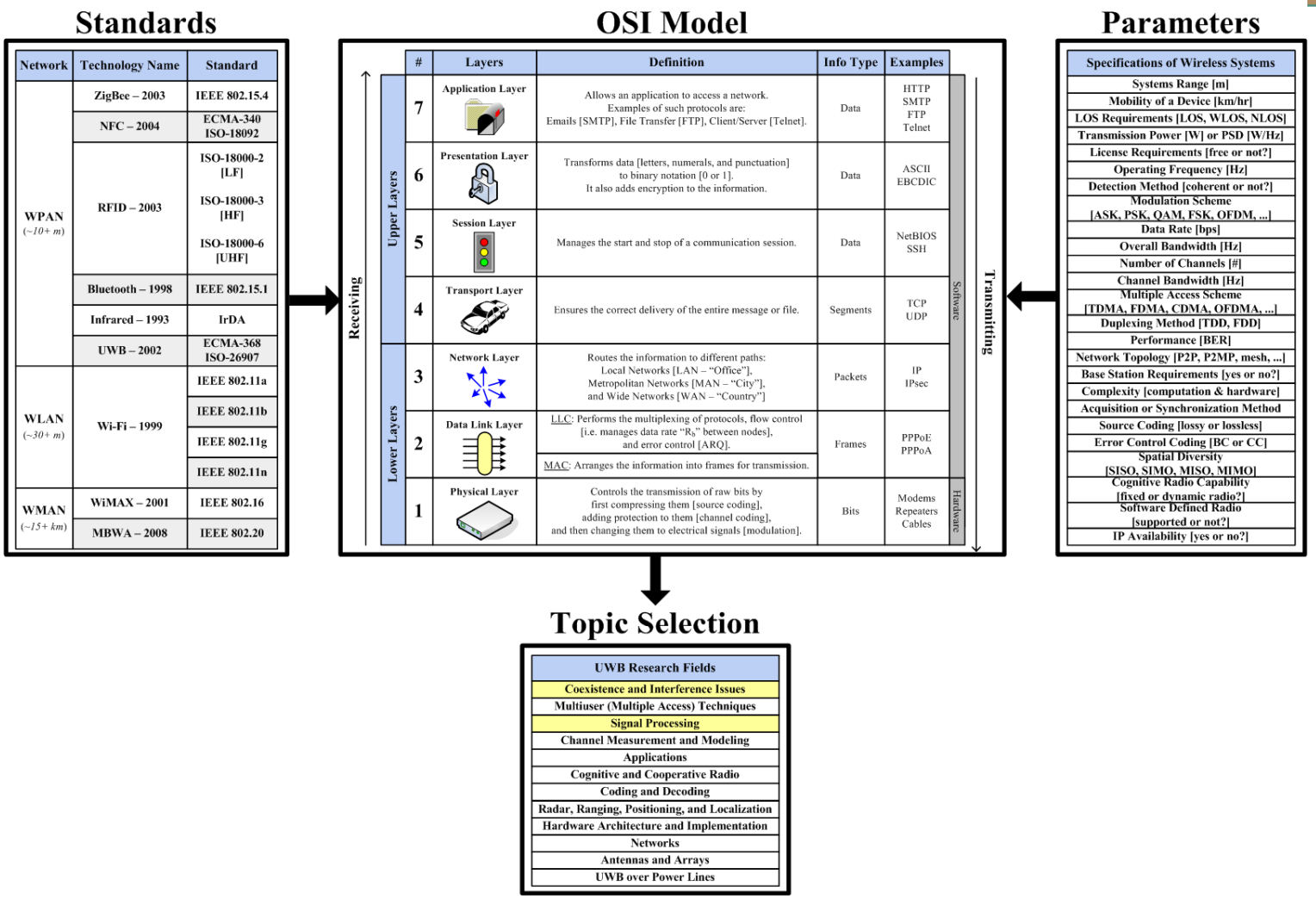
Topic Selection

UWB Research Fields
Coexistence and Interference Issues
Multiuser (Multiple Access) Techniques
Signal Processing
Channel Measurement and Modeling
Applications
Cognitive and Cooperative Radio
Coding and Decoding
Radar, Ranging, Positioning, and Localization
Hardware Architecture and Implementation
Networks
Antennas and Arrays
UWB over Power Lines

