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MaCuDE Webinar

Kalle Lyytinen
Case Western Reserve University, kalle@case.edu

Heikki Topi
Bentley University, htopi@bentley.edu

Jing Tang
Rochester Institute of Technology, jtbbu@rit.edu

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Phase II—Industry Needs
Phase III—Final Report and Recommendations

Kalle Lyytinen
Distinguished University Professor
Case Western Reserve University
kalle@case.edu

Heikki Topi
Professor
Bentley University
htopi@bentley.edu

Jing Tang
Assistant Professor
Rochester Institute of Technology
jtbbu@rit.edu

MaCuDE Timeline

MaCude (Developing the **Ma**nagement **Cu**rriculum for the **D**igital **E**ra) (AACSB/DTAG)

https://macude.org/

MaCuDE timeline

Phase I : **State of educational programs and offerings** (1.1.2020-1.1.2021) (Delayed due to Covid 19)

Lyytinen, K., Topi, H., & Tang, J. (2021). Information Systems Curriculum Analysis for the MaCuDE Project. *Communications of the Association for Information Systems*, 49, pp-pp. https://doi.org/10.17705/1CAIS.04939

Phase II: **Industry practice and future needs** (Originally 2/15/2021- 8/30/2021) - Status report (**Extended till 2/28/2022) (Download here)**

Phase III: **Recommendations and guidelines (Competency Guidelines)**

(3/1/2022-6/30/2022) - ***Final report***

Advisory Committee

- Jan vom Brocke, University of Lichtenstein, Lichtenstein
- Helmut Krcmar, Technical University of Munich, Germany
- Olivia Sheng, University of Utah, USA
- Bernard Tan, National University of Singapore
- (Mary Tate, University of Wellington, New Zealand)
- Joe Valacich, University of Arizona, USA
- (Ramesh Venkataraman, Indiana University, USA)

Emerging Themes

New Environment

- Data in volumes really pervasive
- Growth of data is exponential; 10 times growth experienced by many in a very brief period of time
- Data in tera- and petabytes, involves billions of observations
- Granularity can be very low (every click) to very detailed (thousands of observations per cell, in cancer research)
- Clear difference between ‘big’ data and ‘good quality data’
  - Some dimensions of good: representative, comprehensive, clean
- Important to engage in real time processing with large scalable data sets (edge computing)
- Offering such data sets and related environment within university programs can be challenging due to cost and time to cover all the issues or provide appropriate environments

New Big Data (BD) AI/ Environment

- Distinction between three types of “Big Data” (BD) use contexts call for different skills sets and development approaches:

  1. *Part of the core product/service* (e.g., autonomous vehicles)
  2. *Way to analyze, monitor, and improve the core product/service* (e.g., predictive maintenance)
  3. *Way to analyze, monitor, and improve the business* (processes, situations) outside the core product/service (e.g., process mining)

BD and AI are linked—capabilities endowed by BD need to be built into organizational systems and decision making (AI/ Analytics)

New Environment

- BD techniques have existed for a long time but have only recently broadly applied
  - Many machine learning techniques have been known and applied in narrow domains (vision, image analysis) but broader applications have only recently become feasible (e.g., NLP);
  - AI applications have been around since 90's (e.g., credit rating applications, FICO computation)
- Calls for higher specialization—AI, analytics, or security—are often outsourced (e.g., consultancies, specialized groups) while organizations maintain the rest of application operations by integrating with strong domain expertise
- Growing need to learn new BD and AI technologies
  - Continuing challenge for higher education institutions: how to combine BD/AI with building the foundational skills that enable long-term learning with the need to satisfy employers' current desire to hire graduates ready to perform immediately after graduation?

Broad Categories for New Educational Demands

1. Organizational transformation due to new technological environment / capabilities
2. Essential concepts and concerns related to BD and machine learning
3. Individual competencies required for BD development and applications of AI
4. Competency development providers
   - the role of colleges and universities

Data collection and sampling

- Interview protocol around key changes and issues related to work force demands covering the new BD environment and applications of AI
- Purposeful sampling: different roles and categories in charge of or having responsibility in managing IT / BD operations
  - CIOs, CTOs, Product managers, Heads of Big data consultancy, Head of Big data / machine learning teams
  - Cross industry: consulting, health care, sports, manufacturing, financial services, education
  - Included both North America and Europe (Germany, Switzerland)
  - Overall sample 18 interviews, (45 minutes to nearly 2 hours), c.a. 20 hours of interviews
  - Covered by IRB
  - Interviews transcribed *verbatim* and coded

