Building Research Programs in the Computationally Intensive Theory Construction Genre

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Abstract: The new genre of computationally intensive theory construction benefits from being empirically grounded in patterns from data but also theoretically driven to integrate with an existing discourse. In this chapter, I further emphasize how patterns can serve as building blocks not only in creating novel theories but also in cultivating research programs. In particular, I describe the two moves of modularizing and meta-patterning and show how they can be used to evolve diverse research programs. I discuss the opportunities and challenges of programmatic research within the genre of computationally intensive theory construction and beyond.

Keywords: computationally intensive theory construction, patterns, theories, middle-range theories, research programs, programmatic research, modular research

1 Introduction

Over the last few years, fueled by the rapid development of computation and digitization, novel computational research tools and methods have steadily developed. Advancements in digitization and data collection, algorithmic processing of data, machine learning, and artificial intelligence trickled into the social sciences creating what is now known as computational social science (Lazer et al., 2009, 2020; Salganik, 2019; Watts, 2013). One particular advancement is the application of computational methods for theory development, now commonly referred to as computationally intensive theory construction, or CITC (Miranda, Berente, et al., 2022). Among scholars from multiple disciplines, information systems researchers are keen on developing CITC as a research genre (Agarwal & Dhar, 2014; Berente et al., 2019; Gaskin et al., 2014; Grover et al., 2020; Levina & Vaast, 2015; Lindberg, 2020; Müller et al., 2016; Pardo-Guerra & Pahwa, 2022; Pentland et al., 2020).

A recent *MIS Quarterly* editorial provided guidelines for conducting CITC research (Miranda, Berente, et al., 2022). It identifies the four interrelated processes of data sampling, surfacing patterns, method selection, and theorizing using lexical framing, where patterns identified through computational methods are situated within relevant theoretical, methodological, and practical discourses. Ultimately, CITC aims to produce theoretical insights by drawing on and extending those discourses. At the same time, Miranda et al. (2022) highlight that constructing complete theories is a challenging goal of most single CITC projects. Thus, patterns, which constitute an intermediate outcome on the way to develop theory, can be contributions in their own right—if they have theoretical implications.

In this chapter, I extend upon this premise to show how communities of researchers can create cumulative research programs within the CITC genre. Science progresses incrementally, and thus cultivating theoretical accumulation is key to scientific progress (Tiwana & Kim, 2019). However, identifying patterns with theoretical implications comes at the risk of focusing on isolated research efforts, producing an abundance of novel patterns with little integration. To contribute to the cumulative tradition in a discourse, these patterns need to be considered in subsequent research efforts—they may be refuted, challenge existing theoretical knowledge, or be aggregated to form a more abstract theory. Considering the novelty of the CITC genre, researchers have relatively little experience in how the iterative process from data via multiple patterns to theory unfolds within larger research projects.

Thus, this chapter focuses on the process of aggregation within the CITC genre. How can patterns identified to create novel theories be integrated into larger research programs?

Borrowing from scholars who highlight the importance of metaphors (Swedberg, 2014) and heuristics (Abbott, 2004) in social science research, I propose two heuristics for aggregating patterns, thereby drawing an analogy to design moves in architecture and engineering. These moves are modularizing and (meta)patterning.

First, I argue why a focus on programmatic research that weaves a single fabric of knowledge is much needed to capitalize on the opportunities provided by the new CITC genre. Second, I show how patterns as building blocks of theories in CITC can be building blocks of theories of increased abstraction, thereby contributing to larger research programs. I then articulate the advantages of engaging in such modular programmatic research. In particular, I invite reflection on how patterns can be used to integrate diverse research programs that move away from tactical (Grover et al., 2020), easy (Rai, 2016, 2017), and all-in-one research templates (Puranam, 2018, pp. 159–161). Finally, I reflect on both the opportunities and challenges of programmatic research in the CITC genre and beyond.

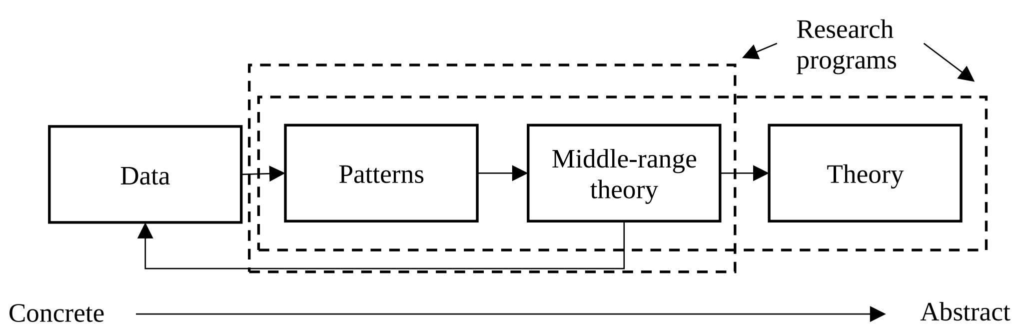

Figure 1: Extending the process of theory development to encompass programmatic research.