Getting a Research Idea …



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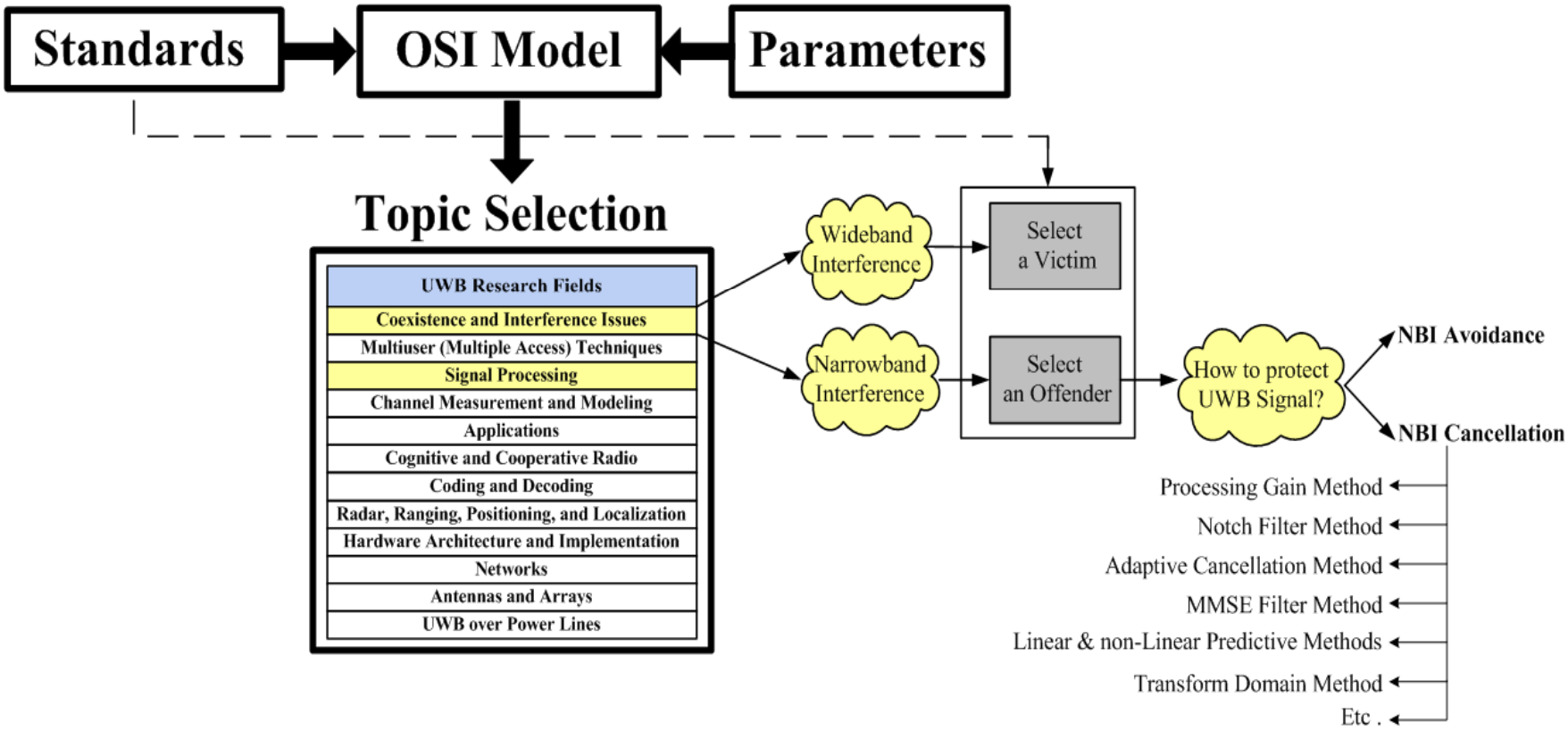