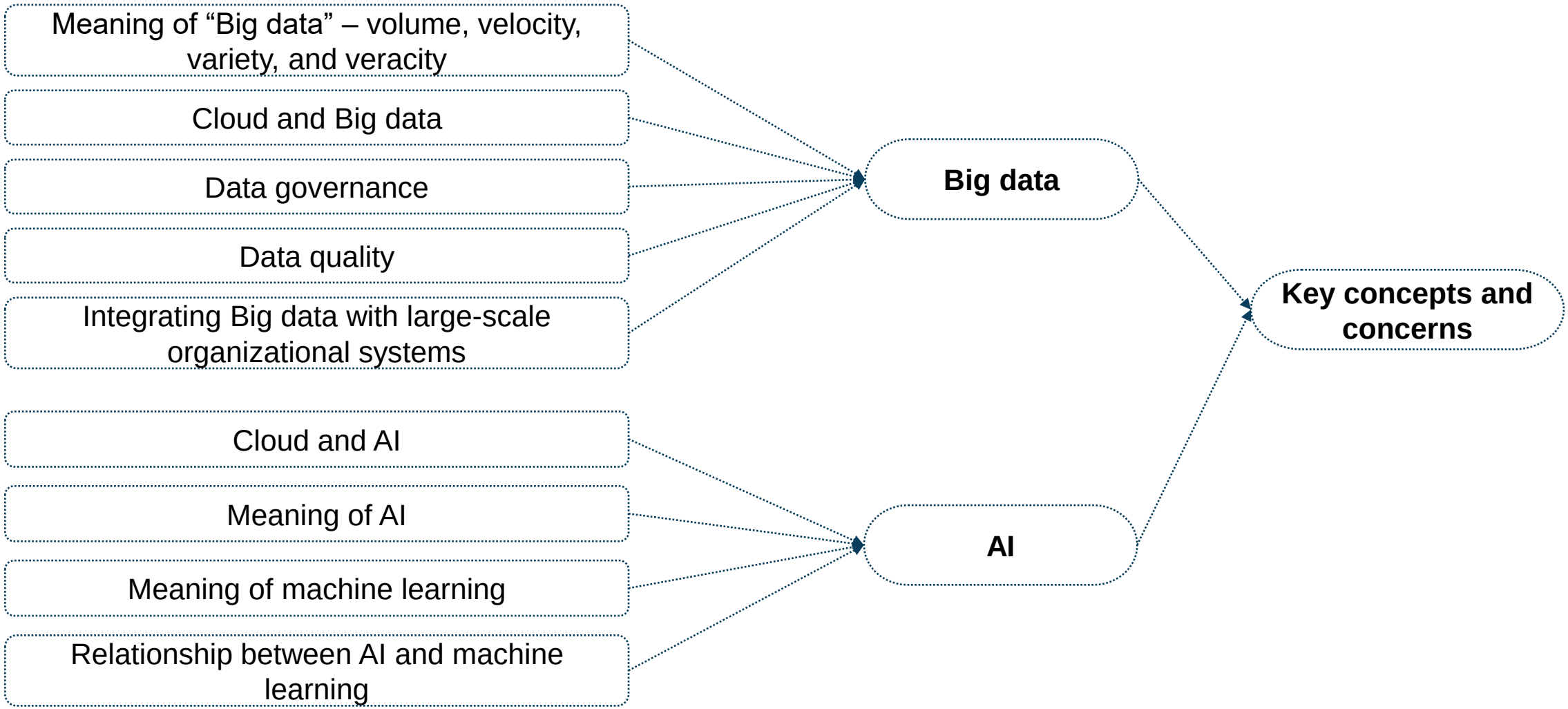
Analysis Method

- Objective: open ended thematic coding to identify and organize key topics and issues around BD and related industry needs—focus on competencies, BD / AI effects and what the term means currently
- In situ, sentence/phrase level coding around key themes
  - Iterated between inductive and theory driven approaches in creating the coding scheme: 60 first order codes
  - Generated an initial coding scheme with the matching items for each dimension
  - Axial coding for higher level codes: 16 higher level codes (second level), 3 “third level” broad categories
  - The coding scheme and dimensions evaluated by all the three coders.
- Reliability
  - Three coders coded the cases (interview); For each case, at least two coders coded it.
  - During the coding, coders re-evaluated the coding scheme and each dimensions (resulting in adding new dimensions and merging some). The 2nd round of axial coding refined the categories and their locations in the final organization.
  - Reliability evaluated with Cohen’s kappa statistic: acceptable (0.75 - 0.99 for each individual codable moment assigned to a code)