2 The Role of Patterns in Creating Theories and Research Programs

A pattern is "an arrangement or sequence regularly found in comparable objects" or "regular and intelligible form or sequence discernible in certain actions or situations" (New Oxford American Dictionary, 2010). The two components in a pattern are the raw sensory information and detected regularities. Pattern surfacing refers to detecting such regularities from empirical observations. Patterns in digital trace data are repetitive and recognizable representations of aspects of a phenomenon that persist or change over time. These patterns can be challenging to identify with large volumes of digital trace data due to the fine granularity and high volumes that exceed human processing capabilities. However, computational tools, such as social network analysis and sequence analysis, can be used to identify complex patterns and structures within digital trace data (Andersen & Hukal, 2023; Lindberg, 2020; Zhang et al., 2022). The CITC genre emphasizes the primacy of patterns identified with computational techniques when creating theories (Miranda, Berente, et al., 2022). In CITC, researchers use computational techniques to surface patterns from digital trace data (Berente et al., 2019).[1]

Theories—consisting of constructs and relationships between those constructs—can be considered abstracted patterns of generalized understandings that specify how empirical and observed patterns are interlocked. Thus, many researchers view theory building as a process of abstraction, moving away from the very particular (data) to the very general (theory).[2] Afterward, a theory can be used "in reverse" by being applied to explain new data (Berente et al., 2019). Theories are also tested with new data in order to be corroborated or falsified. That is, theorization is the practice of abstraction in which conceptual systems are derived and formalized into symbolic expressions. In empirical research, theorization involves moving from concrete observations to abstract representations, models, and theories (Figure 1).

Theory development or construction refers to creating theories (Rivard, 2014; Shepherd & Suddaby, 2016) through the "process of formulating conceptual systems and converting them

[1] I start with the premise that the researcher is interested in analyzing digital trace data with computational techniques. Despite the advantages of digital trace data (Andersen & Hukal, 2023; Pentland et al., 2020), understanding digital traces in their specific empirical context remains a persistent challenge, with recent calls emphasizing the importance of contextualizing digital traces and research practices to address this challenge (Cecez-Kecmanovic et al., 2020; Grisold et al., 2023).

[2] Various notions of theory exist, encompassing conjectures, models, frameworks, or bodies of knowledge, depending on the disciplinary orientation (Gregor, 2006). While most IS theories are theories for explaining and predicting, middle-range theorizing is particularly useful when studying empirical phenomena, bridging the gap between high abstraction and concrete data (Grover & Lyytinen, 2015).

into symbolic expressions” (Jaccard & Jacoby, 2020, Chapter 28). In CITC, computational methods play a key role, but the genre also emphasizes the human researcher’s role in identifying patterns by making sense of those patterns in relation to a theoretical discourse. Patterns are intermediate products toward theory discovery. Identified patterns may serve as sensitizing devices as they point the analyst toward exciting relationships in the data. Existing work in CITC provides multiple frameworks and powerful tools for transitioning across the continuum of data, patterns, and theories (e.g., Berente et al., 2019; Gaskin et al., 2014; Grover et al., 2020; Johnson et al., 2019; Levina & Vaast, 2015; Lindberg, 2020; Müller et al., 2016; Østerlund et al., 2020).

Moving from the less to the more abstract has deep roots in the social sciences in the form of middle-range theorizing. Middle-range theories cater to the phenomenon of interest in a particular context without the ambition to generalize beyond this context. They involve creating hypotheses that are directly testable with empirical observation. Incrementally, once direct regularities are identified and tested, middle-range theorizing aims to evolve a more general conceptual scheme adequate to consolidate groups of special theories (Merton, 1949).

Middle-range theorizing accepts the constraints imposed in certain research domains and empirical contexts. It settles for the more tangible goal of explaining a particular phenomenon rather than generalizing it across contexts (Grover & Lyytinen, 2015). This constraint is prevalent in many disciplines and research projects relying on trace and digital data to construct theoretical accounts (Berente et al., 2019). The availability of digital trace data provides an opportunity to study new social and organizational phenomena. For instance, email and social media digital trace data enable researchers to examine phenomena like information sharing and diffusion patterns (e.g., Aral & Van Alstyne, 2011; Bapna et al., 2019). Uncovering such patterns can ultimately contribute to the overarching theories of social capital and knowledge collaboration (e.g., Rajkumar et al., 2022).[3]

It is well recognized that building theories is a skill that requires disciplined imagination, talent, artistry, and intuition, in addition to the application of the scientific method (Abbott, 2004; Swedberg, 2014; Weick, 1989). Multiple guidelines advise how best to address theory building (Rivard, 2014; Suddaby, 2014). Very often, theories or their elements can be borrowed across disciplines (Oswick et al., 2011), further illustrating the value and scarcity of deep theoretical insights. However, while acknowledging this tacit aspect, theory building is also an incremental process, with researchers continuously adding to our understanding of a given phenomenon (Tiwana & Kim, 2019). This is well illustrated by the fact that even mature theories are subject to change and refinement over time (Whetten, 1989). While instrumental in creating theories, patterns can be leveraged to integrate theories and create cumulative research programs.

