Introduction to Data Economics Chapter 4:

Deeper Dive into Fundamental Data Economic Concepts

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Introduction to Chapter 4: *Deeper Dive into Fundamental Concepts of Data Economics*

“Deeper Dive into Fundamental Concepts”, the 4th Chapter in the Introduction to Data Economics series, marks the end of the introductory chapters of the series and the start of more detailed exploration of Data Economics and related topics. As mentioned in Chapters 2 and 3, Chapter 4 can be read directly after either of those chapters.

If read immediately after Chapter 2, readers will likely see a fair amount of direct references and parallels to Chapter 2 from Chapter 4, but it is suggested that these readers go back and read Chapter 3 at some point.

If this chapter is read after Chapter 3, readers should be even more familiar with the concepts outlined in Chapters 4 and 5. These chapters will reference Chapter 2 liberally, so these readers may want to refresh themselves on the specific material introducing various topics in Chapter 2 as they come across these references in Chapters 4 (especially) and 5.

Chapter 4 directly expands on some of the major concepts introduced in Chapter 2:

- What the discipline of Data Economics aims to achieve and enable, including different methods of defining "Data Economics". Section 1 in Chapter 4 expands on this material introduced in Section 2 of Chapter 2.
- The concept of Data Economic Utility and Data Economic Frames of Reference (or "Data Economies" for short), that is, to use digital data as raw materials to create products that have standalone utility and value. Section 2. 3.1 and 3.2 in Chapter 4 expands on these concepts introduced in Section 3 of Chapter 2.
- The concept of a Data Economic Operating System, a software-based system to turn packages of digital data into valuable products that can be utilized within a Data Economy (or a Data Economic Frame), including an intuitive understanding of "everyday" DEOS and Data Economic Frames we interact with, before expanding into a discussion on a general framework for what a DEOS needs to do to turn raw digital datasets into utilizable Data Asset products. Sections 3.3 to 3.6 in Chapter 4, as well as most of Chapter 5, expand on this material introduced in Section 4 of Chapter 2.

While Chapter 4 focuses on the broad, general concepts around Data Economic Utility and the functionality of Data Economic Operating Systems, Chapter 5 explores a very specific Data Economic Methodology for turning raw digital data packages into useful Data Asset products: the Lydion Data Economic Methodology. The Lydion Data Economic Methodology is the methodology implemented by
the Lydion DEOS to turn raw digital data packages ("Data Quanta") representing the outcomes of tasks completed in the real world into useful and valuable Lydion Data Assets. Chapter 5 discusses the Lydion Data Economic Methodology and the functions that the Lydion DEOS performs in implementing the Lydion Data Economic Methodology in greater detail. It is meant to be read directly after Chapter 4.

1. Introduction to Data Economics and Data Economic Utility

1.1 What is Data Economics?

The most general definition of Data Economics is that it is a science that deals with the implications of *using* ***digital data*** *as units of utility and value that enable economic activity.*

Utility is another word for "use"—and something with use is something of value.

To put it another way, Data Economics is concerned with *treating digital data as raw material that can build or manufacture products with utility;* this can enable us to:

1. Pay for things with these digital-data-based products and
2. Measure the value of things using these digital-data based products.

As a result, Data Economics lets us sell, license, and buy the "ownership of the utility—or *uses*—of data" without losing control or ownership of the underlying data or datasets.

(Coming Soon) Diagram 1.1: "Definition(s) of Data Economics"

1.2 What does Data Economics Enable?

Data Economics is interested in enabling 3 key scenarios:

1. Others can pay you money in exchange for specific units (or pieces) of your data.

2. Others can provide things (goods, services, labor) in exchange for specific units of your data—effectively allowing you to pay with your data.

3. Others can give you access to and the ability to use specific units of their data in exchange for specific units of your data.