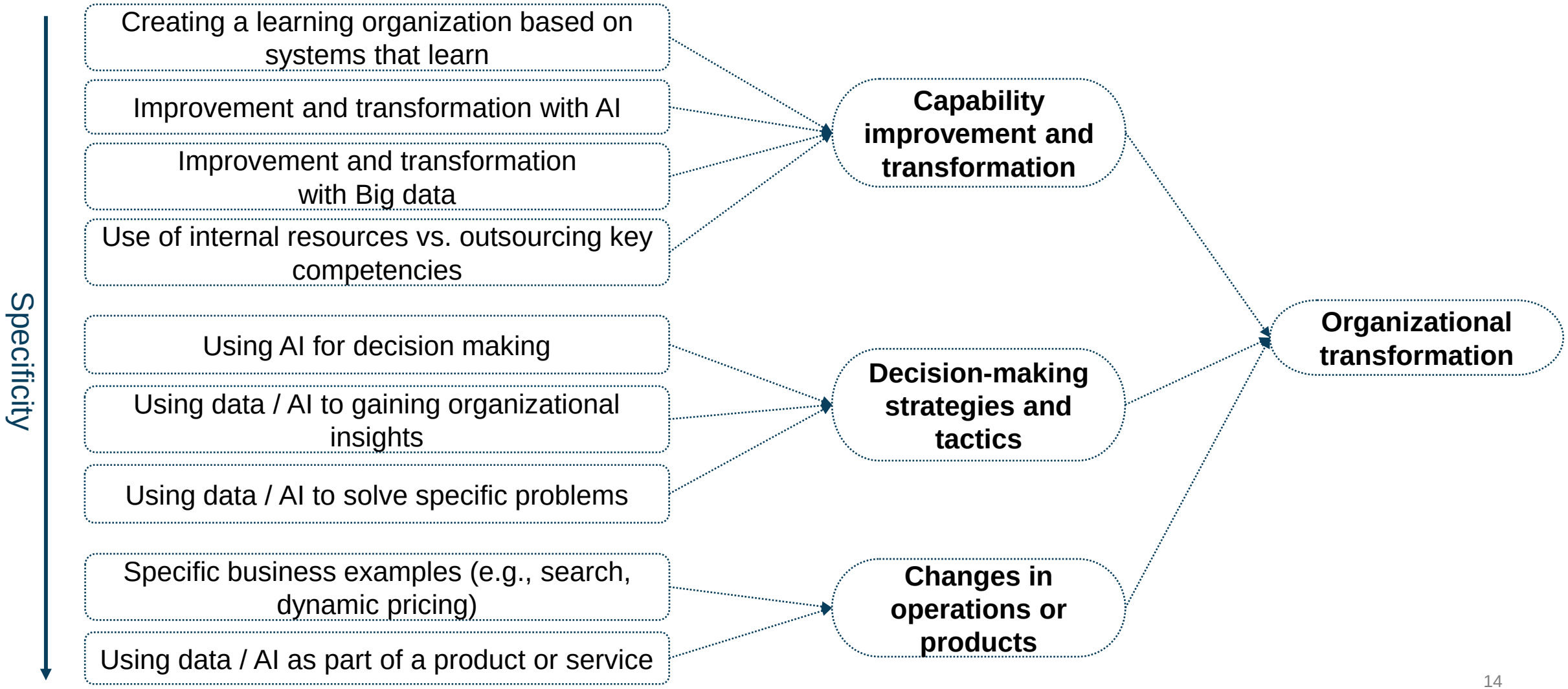
Theme I: Key Concepts and Concerns

- BD
  - Volume, velocity, variety, and veracity
  - The size and volume growing fast; growth has been exponential in the last 5 years (from tera to petabytes; real time edge processing now uses terabyte level data sets)
  - Constantly changing meaning of Big data
  - Big data and cloud becoming inherently related (with related tools and service stacks)
  - Data governance and quality different from old ‘structured’ data administration
- AI and Machine Learning
  - AI: automating BD analytics & modeling, moving from analysis to prediction and insights
  - AI and cloud also inherently related (most use specific tools such as Tensorflow)
  - Relationship between AI and machine learning/data science:
    - AI is a highly broad field and the broader term…
    - Machine learning composed of a specific set of techniques and problems enabled by the access to growing and bigger data sets