2.1 Moving From Theories to Research Programs

Scientific pursuit is a collective endeavor. Imre Lakatos refers to such a collective effort of scientists in a particular domain as a "research program" (Lakatos, 1978). A research program naturally encompasses multiple theories that need to be evaluated as standalone blocks, as positivists suggested, and as a collective effort. In Lakatos's view, a research program is progressive if it leads to the development of more general theories over time, and it is degenerating if it does not. Specifically, a research program is theoretically progressive if each new theory in the sequence has excess empirical content over its predecessor and thus predicts

[3] Notwithstanding this advantage, making these connections can be challenging as research could be biased by the available opportunities (Grover et al., 2020; O'Mahony & Cohen, 2022; Rai, 2017).

novel and unexpected facts. A research program is empirically progressive if the new facts the theory predicts are validated to be true (Musgrave & Pigden, 2021).

Across multiple disciplines, including in information systems, there is a recognition of the need for programmatic research that weaves a fabric of knowledge from multiple attempts and individual efforts of researchers. Tiwana and Kim (2019) use the analogy of building an edifice from bricks. They state that in information systems "individual studies with substantive standalone merit do not readily assemble into a larger theoretical edifice unique to MIS phenomena" (p. 1029). They urge information systems scholars to cultivate theoretical cumulation across adjacent research streams and to connect the dots between theories across studies. Their approach emphasizes the need to bridge the gap between theory-driven and data-driven research (Tiwana & Kim, 2019).

The thesis of this chapter is that CITC can contribute to creating cumulative research programs precisely because it is a genre focused on studying empirical data with computational tools and situating work within relevant theoretical, methodological, and practical domains through lexical framing (Miranda, Berente, et al., 2022). Next, I unpack how CITC can contribute to research programs by focusing on how patterns, which are the building blocks in the CITC genre, can be building blocks for theories of increased abstractions and, consequently, research programs.

3 Patterns as Building Blocks in Research Programs

For patterns to have theoretical implications, they need to engage with and contribute meaningfully to a theoretical discourse, that is, to a cumulative tradition beyond individual studies (Tiwana & Kim, 2019). While acknowledging the reality of research feasibility (Rai, 2017), and the risk of overreliance on empirical studies of novel phenomena (Grover et al., 2020;

O'Mahony & Cohen, 2022), I propose principles for building incremental research programs while using patterns as building blocks. These principles are inspired by design and engineering fields, where larger systems are designed and built from smaller building blocks. Just like a team of builders constructs a building from bricks, a team of researchers can collaborate on a research program, and just like a building could be then improved and extended, so can theories in a research program. In CITC, I propose two pattern-based practices *modularizing* and *meta-patterning*.

3.1 Modularizing

Large systems are built from smaller ones. The more modular the small systems are, the easier it is to put them into the larger system. Modularity broadly refers to the independence and ease of integration of the smaller systems. More formally, modularity is a key property of complex systems, both organic and artificial (Simon, 2002). Modules are highly cohesive building blocks with tight internals that are loosely coupled to create a larger system (Parnas, 1972). In artificial systems, modularity economizes on the bounded rationality of designers (Ethiraj & Levinthal, 2004). It enables specialists to focus on their domains and later integrate their work through standardized interfaces and protocols (MacCormack et al., 2006). Modularity gives designers more flexibility in conceiving and evolving the engineered system. It allows integrating modules through operators such as porting, inverting, excluding, augmenting, substituting, and splitting modules (Baldwin & Clark, 2000, pt. III; Gamba & Fusari, 2009; Woodard et al., 2013).

Next, I make the move from combining modules into systems to combining patterns into theories. Grodal et al. (2021) tie modular operators with the categorization process when analyzing qualitative data and crafting theoretical contributions in qualitative research. Specifically, by dropping, merging, splitting, relating, contrasting, and sequencing categories, researchers can develop and drop hypotheses that form the foundation for new theoretical insights. For instance, researchers may find that some categories are redundant or irrelevant to the core phenomena being studied and thus decide to drop them. Conversely, they might merge categories that share underlying similarities into superordinate categories. Refining categories helps stabilize them and develop working hypotheses that can lead to more abstract theoretical insights (Grodal et al., 2021).[4] Similarly, in CITC, patterns are valuable as research output if they are related to a theoretical discourse and thus have clear theoretical implications. Publishing patterns with theoretical implications enables quicker knowledge dissemination (Miranda, Berente, et al., 2022). However, patterns can become building blocks within a cumulative tradition as they are added to the discourse and can be built upon in subsequent research.

Tiwana & Kim (2019) advance the idea of connecting the dots between different research streams. They propose that information systems research is characterized by empirical rather than theoretical cumulation and suggest the concept of "nomological rubberbanding" to cultivate theoretical cumulation across nomologically adjacent research streams. In their view, "a nomological string refers to a set of causally ordered nomological networks—each typically a research stream—where one stream's dependent variable is the next stream's predictor" (p. 1031). Tiwana & Kim (2019) give an example of such a string from the IT-outsourcing literature, where Stream 1 is IT sourcing choices, Stream 2 mechanisms for explaining choices effectiveness such as agility, and Stream 3 is IT outsourcing consequences such as on firm performance.

[4] As an example, DiBenigno (2018) identified two categories: "developing personalized relationships across groups" and "anchoring group members in their home group identity." These categories, while distinct, fully made sense when combined, as one involved building ties across identity groups, and the other entailed anchoring oneself in an existing identity (Grodal et al., 2021, p. 602).

