



# Theory Building with Big Data-Driven Research

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# Background for research agenda

Growth of Big Data (Velocity, Volume, Variety, Veracity, Value)

Growing access to Big Data and Computational Resources by researchers

Growth in big data driven research

Loss of focus in theory building in IS

Lack of generalizability and explainability

Very easily falsifiable, will not stand the test of time

Past has passed: Will not explain the future

## Focus of talk

- ☐ Moving away from “What” to the “Why”
- ☐ Introduce greater trust on the findings through methodological rigor

# Being topical vs repute of building blocks...

- In order to succeed, a topic must be
  - **Timely, Relevant** and **Novel**
- A study is evaluated by editors from three views:
  - **Generalizability, Rigour** and **Relevance** of contribution

A **Good Study** must have a **Good Theoretical Contribution**

- ✓ Just adding references to prior art is not theory, but helps to build theory
- ✓ Data and analysis used to validate the same theoretical model across different contexts (geography/time) is not good theoretical contribution
- ✓ The theory should explain a small slice of a phenomenon or relationships among concepts (constructs) which no-one else has explained in a context
- ✓ A good theory should have **uniqueness, parsimony, generalizability, reproducibility, falsifiability, internal consistency** and **stand the test of time**
- ✓ **Method** versus **Domain** dilemma – A detailed look required

# Theory Building - Method vs Domain dilemma

## Methodological Contribution

- Algorithm development / integration (What)
- Experimentation & cross-validation
- Mathematical validation (lemma etc)
- Context Specificity of Methods vs Data type
- Boundary conditions
- Methodological rigour in data analysis more for inferences about method

## Domain Contribution

- Predictive Inferential model (Why)
- Explaining new linkages between theory
- Empirical validation mostly
- Understanding paradigms and metaphor fitment (interpretive, radical humanist, functionalist, radical structuralist)
- Multi-method validation (survey, experiments, data science based, etc)
- Methodological rigour in data collection more for inferences about data

# Understanding theory in IS literature

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Data and its description is not theory, literature by itself is not theory, but helps to build it

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Address design, use, impact and interaction of ICT artifacts (e.g. emerging technologies)

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Address domain, socio-political, behavioural, structural or ontological, and epistemological questions

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Analysis within and across entities like individuals, organizations, society and polity

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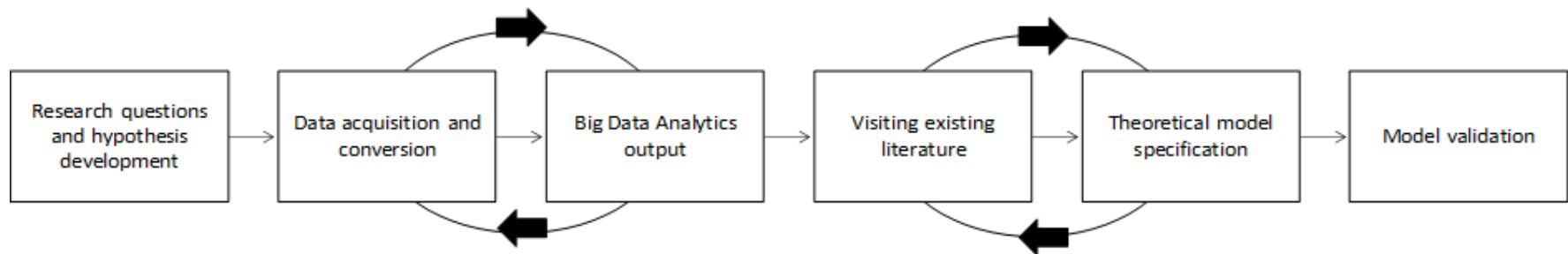
Adopts one or more theoretical lens to extend / contradict existing knowledge

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Explain linkages among constructs / proxy measures to explain the reasons for observations

# Theory Building in IS for Big Data Driven Studies

- Identify literature gap
- Define unit / context of interaction with IT artifacts - individuals, organizations, society, and policy
- Need to develop research questions with hypothesis
- Data and theory needs iterative revisiting
- Model needs statistical validation



# Rethinking research methodology

## Data collection / sampling

- Replicability of research
- Objectivity of identifying samples
- Reducing noise / veracity in big data
- Addressing measurement problem

## Bringing objectivity to constructs

- Reliability (Intercoder reliability, category reliability)
- Validity (Face validity, Concept validity)
- Use of text mining, NLP and network science
- Move beyond association (causality vs reverse causality)

# Theory building using Big Data

## Use of big data methods

- Descriptive analysis of data
- Text mining (Topic modeling, word clouds)
- Network modeling (Association among words, community detection)
- Image mining (high level and low level attributes)
- Video analysis (still nascent stage...)