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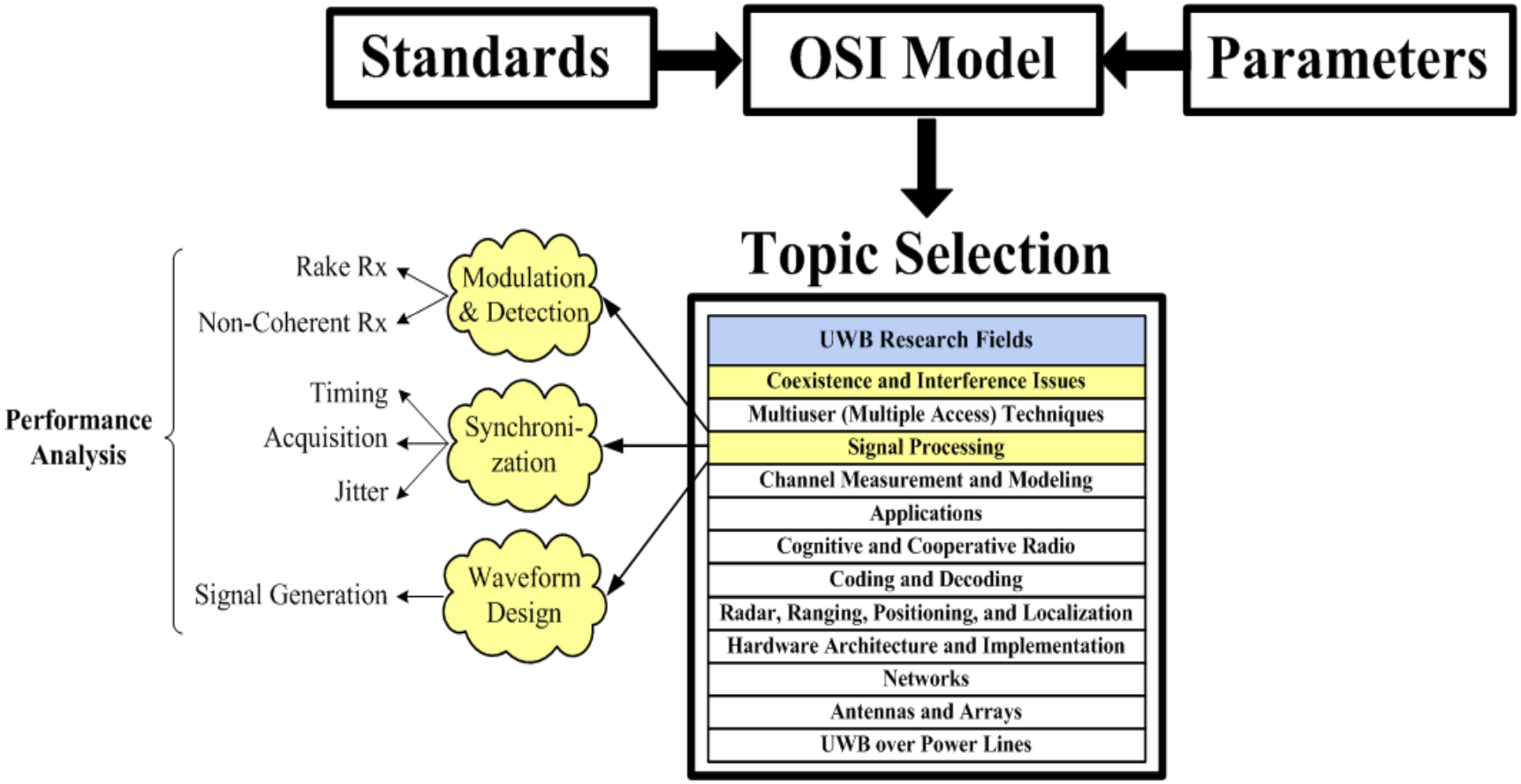


Getting a Research Idea …

- Why was our model based on “Standards” or “Systems” [e.g. Wi-Fi, WiMAX, UWB]?

  - To ensure practicality
  - Provides answers to current needs
  - Benefits are more obvious
  - More tangible

- Though, this need not be the case!!

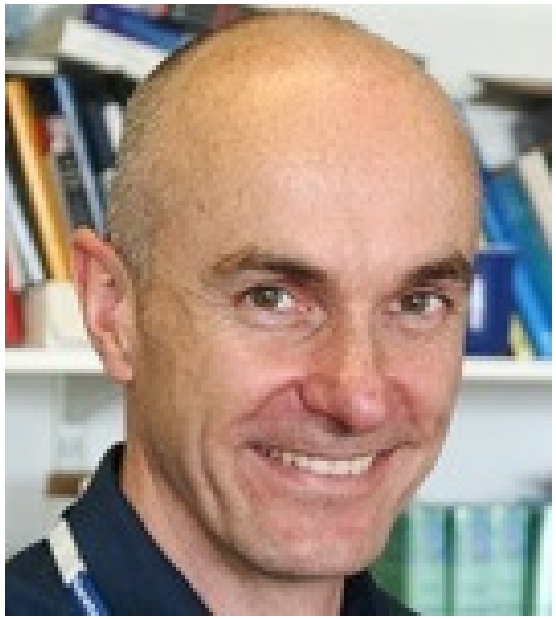
Getting a Research Idea …

- Prof. Robert Gallager
- PhD Thesis in 1963:
  "Low Density Parity Check" (LDPC) Codes