Nomological rubberbanding is one practice that takes a modular perspective on theories, where the consequences of one theory can be the antecedent of another. Patterns offer a natural expansion of nomological rubberbanding connecting the dots not only between mature cause-and-effect constructs but also as modular building blocks in theories. Because patterns have an intermediate abstraction, they are more malleable and flexible than fully developed constructs and abstracted theories. For example, consider patterns of connective actions consisting of how social media participants use social media to achieve collective goals (Vaast et al., 2017, fig. 8). These patterns can be easily ported to other domains beyond online social activism (Vaast et al., 2017, fig. 9).

As an example of pattern flexibility, consider how Miranda et al. (2015) benefited from patterns of social responsibility identified by marketing researchers and then repurposed those patterns to understand the diffusion of these patterns through organizational communication. Specifically, the paper benefited from patterns of social responsibility identified by management researchers, such as the Brand-Promoter schema (Wang & Swanson, 2008), the Good-Citizen schema (McWilliams & Siegel, 2001), and then repurposed those patterns to understand the diffusion of these patterns through organizational communication. This exercise led to the identification of a new pattern, Master-of-Ceremonies schema, with little precedent in the literature (Miranda et al., 2015, p. 602).Outside CITC, the idea of integrating research findings and conclusions across studies is receiving recent attention.

Using patterns as building blocks contributes to creating research programs. Network theory provides a precursory good example of how patterns can be integrated across studies in a research program. For example, consider an early pattern in the strength of weak ties study (Granovetter, 1973). Granovetter found that a person is more likely to find a job through a weak tie than a strong tie within a network of acquittances. This pattern was further developed to understand the spread of information in social networks. For example, the search-transfer study integrates the patterns for information spread with the nature of shared knowledge. In particular, it shows that weak ties facilitate the sharing of simple knowledge. However, they impede the sharing of complex knowledge, which requires a strong tie between the two parties to a transfer (Hansen, 1999). Building on this pattern, theories of information brokerage were developed to integrate other patterns of network structure and knowledge transfer (Reagans & McEvily, 2003).

3.2 Meta-Patterning

The second principle draws from a practice widely used by designers and engineers of identifying and reusing architectural design patterns (Henfridsson et al., 2014). Design patterns were first introduced by the architect Christopher Alexander (1965, 1966). These design patterns are identified from the cumulative experience of what works well. They are then abstracted and standardized. "[E]ach pattern represents our current best guess as to what arrangement of the physical environment will work to solve the problem presented" (Alexander, 1977, p. 15). For instance, the entrance transition pattern facilitates the feeling of arrival and transition from the external environment to a building. This conceptual pattern is implemented in architectural elements such as porches or porticos. The concept was later adopted by software engineers, notably in the object-oriented programming paradigm (Gamma et al., 1995) and later in software and enterprise architecture (Arlow & Neustadt, 2004).

In translating the concept of a design pattern to research, I adopt the term "meta-pattern" to avoid confusing it with patterns as regularities identified from data and observations. Meta-patterns are identified through research experience across contexts and disciplines. There are plenty of examples of meta-patterns often framed as best practices, heuristics, and "tricks of the trade” (Abbott, 2004; H. S. Becker, 2008; Swedberg, 2014). For example, researchers familiar with grounded theory methods (GTM) recognize Glaser’s (meta) coding families (1978). For instance, one family of codes is about the six Cs, including codes about the causes, context, contingencies, consequences, covariances, and conditions (Glaser, 1978, p. 75). Researchers are encouraged to use these abstract codes as sensitizing devices and a starting point when using GTM. Similarly, grand theories such as sociotechnical systems (Nardi, 1996), order of worth (Boltanski & Thévenot, 1999), and structuration theory (Giddens, 1984) provide useful frameworks for studies across domains including information systems (e.g., Desanctis & Scott, 1994; Miranda, Wang, et al., 2022; Orlikowski, 1992).

Meta-patterns can also result from the success of a heuristic in one study. For example, Abbott (2004, p. 130) reviews Harrison White’s study on social mobility, where he showed that vacancies rather than people’s talent drive promotions in organizations (White, 1970). This insight followed a reversal move where instead of explaining the promotion outcome with entities that exist (e.g., choices and talent), White explained it with entities that do not exist (e.g., vacancies). Abbott proposes that reversal can serve as a useful heuristic in social science. In particular, White’s findings drew attention to the role of dynamics over individual attributes in understanding social mobility, challenging, therefore, the incumbent meritocratic explanations.

In contrast to creating new patterns by combining existing ones through modularization, patterns derived through meta-patterning bring together patterns from different contexts across various levels of abstraction. Meta-patterning is thus similar to colligation (Whewell, 1847), conceptual blending (Fauconnier & Turner, 2008), and conceptual combination (Tsoukas, 2009), where a new concept is created by blending two pre-existing concepts so that the blend inherits some of its properties from each of the inputs and usually has emergent properties of its own

(Oswick et al., 2011). For example, White's vacancy chain patterns blend the concept of a hole from physics, popular in studying semiconductors, with the notion of social structure.[5]

In CITC, what differentiates meta-patterning from patterning is that patterning infers patterns from data via computational methods and researcher reflexivity. However, meta-patterning infers further patterns from broad templates gained by the experience of the researcher and the community and often the association between existing patterns through applying heuristics. These heuristics will naturally differ across domains of research and adopted methods. However, applying these heuristics to patterns from data further formalizes these patterns.