Theme I: Key Concepts and Concerns



Theme II: Organizational Transformation



Theme II: Organizational Transformation

- **Capability improvement and transformation**
  - Organizations use BD and AI to create a new kind of learning environment, improve automation rates, and support organizational decisions and routines. (BD/AI enabling new kind of org. learning → metahuman systems (Lyytinen et al 2020)
- **Decision-making strategies and tactics**
  - Use BD and AI to generate insights for supporting making data-driven decisions and developing strategies or tactics. (Big data/AI for decisions)
- **Changes in operations or products**
  - Use BD or AI to optimize or simplify the operations, improve their products, or develop novel products (Big data/AI for products/operations)

Theme II: Organizational Transformation (examples 1st order codes)

Improvement and transformation with Big data

"Then we use that information to, in the product, the next time that user visits, or even in the Marketing, as we send them out a Marketing email or something, "

Improvement and transformation with AI

"We were using linear models just up until a couple of years ago, and now fast forward to today and we're using neuro networks and really sophisticated Machine Learning. So we definitely compete with companies."

Creating a learning organization based on systems that learn

"The future workforce will be responsible for optimizing and improve AI logic by defining rules or doing training to improve the automation rate."

AI used for decision making

"We will continue to make truly data-driven decisions (for sales, risk, finance and other departments)"

Using data or AI to gaining organizational insights

"Big data could be used to identify behavioral patterns and thus identify opportunities but also needs. This is done favorably with AI functionalities. AI can also help to simplify repetitive work and thus support and relieve the business."

Using data or AI to solve specific problems

"Using AI technology to develop new cell therapy, like T-cell therapy, or therapy, to make personalized immunotherapy products."

Specific business examples

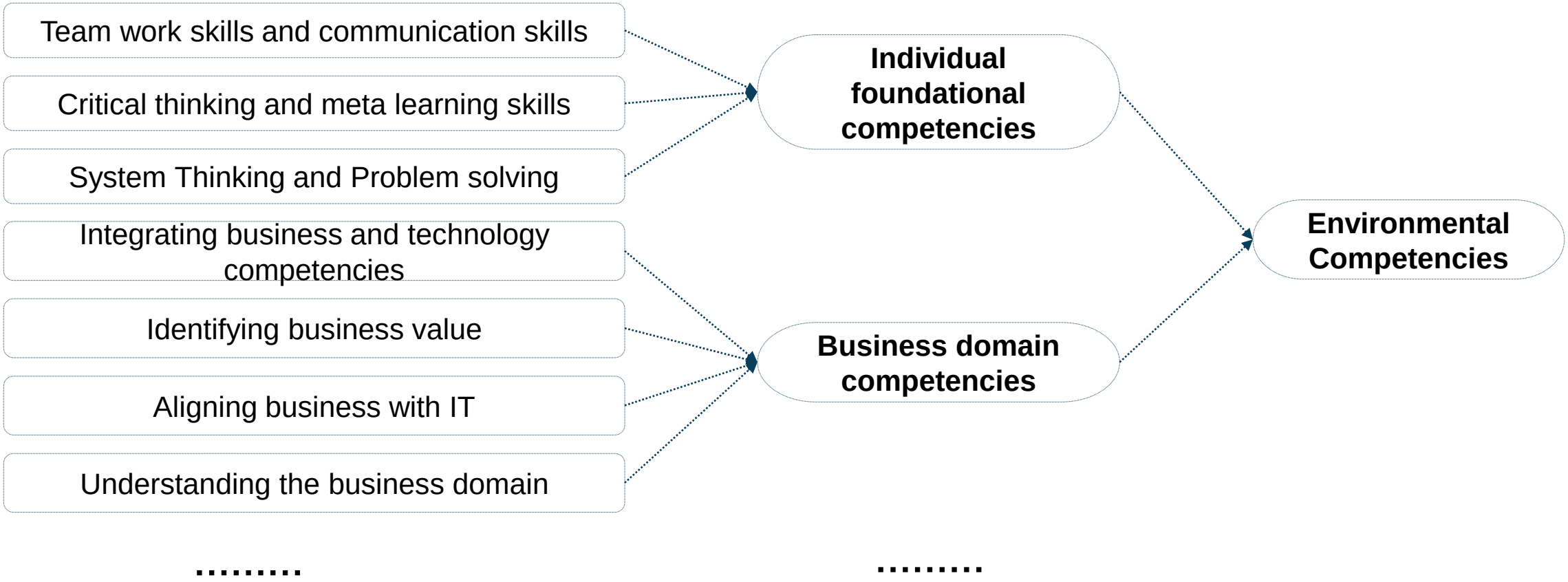
"We're doing some monitoring of how students are using Canvas and their engagement and utilization of it. We're starting to do some level of social media monitoring and trying to predict sentiment of certain Hashtags across the university, like with university admissions and marketing."