## Revisit theory

- Identify constructs from literature
- Constructs as proxies to capture concepts
- Ideate on possible dependent variable
- Borrow theory from other related discipline
- Check trust on building blocks



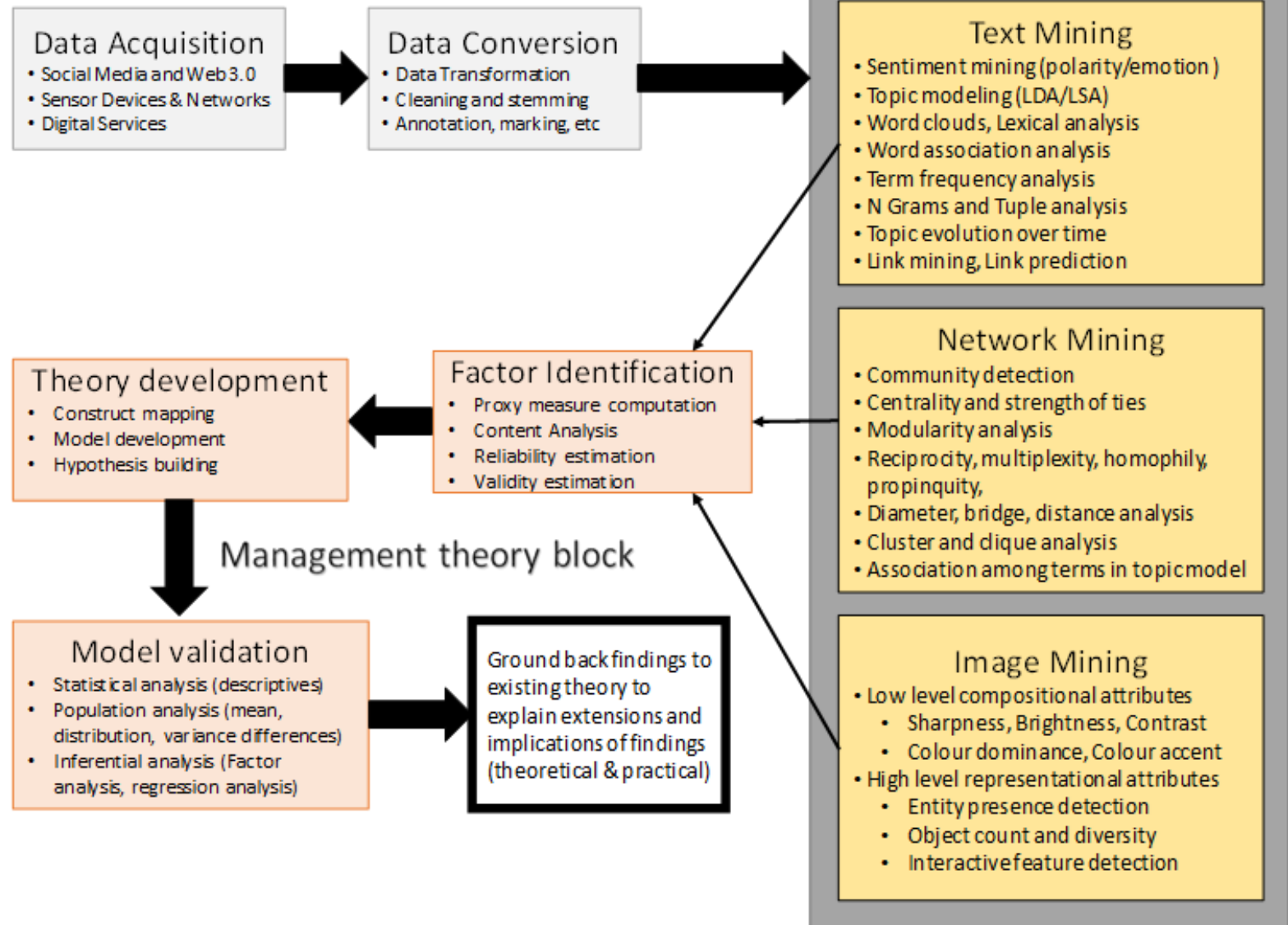
# Model Validation

## Preliminary analysis

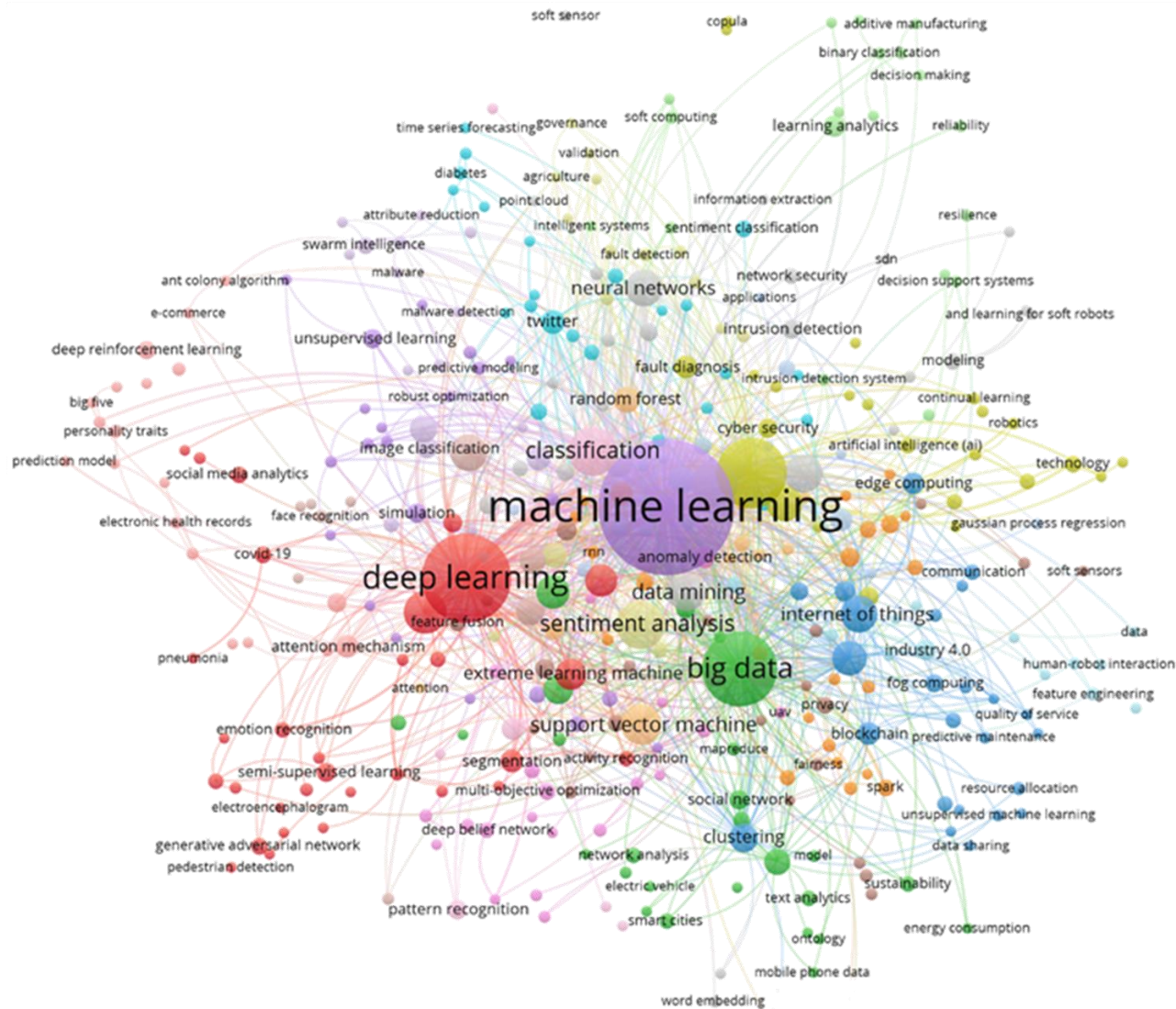
- Differences between groups, units, typologies
- Use of Descriptive Statistics, T Test, ANOVA, etc
- Visualization of unstructured data
- Revisiting theory

## Inferential Analysis

- Dimension reduction (e.g. penalised regression / factor analysis)
- Multiple regression analysis / SEM
- Inferential classification methods (Logistic regression)
- Machine learning and deep learning (non linear relationships)
- Ideate on *replicability*, *explainability*, *fairness* and *transparency*
- Mixed research methods sometime help



## Blowing out the Big Data Analytics Block



So how to make meaning out of this ML

What meaning / information is achievable?