There is an opportunity to emphasize the notion of meta-patterns and promote the need for identifying and sharing them. Such meta-patterns can be conceptual, like Glaser's coding families, or associative, like White's vacancy chains. What is unique about CITC is that it brings together researchers across theoretical, methodological, and domain expertise. There is naturally an opportunity for blending and cross-pollination. Finally, modularizing and meta-patterning are often employed simultaneously (Figure 2). By modularizing patterns and re-using them, researchers can create new patterns that can be tested, integrated, and abstracted. With meta-patterns, these empirical patterns can be abstracted into middle-range theories.

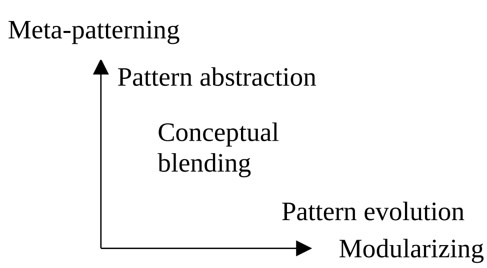

Figure 2: Research moves afforded by modular patterns and meta-patterning.

[5] Abbott notes that White was a physicist turned sociologist and perhaps already knew about a system in which holes played an important role.

3.3 Example of Modularizing and Meta-Patterning

To make the discussion more concrete, I give examples of modularizing and meta-patterning from one published information systems study (Vaast et al., 2017). Although this is one study rather than a research program, the examples still apply beyond one study, and indeed, this publication was preceded by smaller conference papers that published these interrelated findings (Vaast et al., 2014; Vaast, Lapointe, et al., 2012; Vaast, Negoita, et al., 2012).

Vaast et al. (2017) leveraged mixed qualitative with computational methods, including cluster and social network analysis, to develop a new theory of connective affordances through social media from patterns of roles and online interactions in social movements. The context of the study is the Gulf of Mexico oil spill of 2010, for which the authors collected digital trace data from Twitter (currently known as X). The overarching question of the study is how social media can afford social action (Figure 3). In answering the question, the study examined three episodes of social action related to the oil spill. From a dataset of thousands of tweets related to the incident, the study first examined who participated in these episodes. This examination included self-reported roles as well as roles as perceived by the researchers ①. The researchers also examined the patterns of feature use. These features include sharing or posting new content, relaying or retweeting existing content, and interacting or replying to others' content. They used clustering analysis to create common bundles of these use patterns ②. User roles and feature use patterns were then integrated and examined in each episode ③. Combining these two conceptual patterns illustrates using them as modules in conceiving and evolving a new pattern.

In integrating these patterns, the study leverages network theory and particularly meta-patterns referred to as motifs (Milo et al., 2002). Motifs refer to common structural arrangements in a larger network. In the study, Vaast et al. (2017) use motifs to extract patterns of interdependence of different actors in each episode. Because such interdependence depends on feature use, Vaast et al. (2017) refer to these patterns as connective affordances. In particular, connective affordances are characterized by the dependence among technology users through technology features. This new concept is blending the existing concept of collective affordances with connections afforded by social media (④ and ⑤). The theoretical lexicon of this study is that of affordances of technology in collective settings (Ellison et al., 2015; Leonardi, 2013). The connective affordances patterns contribute to this discourse a theory of connective affordances (⑥ and ⑦).

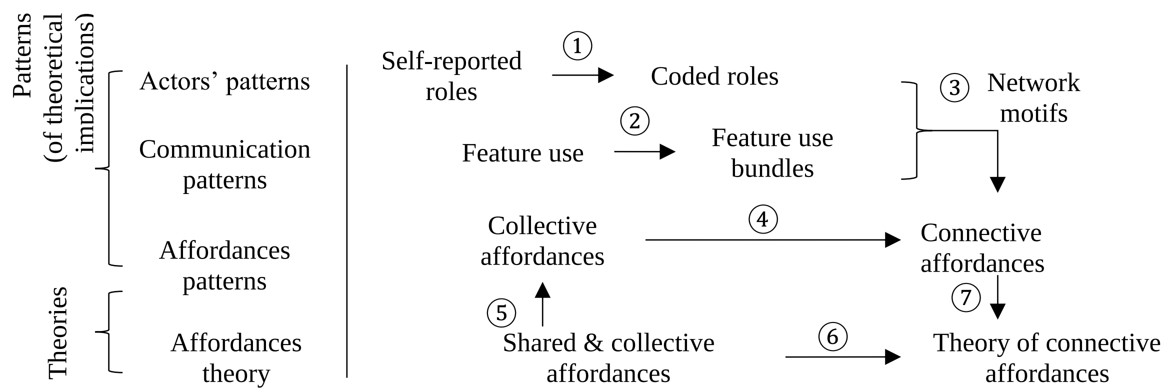

Figure 3: Example of using patterns from trace data as building blocks from Vaast et al. (2017)

This example demonstrates the expansive nature of patterns that computational methods can surface. They extend well beyond traditional constructs and relationships to encompass phenomena observable in digital trace data, such as network motifs, text, and cluster association. Other types of patterns, like sequences and visualizations, are also used in CITC research (e.g., Arazy et al., 2020; Gaskin et al., 2014). This example also illustrates the key difference between modularization and meta-patterning. Whereas modularization is about combining patterns at the *same level of abstraction* to build more complex theories or models, meta-patterning is about *synthesizing* patterns following other heuristics, or meta-patterns, to increase the level of abstraction.