Using data or AI as part of a product or service

"So as I mentioned, the Machine Learning of that data is used in almost every single page on the website, and almost every product on our product roadmap has just more and more of this Machine Learning embedded in it."

Theme III: Individual Competencies (Part 1)

Fundamental environmental competencies



Fundamental environmental competencies (examples of 1st order codes)

Team work skills & communication skills

"I do think that cross-functional, cross-discipline training, even if it's just a single course or set of small courses, is really important."

Critical thinking and meta-learning skills

"That's totally different from crunching the data. That type of practice may help. Some critical thinking."

Problem solving and systems thinking

"A competency is problem-solving, troubleshooting, really cause analysis. I think some of the continuous improvement concepts are actually what I'm gonna say here, too, competencies."

I think that systems thinking needs to be called out. … By studying and discerning systems, one develops systemic patterns that allows a faster and critical understanding of a new system when you encounter it. It also allows you to "borrow" parts of one system that solve a problem and "inject" those borrowed parts into a new system to solve problems in new ways."

Integrating business and technology competencies

"There is a new breed of IT that is dressed in business. It isn't dressed IT, but dressed in business, and they basically sit at a table with Senior Management providing decision in support services."

Aligning business with IT

"you know the business side of this, people like Produce Managers, they have to understand what is capable of being done because they're the ones who have to take the business requirements and understand the technology enough and merge it together into …."

Identifying business value

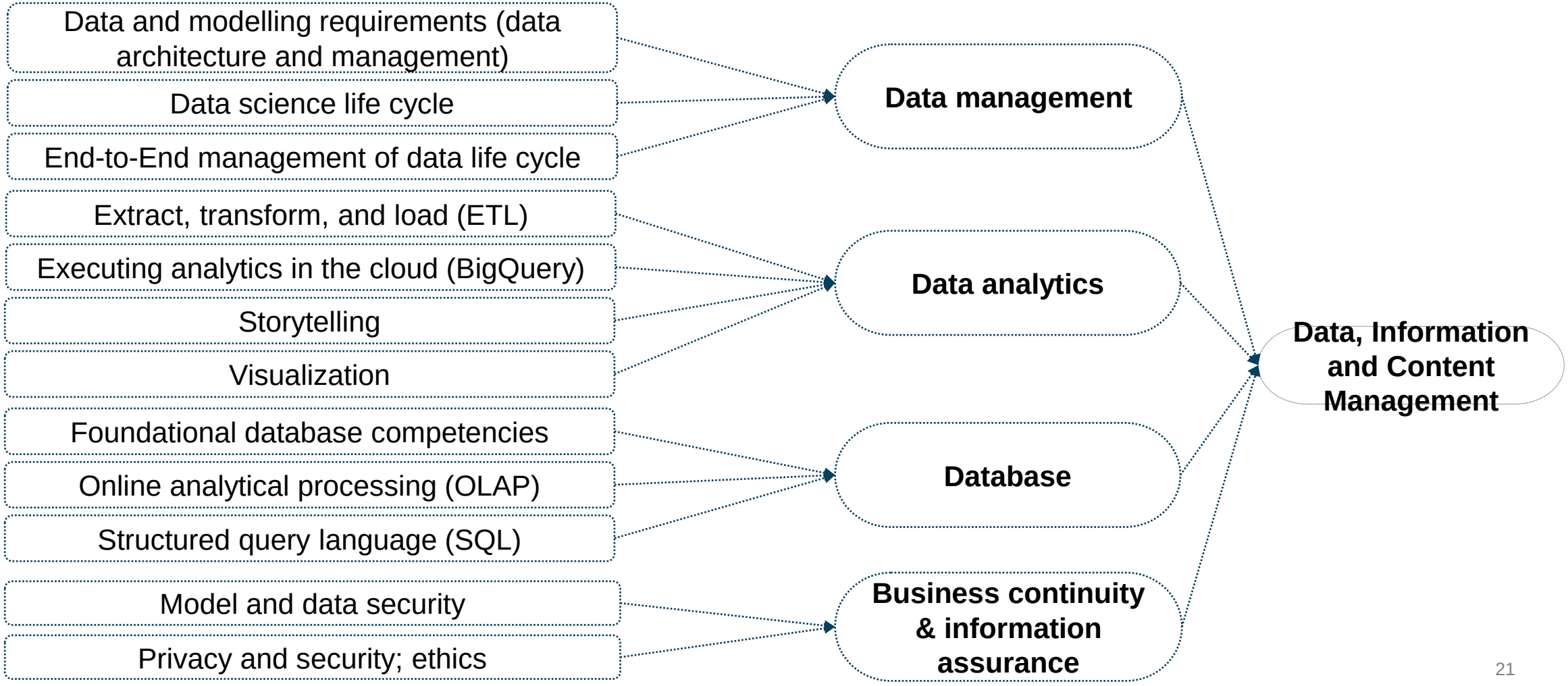
"For developing or programming our own AI solutions, our employees have no deep knowledge of mathematical models and how to build mature and value-creating AI applications."