Pattern  
Associations

Clustering

Classification

Regression

Sequence  
mining

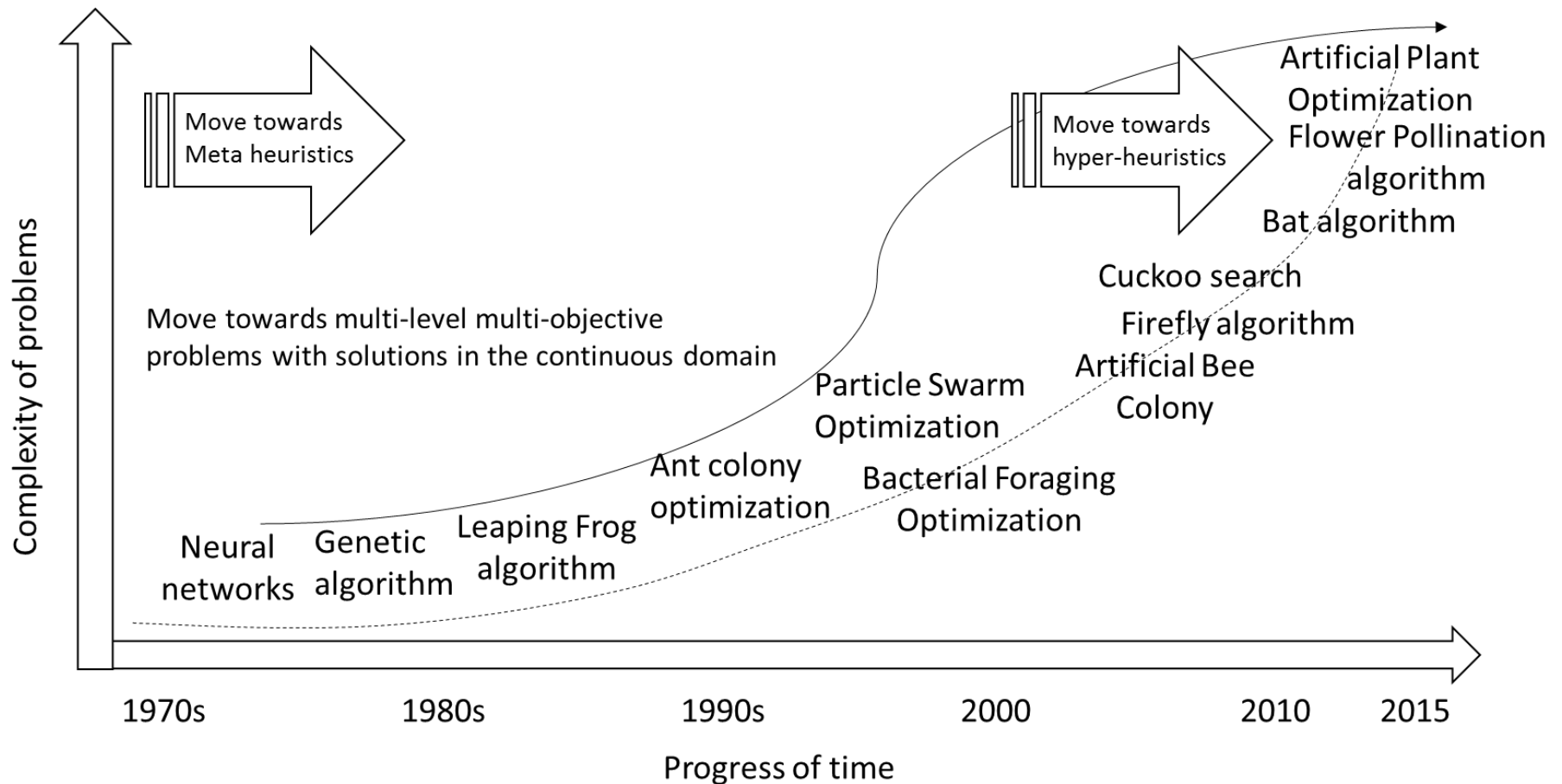
Summarization

Anomaly  
detection

Network mining

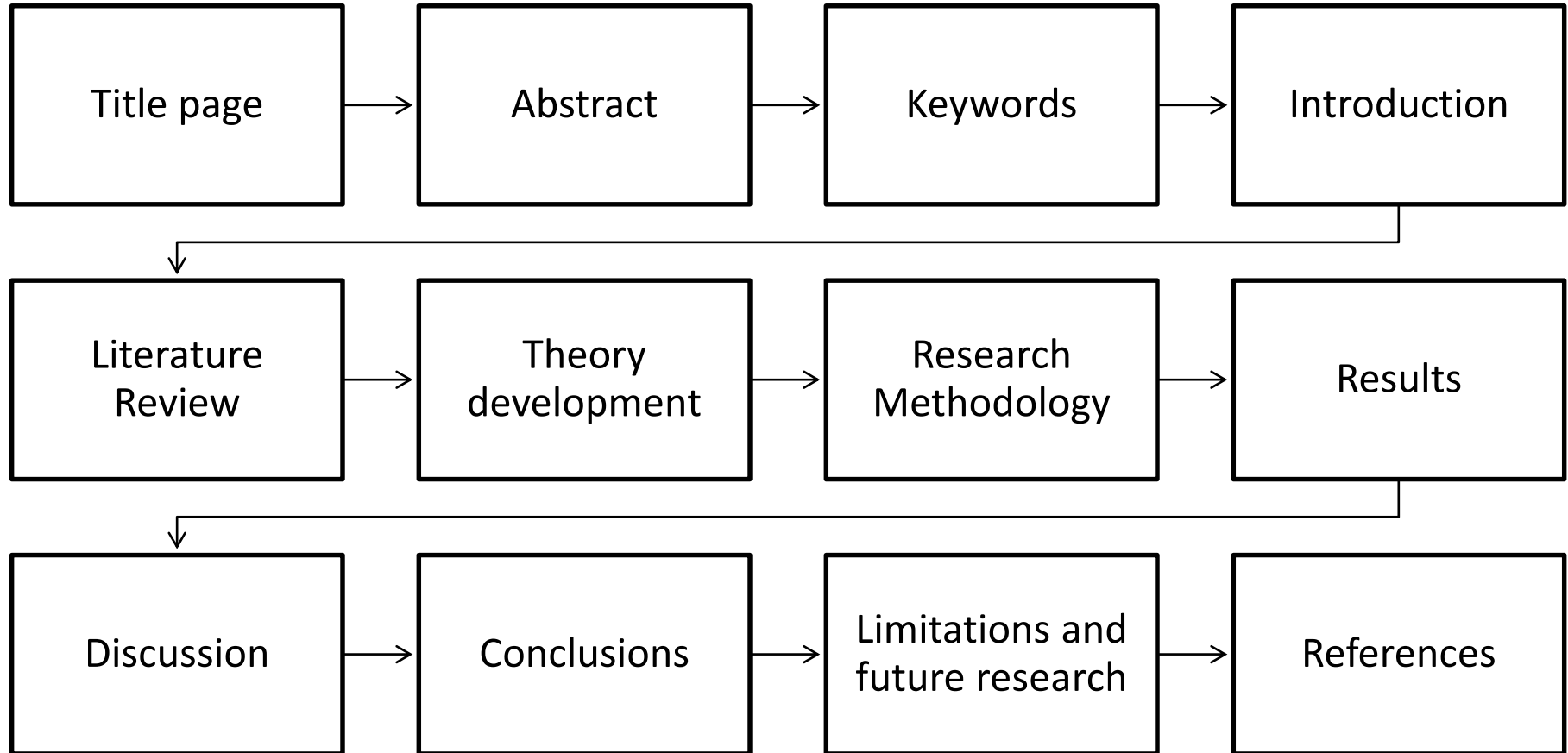
Emergence of  
Bio Inspired Machine Learning

# Machine Learning for Data Analytics



Kar, A.K. (2016). Bio Inspired Computing - A Review of Algorithms and Scope of Applications. Expert Systems With Applications, Vol. 59, pp 20 - 32.

# Ensure article structural compliance



# Ensure you follow each stage

#	FOCUSED OBJECTIVE	POSSIBLE METHODOLOGICAL SOLUTIONS
1	Data acquisition based on “theoretical research questions”	Sampling, keyword, entity and user profile identification. Address data imbalance problems if needed.
2	Handle outliers in data better	Data cleaning, stemming, sub-sampling
3	Improve validity of measures	Qualitative intervention and inputs of subject matter experts may be required. FGDs and field experiments may help.
4	Improve reliability of measures	Reporting inter-coder reliability and category reliability for content analysis type approaches.
5	Use computationally derived measures from data in inferential model	More than one measure is a better proxy for constructs identified from literature. Hypothesis building is very important.
6	Understand data limitations from a single type of data	Use of text, networks, images and links or a mix of these data types, for building the models would be desirable.
7	Address data measurement challenges due to biases affecting the generation of the data	Using objective or computed variables which can be used as control variables, would improve trust on the outcome.
8	Minimize trade-off between internal and external validity of research model	Differences between groups, inferential statistics like penalised regression, logit models or multivariate analysis.
9	Check the data compatibility in measures	Time period match of data, adjusting for multi-source data problems
10	Realistic assessment of limitations and trade-offs should be reported.	Report low explainability of inferential model, if needed. Data is expected to have high noise.