4 Programmatic Research

Pursuing more general theories from particular and middle-range theories is compatible with Lakatos's concept of a research program (Lakatos, 1978). Lakatos (1978) proposes multiple criteria for what constitutes good science. Good science should solve problems effectively, demonstrate accumulation and growth, and be evaluated in comparison to rival explanations. Progressive research programs predict novel facts, lead to new discoveries, maintain a core of fundamental assumptions with a modifiable set of auxiliary hypotheses, and produce theories with high empirical content and predictive power. As such, studies in a research program can focus on satisfying different criteria. Other scholars brought similar criteria of what constitutes a scientific explanation (Nagel, 1961; Woodward & Ross, 2021).[6]

Similarly, based on the internal vis-à-vis external environment of what is explained, one can bring forward synthetic and evolutionary explanations (Simon, 1996, Chapter 2; Tinbergen, 1963). Similar criteria are provided by scholars in the social sciences (Abbott, 2004; DiMaggio, 1995) and information systems (Shmueli, 2010). I now show how using patterns as building blocks can advance research programs on multiple such criteria.

4.1 Promoting Diverse Programs of Explanation

In this work, I adopt the three types of scientific explanation proposed by Abbott (2004, Chapter 1). First, the pragmatic view of explanation focuses on making interventions with a "narrow neck of causality." The example Abbott provides is the germ theory of disease. Second, the semantic view translates the understanding of a phenomenon from one domain to another. For example, economists tend to explain social behavior through the lens of individual utility and

[6] For example, Nagel (1961) proposes four types of historical, functional, probabilistic, and deductive explanations.

self-interest (G. S. Becker, 1993). Third, the syntactic view explains a phenomenon by introducing novel concepts or vocabulary to describe it. Two examples are the work of Freud and Piaget in psychology.[7] Finally, these three views are complementary, for example, a drug trial provides a pragmatic explanation of drug effectiveness, but that explanation is further improved when a semantic view (e.g., through microbiology) is provided.

In information systems, there are examples of the three types of explanation. The pragmatic view of explanation is widely adopted in the economics of information systems and the adoption of econometrics methods to study information systems phenomena (e.g., Bapna & Ganco, 2021; Dewan et al., 2017). On the other hand, earlier work in information systems has largely adopted the semantic view by borrowing from sister disciplines to create behavioral or economic explanations of information systems phenomena (e.g., Bhattacherjee, 2001; Davis et al., 1989). Finally, many studies of information systems have proposed new vocabulary to tackle digital phenomena (e.g., Baskerville et al., 2020; Yoo et al., 2010).

How can patterns contribute to creating multiple explanatory accounts? An implicit assumption is that these three views of explanation vary in their level of analysis. A semantic program implicitly focuses on the macro level view of the phenomenon (across multiple domains), a syntactic program spans different levels, while a pragmatic program is often focused on the micro (for a narrow neck of causality). These are general characterizations, and exceptions may exist, but what is important is the consideration of bridging the macro/micro divide in light of the data available for studying the phenomenon (Rai, 2017).

[7] Sigmund Freud introduced the concepts of the id, ego, and superego, along with the idea of the unconscious mind and defense mechanisms like repression and projection. Jean Piaget developed a theory of cognitive development with stages (sensorimotor, preoperational, concrete operational, and formal operational) and introduced the concept of schemas.

While the distinction between the macro and micro view in research often centers on the level of analysis (Epstein, 2015; Klein & Kozlowski, 2000; Latour, 2005), this distinction can also be made with respect to the nature of generalization. Substantive or contextualized theories offer narrow but rigorous generalizations, whereas formal or abstract theories apply in multiple domains, but their generalizability is to be tested (Glaser & Strauss, 1967; Walsh, 2015). Building on this idea, In CITC research, patterns can be used to unify different modes of explanation and create a bridge between formal/abstract and substantive/contextualized theorizing.

First, as building blocks grounded not only in a methodological lexicon but also in a theoretical and practical lexicon (Miranda, Berente, et al., 2022), patterns offer a language or syntax for studying a phenomenon of interest. For example, social network theory is often conceived as the culmination of patterns of social structures and patterns of their properties (Borgatti & Halgin, 2011). Evolving new patterns through modularizing and meta-patterning enables the creation of semantic and pragmatic explanatory accounts. In particular, patterns grounded in data can be integrated within as well as across domains throughout modularization. The resulting explanation account is semantic at the empirical level. For example, the search-transfer problem "combines the concept of weak ties from social network research and the notion of complex knowledge to explain the role of weak ties in sharing knowledge across organization subunits" (Hansen, 1999, p. 82). Through meta-patterning, empirical patterns can be abstracted, creating a pragmatic explanation account. For example, as outlined in §3.2, throughout the reversal meta-pattern (Abbott, 2004), the patterns of career promotions made the vacancy chain model of social mobility (White, 1970).