Understanding the business domain

"Passion/desire for business outcomes and understand why of everything (customers, processes, how things run), if you do the analysis right, they shouldn't be a surprise. Some instances can be surprises, need to ask 'why'"

Theme III: Individual Competencies (Part 2)

Data, information, and content management



Data, Information, and Content Management (selected 1st order codes)

Foundational database competencies

"A lot of data coming in a structural format, so the skills to understand and be able to handle and process those various different type of data is key, but when you see this various type of data coming from different formats, coming from different systems, then how do you process it?"

Executing analytics on the cloud

"Data Science programs and folks coming out as new hires, and people are getting a pretty good introduction to the types of analyses that are available, how to execute those analyses, you know kind of the mechanical running the Python or the other tools, whatever it is, to do that."

"There is a lot of discussion about the prevalent use of the cloud. I suggest also mentioning the services provided by clouds beyond compute and storage such as in GCP services such as BigQuery, Dataflow, Tensorflow, etc.

Visualization

"Data visualization is very important, especially when you're presenting it to Managers and Corporate Executives. It's just that from the standpoint of my team, we're more into innovation,…"

Privacy and Security (Ethics)

"Ethics is a framework for making moral decisions, a set of tools to help you apply your morals and values,' and I think that would be very useful in an IT sense as well, and so those kinds of things I think should come into the curriculum."

"This topic of Ethical AI, in which is AI adheres to well-defined ethical guidelines regarding fundamental values such as individual rights, privacy, non-discrimination, and non-manipulation, is growing rapidly. Businesses that ignore this area risk reputational, regulatory, and legal actions."

Data and modelling requirements

"Now the second challenge is students come out of college taught how to wrangle data, taught how to use models on data or algorithms on data to build models on all of that."

Data science life cycle

"I think the continuing specialization of the workforce, in terms of slicing and carving out different segments of the dataset's life cycle, that's gonna continue to take over so that not everyone needs to be a full-fledged Data Scientist the way people like to define it"