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# Thank you



# Bio in Brief – Arpan K Kar

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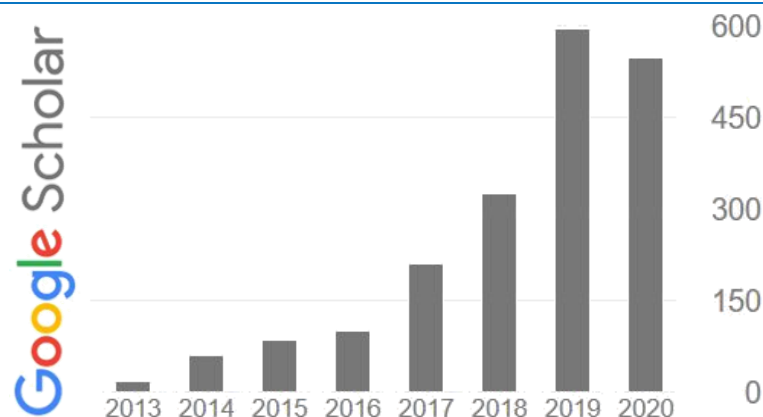
- **Education:** BE - IT (JU Gold Medal), Fellow (MBA + PhD) from XLRI Jamshedpur.
- **Affiliation:** Associate Professor, IIT Delhi
- **Academic Experience:** 9<sup>th</sup> Year
- **Past Affiliations:** IBM Research, Cognizant Business Consulting and IIM Rohtak
- **Research productivity**
  - ✓ 6 Books authored / edited (T&F, Springer)
  - ✓ Articles in Scopus indexing over 100
  - ✓ Total authored articles: 140+
  - ✓ 42 articles meet IIT Delhi norms for highest quality publications (ABDC A/ABS 3/IF>2)

## • Service to research ecosystems

- ✓ **ERB:** *Int. J. of Information Management* (Elsevier)
- ✓ **Coord Ed:** *Information Systems Frontiers* (Springer)
- ✓ **Ass. Ed:** *Global J. of Flexible Systems Mgmt* (Springer)
- ✓ **Ass. Ed:** *Int. J. of Elec. Government Research* (IGI);
- ✓ **Area Editor:** *Adv. In Th. & Prac. in Emerging Markets* (Springer)
- ✓ **Editor in Chief:** G J of E-Business and Knowledge Mgmt
- ✓ Over 12 Reviewer Excellence Award: I&M, GIQ, IJIM, JRCS, ASOC, LUP, LNCS, etc

## Research Grants ≥ 7 Crore INR

Cyber Peace Foundation / Facebook; Fidelity International; DST; PWC; European Union; CSc, MEITY; ICSSR; MoTA, MoT, Univ. of Connecticut, USA; VV Foundation; HSMI, MoUD



## Recent Guest Editor Roles / Conferences

- SI in Int. J. of Information Management (Data Science), 2021
- SI in Industrial Marketing Management (Platform Economy), 2021
- SI in Aus. J of Information Systems (Online engagement), 2020
- SI in J. Advances in Management Research (Social media), 2019
- SI in Information Systems Frontiers (Smart City) 2018
- AE / Track Chair in ICIS, PACIS, ECIS conferences

## Selective Recognitions

- Best selling case author, IVEY Cases, 2020
- B. K. Birla Distinguished Research Scholar Award for Management, 2019
- Int. Federation for Info. Processing - I3E Best Paper Awards: 2017, 2018
- PMI Young Research Scholar Award 2016
- IIT Delhi Teaching Excellence Awards 2017 2018
- Best Research Output, IIT Rohtak Annual Reports (2013, 14)
- JL Batra Best Researcher award by the AIMS, 2010
- Gold Medal, TCS, for Image Analytics Research, 2007

## Training Programmes ≥ 10 Crore INR

- Over a 15 Training Programmes nationally/internationally