The two possibilities, abstract to abstract and abstract to empirical, are plausible although more likely to occur in other genres than CITC (Hedström & Swedberg, 1996, fig. 1). For example, abstract theorizing is often the exercise of logically deriving a set of propositions from their premises and then testing them with empirical observations (Merton, 1949, Chapter 39). However, the emphasis on patterns and the research practices of evolving them can guide research in other paradigms and genres. I further elaborate on this idea in the discussion section.

4.2 Evolving Research Programs

Weick (1989) proposes that theory building is an evolutionary process that requires conducting thought experiments with plausible conjectures for what's being explained. An evolutionary process requires mechanisms for creating various solutions and selecting and retaining the best ones (Baldwin & Clark, 2000, Chapter 9). Modularizing and meta-patterning are variation-creation processes that enable researchers to evolve new patterns from existing ones. Some evolved patterns will be superfluous, while others may be amenable to further abstraction and generalization. Such abstraction can be representational or theoretical. Representational abstraction describes how researchers generate patterns from data as they focus on what is important and represent regularities using conceptual terms. Theoretical abstraction builds on representation and translates it to a community of researchers in a way that attends to their existing knowledge and adds to it with compelling evidence.

Both representational abstraction and theoretical abstraction benefit from modularizing and meta-patterning. Representational abstraction is a key element of data-driven inquiry, and depending on the state of discourse, conceptual and associative patterning can make important contributions. Furthermore, theoretical abstraction, by engaging with the established theoretical discourse in a field, allows for the development of novel or alternative explanations and predictions about a phenomenon.

The selection criteria of what constitutes theoretical contribution still apply (e.g., Miranda, Berente, et al., 2022). Such flexibility enables the experimentation of multiple tentative patterns and middle-range theories. Through modular patterns, CITIC researchers have access to a broad range of plausible patterns, and with meta-patterning, they can make the move for representational abstraction. For example, a researcher studying bots in online communities can examine their interaction patterns by bringing patterns of network exchange (Faraj & Johnson, 2011) and make a reversal move to focus on how bots can make some existing patterns less salient and then interpret the implication of such effect (Safadi et al., forthcoming). Such a tentative theory can be developed and tested independently from the research program using established criteria and guidelines for validity and rigor.

Finally, pattern generalizability can lead to theory generalizability. For instance, patterns holding ground across contexts open the door for general explanations of their existence. For example, the ubiquity of power-law network structures in online networks begs for a theoretical account of their formation and persistence (Johnson et al., 2014).

5 Discussion: Opportunities and Challenges

"Instead of thinking of theory creation as being analogous to drafting on a clean sheet of paper, it is more helpful to think of it as one of erasing, inserting, revising, and re-connecting ideas scattered on many papers that are scribbled full of experiences, insights, and musing of ours and others." This quote by Andrew Van de Ven (2007, p. 105) summarizes the spirit of this article. Our goal as a research community is to have principles for building incremental research programs within the genre of computationally intensive theory construction. Providing such principles requires building blocks and processes for putting them together. My overarching argument is that patterns identified from empirical observations through computational methods can serve as building blocks for theories and research programs.

5.1 Guidance for Individual Researchers Engaging in Programmatic Research

Programmatic research is eventually a collective effort. Even as it emphasizes collaborative and interdisciplinary endeavors, individual researchers play pivotal roles. Individual researchers interested in programmatic research can benefit from deeper specialization while leveraging other researchers' contributions to the genre.

First, programmatic research enables deeper specialization and a division of labor. Researchers could identify their niches, focusing on developing contributions from patterns (Miranda, Berente, et al., 2022) rather than complete theories (Hirschheim, 2019). This chapter suggests that building expertise around certain digital phenomena and method competencies is a valuable endeavor. Second, modular research encourages designing studies with an eye toward how they connect to broader theoretical or empirical questions. By taking such an approach, researchers make work more integrable and valuable to collaborative efforts.

The two suggestions require adopting and promoting open science standards. Adopting norms about sharing data, code, and findings early and openly not only enhances the visibility and impact of one researcher’s work but also creates options for future research programs. More importantly, it creates a community of researchers to engage in programmatic research.

5.2 The Role of Institutions

Adopting a programmatic approach to research and using patterns as building blocks requires an institutional environment that encourages creating and sharing them and developing standard notation for reporting. For instance, network studies succeeded in evolving patterns because the patterns are often concrete and share standard notation.

It is worth noting that some fields, like psychology, are well known for their emphasis on developing shared instruments (Swogger, 2013). Other fields, like computer science, promote sharing data sets and standard benchmarks as proper contributions. For example, advancements in machine translation in the early 2000s were only possible after creating and sharing (imperfect) datasets and benchmarks (Koehn & Monz, 2005; Papineni et al., 2002).

The space in academic journals is limited, and ‘all-in-one’ studies are necessarily limited to presenting a certain level of detail—at the cost of transparency. However, this transparency is important when using computational methods that generate results that are biased not only by the specific discourse (e.g., the features that might matter for this discourse) but also by the specific algorithmic implementation. Extensibility, in turn, is important for re-using patterns as modules in other studies. When patterns of theoretical implications are shared and reported properly, it is possible to conceive of follow-up studies that focus on conceptual abstraction, theoretical abstraction, or both.