End-to-end management of data life cycle

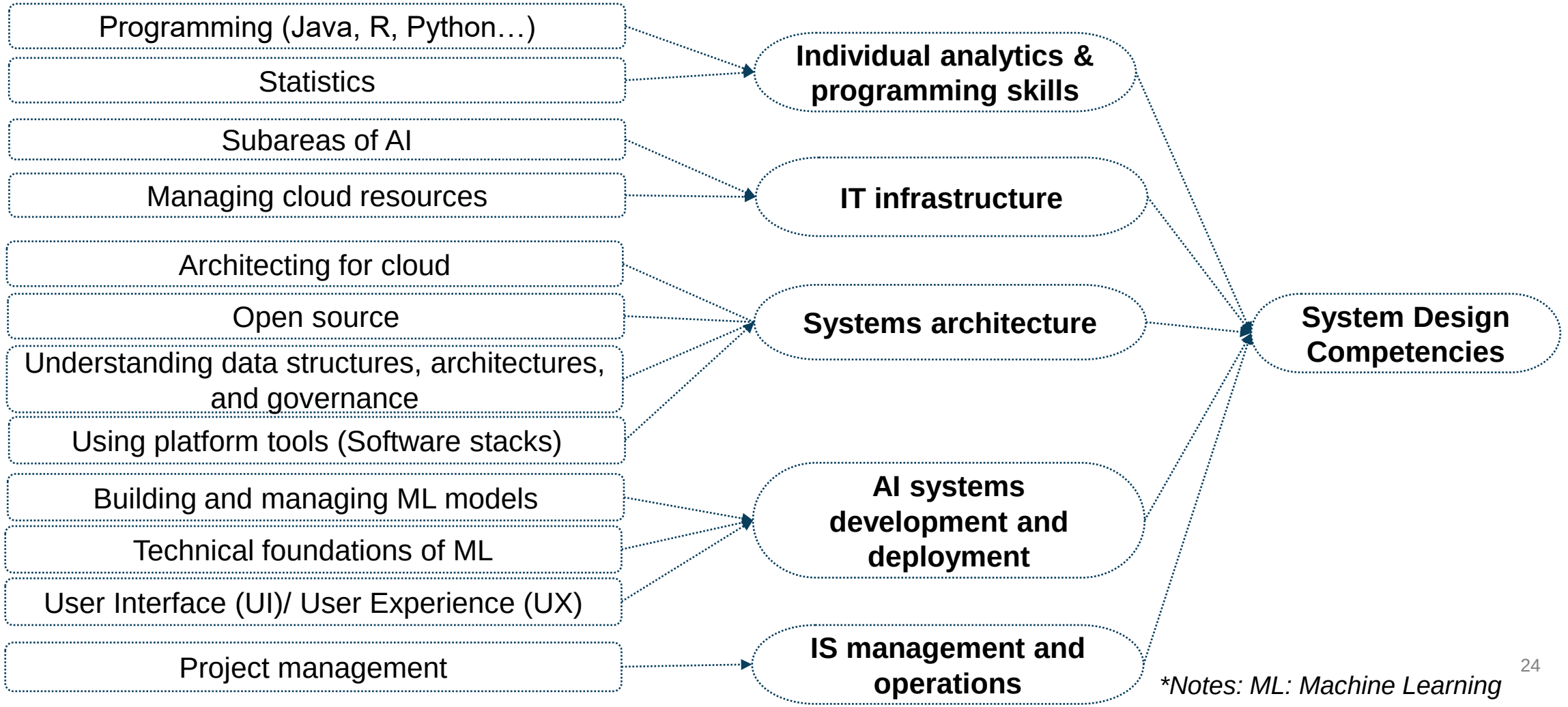
"I think what we'd like to see is continued work around their understanding of Big data working with this. Working on the more technical side, of course, implementation, the manipulation of Big data"

Critical Skills

- **Data and modeling** skills **critical** (SQL, foundations of databases)
- Skills to **manage data across its life-cycle** and organize it accordingly (modeling, dictionaries, governance)
- **Analytics skills** critical but only part of the overall skill sets, covers also OLAP
- Visualization and other forms of data exploration becoming common
  - Tableau as the main environment (“new Excel”), BI
- **Domain knowledge** needed to build narratives around data
- Expanded needs to understand security and privacy (varies between countries and regulations)
  - Includes also valuable machine learning models (trade secrets)
  - Implementation of security is often in the hands of those with top-level capabilities

Theme III: Individual Competencies (Part 3)

Systems design competencies



*Notes: ML: Machine Learning

Systems design competencies (selected 1st order codes)

Programming

"So API Python is also an absolute necessity at the moment, just with how many Cloud systems we have. I would say we have a couple of traditional ATL Developers, the Informatics people, but that's even becoming a bit more minimalized because the need for true data warehouse design is getting smaller"

Architecting for cloud

"I think right now they're lacking a bit of the Cloud technology data skills. That's probably my biggest gap, and I haven't had someone who could come in and say, 'We could do that project for this amount of money' in Cloud technologies to be able to counter basically that business justification of Cloud and versus on premise."

"..we have massive amounts of on-demand compute that we are able to employ many of these techniques. ..training jobs that run for over 24 hrs with hundreds of VMs processing data. The cost of massive amounts of compute instances could become an issue for students to leverage in hands-on exercises."

Managing cloud resources

"I think right now they're lacking a bit of the Cloud technology data skills. That's probably my biggest gap,"

Understanding the ever evolving offerings as well as the build vs. buy decisions (when and whether to use these services) are critical skills."

Understanding data structures, architectures, and governance

"they need a sound understanding of concepts like data stores well beyond just your relational data stores. You know Big data stores, streaming, logging, everything in that realm, but that's more of an Engineer to get the data where it's supposed to be."

Machine learning, building and managing ML models

"Second of course is strong competency in the use of Machine Learning packages or models. This field is evolving aggressively."

Machine learning, technical foundations of ML

"For developing or programming our own AI solutions, our employees have no deep knowledge of mathematical models and how to build mature and value-creating AI applications."