Massachusetts Institute of Technology

Getting a Research Idea …

- Gallager's code was forgotten!
- 1996 rediscovered by: Prof. David MacKay
- Took over 30yrs !!!



UNIVERSITY OF CAMBRIDGE

Getting a Research Idea …

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  - Connects the sub-fields together
  - Research extensions becomes more evident
  - Bridges the gap during collaborations

Getting a Research Idea …

- Other Methods?

  - Monitor new publications.
  - Check what others read: Top-100, Top-10

Top 100 Documents Accessed: June 2009

ComSoc Top Ten

The May 2009 list of the ten most popular articles on PDF views through IEEE Xplore:

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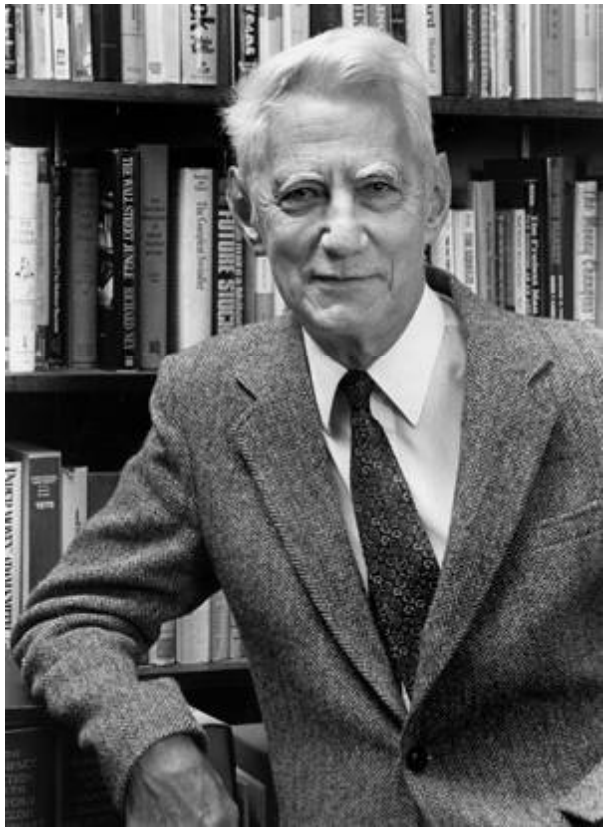
- [ ] Conclusion

How to Search?

- Claude Shannon
- Father of:
  "Information Theory"
- 1948:
- "A Mathematical Theory of Communication "
- Over 50 years of Digital Communications!!



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- Body of knowledge has increased a lot!
- But we have “Search Engines”:

How to Search? …

- Good Tools:

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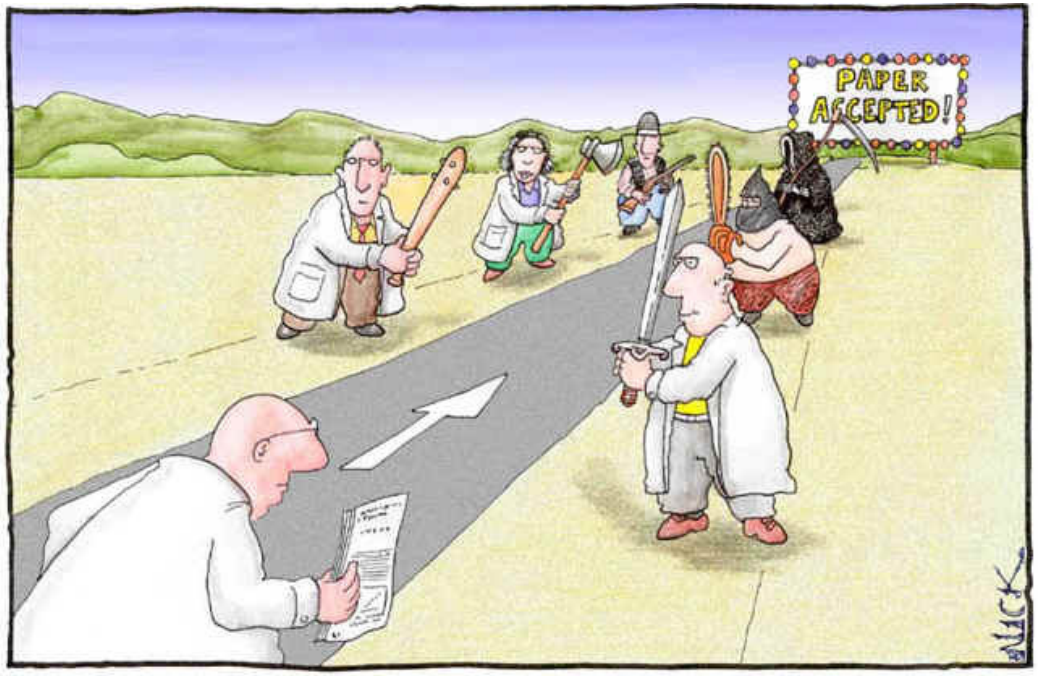
A Metric for Research

- Most common metric of worthiness:

  "***What peers think of the proposed work?***"

  "***accept***" OR "***correct***" OR "***reject***"



A Metric for Research …

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- Any other measures???

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- Impact Factor (IF) → "Journals"

$$IF = \frac{No.\ of\ \ Times\ a\ Paper\ \ is\ Cited}{No.\ of\ \ Papers\ Published}$$

A Metric for Research …

Conference Proceedings	
Names	**AR**
InfoCom	*~ 20 %*
MSWiM	*20 ~ 25 %*
ICC	*~ 35 %*
CAMAD	*~ 35 %*
MobiWac	*~ 35 %*
CCNC	*~ 35 %*
GLOBECOM	*35 ~ 40 %*
PIMRC	*~ 43 %*
WCNC	*~ 45 %*
VTC	*~ 45 %*

Journals and Magazines – 2006/2007	
Names	IF
IEEE/ACM Transactions on Networking	*1.789 | 1.831*
IEEE Journal on Selected Areas in Communications	*1.816 | 1.799*
IEEE Communications Magazine	*1.678 | 1.704*
IEEE Transactions on Network and Service Management	*2.211 | 1.609*
IEEE Transactions on Communications	*1.208 | 1.302*
IEEE Transactions on Wireless Communications	*1.184 | 1.234*
IEEE Communications Letters	*0.684 | 0.869*

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Main Advantage →

A Metric for Research …

- ISPR – International Symposium on Peer Reviewing

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- Their Objective:

  *"**apply peer review to current peer reviewing methodologies**"*

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Conclusion

- Can Research be Taught?
- YES
- There are important aspect to research that could be acquired.
- These aspects should "***facilitate*** *or* ***catalyze*** *original contributions*"
- We showed how it can be done:
  - Coherently
  - Systematically
  - And demonstrated a possible framework

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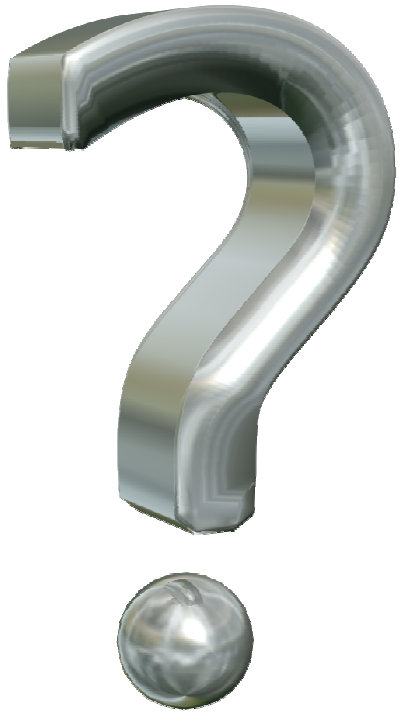
Any Questions!

"Sometimes questions are more important than answers."

– Nancy Willard, Ph.D.



THANK YOU!! ☺