The field of information systems is pluralistic and multidisciplinary, emphasizing continuously expanding boundaries, fostering cumulative research traditions, and producing significant research that addresses practical issues and contributes to societal progress (Agarwal, 2016; Burton-Jones et al., 2023). In addition, information systems researchers are leading the way in studying digital phenomena, method diversity, and computational skills. Thus, the field of information systems is well-posited to serve as a platform that transcends traditional research paradigms and embraces programmatic research (Rai, 2018; Tiwana & Kim, 2019). Through continuous refinement of methodologies, adoption of new research paradigms, development of theoretical traditions, and practical contributions, the field of information systems can nurture research programs where numerous talented scholars can make valuable contributions (Sarker, 2023; Seidel & Watson, 2020).

5.3 Beyond Computationally Intensive Theory Construction

Although this work is focused on CITC in information systems, its overarching goal of building cumulative research programs is shared across genres and disciplines. Indeed, one opportunity is to weave CITC patterns with work from other genres into a single fabric capable of revealing different patterns at different scales. In particular, (1) the resurgent focus on mechanisms as a basis for scientific explanation can benefit from patterns as building blocks, and (2) the gap between empirical work and theoretical work can be bridged without necessarily blending the two genres.

First, there is a renewed interest in providing scientific explanations regarding minimalistic mechanisms that directly correspond to observations and steer away from general laws and theories (Bechtel & Richardson, 2010; Glennan, 2017; Machamer et al., 2000). Many scholars in social science advocate mechanisms for explaining social phenomena (Gross, 2009; Hedström & Swedberg, 1996; Makadok et al., 2018; Steel, 2004). In contrast to theories and laws where often latent constructs are invoked, the entities and dependencies of a mechanism map to the real entities and dependencies of the target system (Bokulich, 2017). To establish such a mapping, researchers need to establish the recurrence of these entities and dependencies from data. As such, patterns can be building blocks in establishing various mechanistic explanations, especially when data is fine-grained, large, and complex.

Second, data-driven and theory-driven research may seem like opposing propositions for doing science, and scholars have been calling for a middle ground (Suddaby, 2014). While such a trade-off may be hard to strike within individual studies, the good news is that research programs can incorporate both types of work. In particular, patterns with theoretical implications

(Miranda, Berente, et al., 2022) are the glue that can tie together empirical and theoretical work. As I argued in this work, such patterns can evolve on both dimensions through the practices of modularization and meta-patterning. These practices offer an exciting opportunity for working across disciplines and paradigms without making assumptions or debating the primacy of one view (Anderson, 2008; Puranam, 2019).

5.4 The Potential for Inertia in Conceptualizing Novel Phenomena

Notwithstanding our positive stance, I discuss some of the challenges associated with programmatic research. Commitment to programmatic work may favor established paradigms and limit the researcher's ability to see a new phenomenon as a categorical departure. For example, information systems researchers investigating platforms largely continued to apply established lenses to understand diverse platforms. Stark and Pais (2021) differentiate platform-based organizing from market-, hierarchy-, and network-based organizing, noting that while those focus on contracting, commanding, and collaborating, respectively, platforms focus on co-opting. Given the pace of the evolution of digital phenomena, information systems scholars should remain open to the possibility that the phenomenon being investigated is the start rather than a continuation of a research program. For example, digital platforms have recently deviated from fostering participation and connectivity toward capturing data and monopolizing innovation and creativity (Safadi & Watson, 2023). CITC researchers who undertake data-driven theorizing must be sensitive to this possibility.

5.5 Ethical Considerations

In some cases, researchers may wish to relinquish a theoretical trajectory because its implications turn out to be unethical, even immoral. An extreme example is that of eugenics, which is the study of the genetic improvement of humans that was widely practiced in the early 20th century, particularly in the United States and Europe. As another example in management studies, one highly influential theory has been transaction cost economics (Williamson, 1975). Though Williamson offered an elegant understanding of the conditions under which transaction costs accrue, the normative implication of the theory was deemed “bad for practice piece” as organizations perform more functions beyond structuring efficient transactions when the market fails (Ghoshal & Moran, 1996). Finally, using digital trace data is rife with ethical hazards around the privacy and dignity of the research participants (Hakimi et al., 2021; Leidner & Tona, 2021).

6 Conclusions

Computational tools are now increasingly used as scientific tools to aid scientists in pattern recognition from increasingly larger and more sophisticated data (Langley & Bridewell, 2005) and have been borrowed by multiple fields, including information systems (Agarwal & Dhar, 2014; Miranda, Berente, et al., 2022; Rai, 2016). Prior work in the emerging genre of computationally intensive theory construction emphasized the role of human pattern recognition and machine pattern recognition as well as the potential synergies between the two (Berente et al., 2019; Lindberg, 2020). “Science is a conversation between rigor and imagination. What one proposes, the other evaluates” (Abbott, 2004, p. 3). As prior work focused on rigor (Miranda, Berente, et al., 2022), I take a step forward and unpack how patterns can be building blocks for creating individual theories and evolving cumulative research programs that promote diverse views of scientific explanation. I describe the two research moves of modularizing and meta-patterning that leverage patterns as building blocks for the creation of research programs that move away from tactical (Grover et al., 2020), easy (Rai, 2016, 2017), and all-in-one research templates (Puranam 2018, pp. 159–161).

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