Project management

"It used to be you had to have people with Project Management. That was critical and that was everyone competed for that, and now it's that plus the data, the Machine Learning"

Critical Skills

- **Programming**:
  - **Python and SQL—core** pair of languages for Big data/analytics type of work
  - **Use of stacks and frameworks** now mainstream (such as MEAN, MERN, LAMP stacks and Django, Ruby on Rails, AngularJS, and Vue.js frameworks)
  - Increasing role of Spark?
- Training **in statistics** is becoming a necessity
- **Understanding f**or **specific types of machine learning models** increasingly required
- **Architecting and running applications in the cloud** using software stacks, understanding related (edge) architectures and organization of service stacks are necessary components of basic design skills
- Different levels of skills to develop and use machine learning models necessary in teams—basic skills and understanding required from everybody
- Critical environmental skills relate to **project management, requirements discovery and UX**
  - These are not going to go away
  - Both are taking different forms than they traditionally had
    - E.g., agility in project mgmt; rapidly emerging and changing requirements in BD projects

Critical Skills

- The area is moving **fast** and requires constant learning and attention—however, many **'fundamentals' have remained relatively stable** (such as programming/ database and algorithmic thinking)
- The increased **importance of cloud and cloud platforms**—a great majority of computing activities now are carried on platforms
  - Need to understand how they work, even though (or because of) they are very complex
  - Exponential growth in data drives the need for cloud resources in both processing and storage, but availability of advanced capabilities in analytics and AI (in software stacks) is an important cloud environment selection criterion
  - Difficult and expensive for academic departments to provide free access to full capabilities on the dominant cloud platforms
  - Opportunity for AIS: negotiating a deal with, for example, Microsoft to make Azure available to IS depts at a very low cost
- **Neglected importance of the preparatory stages of the analytics lifecycle** (data acquisition, data cleansing) and the activities at a higher level than a single project, such as **organization-wide data and model governance**
  - These competencies are latent, undervalued and underappreciated
  - Importance of "raising the baseline level of data competency"

Competencies: Required vs. Lacking

Individual Competencies	Competencies required	Competencies currently lacking
Fundamental environmental competencies		
Individual foundational competencies	3	1
Business domain competencies	9	5
Data, information, and content management		
Database	10	3
Data analytics	4	2
Data management	4	4
Business continuity and information assurance	0	1
Systems design competencies		
Individual analytics skills	10	1
IT infrastructure	3	3
Systems architecture	7	5
Systems development and deployment	5	3
IS management and operations	3	1

Main competency gaps: foundations, data management design

**Notes: Number of cases in the cell. 18 cases in total*

Questions

- Are there missing issues?
- Does the analysis include observations that are clearly incorrect?
- From the perspective of IS education, which one(s) of the findings have the highest priority in the short-term and long-term?
- What has truly changed compared to our collective understanding of the field of IS?
    - Unprecedented levels of complexity and scale and related education for cloud and service stacks
    - Dealing with inherently uncertain tasks during educational processes
    - Legal, regulatory and ethical justifications for protection of privacy as an emergent key issue
        - New core categories of non-functional requirements?

Questions

- Are there hidden changes reflected in the new meaning of key areas of learning?
  - E.g., data quality, data governance
- Are there new elements of an MIS core that start to emerge from these initial findings?
- Is there room for a generalist program (such as the MSIS)? What are the specialist programs most likely to succeed? There is a need both for deeper technical specialization and domain specialization
- How much should we focus on data security and privacy?
- What has changed compared MSIS 2016 and IS 2020?

Next Steps

- Phase II
  - Draft report finished 3/15/2022—available by request
  - Collection of IS community feedback
  - Final Phase II report 4/31/2022—will be submitted to CAIS in June 2022

Phase III ((3/1/2022-30/6/2022)

- Phase III
  - Development of recommendations and final project report
  - Receive industry feedback and conduct webinars for the key recommendations (Early June 2022)

Phase III ((3/1/2022-30/6/2022)

- Phase III

  - Develop a competency framework for AI-BDA to guide future curriculum development and implementation—recommendation to form a task force at AIS
  - The role of Design skills and Design Thinking as part of the AI/BDA development (as a set of applications/ services)
  - From technical skills and tasks to imagination skills—what is the design mindset in BDA/AI context? (*This is a unique IS perspective in the business schools)*
  - *How to demonstrate the value of IS perspective in business schools*
  - How to build alliances with CS and other fields?
  - How to recognize the demands of new cloud environment and teach this?
  - How to hire, retain, and build up new competencies in IS faculty (affects tenure decisions, shortage, retraining needs)?
  - How to help train existing workforce (certificate programs, stackable degrees)?