(Coming Soon) Diagram 1.2: "The 3 Types of DEs - 3 Types of "Paying for Things" with Digital Data"

The current business models that enable the monetization of digital data typically treat such data as a featureless commodity that is bought, licensed, and sold in bulk as digital datasets. Consequently, the current models for utilizing digital data are as follows:

1. Serving as data sources for digital applications delivering specific features / value to users, and hence financial value/revenue for the creator of the digital application.

2. Serving as a commodity that can, when analyzed, can produce insights leading to potentially more financial value—but these insights have to be implemented via strategy and execution to gain further utility (that can themselves require additional resources.)

3. More recently, due to the advent of cryptocurrencies and utility tokens—using uniquely nominated and identifiable packages of data (tokens) as a form of "currency" that can be used (usually in an exchange) to gain goods, services or other utilities/outcomes made available by the token. This development is significant, since it marks an evolution in the utility of digital data from only being exchangeable for traditional currency to being exchangeable for other types of goods and services.

We refer to these models as "legacy" models for understanding the value of data. The science of Data Economics contributes a new layer of understanding to how data gains value through

utility.

(Coming Soon) Diagram 1.3: "Traditional Utility of Digital Data"

Data Economics, in contrast to previous models and understanding of the value of data, considers that digital data can serve as a raw material for manufacturing (or *minting*) products that have utility and value.
We call these products that are created using digital data *Data Assets*.

Therefore, Data Economics enables the creation of products using digital data that themselves have value and can be used (or utilized) to create new, valuable outcomes—such as gaining access to money or other types of goods and services.

1.3 Understanding "Data Economic Utility" Compared to "Traditional Economic Utility of Data"

The difference between the legacy models for utility of data and the "Data Economic Utility" of digital data can be demonstrated with an analogy. Imagine the datasets owned by you or your company as parcels of land and the data streams you generate or access as lakes and rivers. If asked to "utilize" your land and water bodies, you have some options:

1) You could either sell or rent the land and water bodies, as a whole or in pieces.

2) As another option, you could use the land, the water bodies, and the resources they contain to build products that have their own uses (or *utilities*).
    a) You could mine or otherwise extract resources (minerals, oil etc.) from the land and water (fish, drinking water) and sell or rent those resources.

    b) You could use or utilize these extracted resources to create products by putting them through a manufacturing process. For example:
        i) forge metallic products from extracted ore,
        ii) purify and package the water to sell it as bottled water,

iii) till the land and sow seeds to grow crops.

c) In many cases, you may even combine resources and products generated from your land and water to create new products, such as:
   i) combining the ore, metallic products, and oil to build an engine,
   ii) building canals to use the water to irrigate your crops, or
   iii) routing water to a hydroelectric pump powered by the engine you built.

(Coming Soon) Diagram 1.4: "Data Economic Utility - Data Asset Products from underlying datasets"

Similarly, within a Data Economic Frame of Reference, or what we call "Data Economies" for short, we can treat our datasets and data streams as reusable raw materials. Within such a Data Economy, we can use our data and datastreams in a variety of ways, including:

1. Extracting data from datasets and streams to manufacture (or mint) products called Data Assets using the underlying data. These Data Assets can then be sold, licensed, bought, or otherwise utilized. *These are called "Base" or "Foundational" Data Asset types.*

2. In addition to being utilized directly, Data Assets thus extracted can also be used as inputs (raw materials) for producing other types of Data Assets.

3. Multiple types (or classes) of Data Asset products can be combined to form new types of Data Assets.

The second and third examples above, where Data Assets are combined as inputs to other Data Assets, result in "Derived Data Asset" types, meaning they derive at least part of their data from one or more "parent" or "source" Data Assets.

Author's Note: The above concepts are explored in some detail, including the key concepts of "Pure" and "Mixed" Data Economies in Chapter 3: Types and Examples of Data Economies. While Chapter 3 is not required reading for the rest of this Chapter, It is recommended that the Chapter 3 Chapter

be read either before, after, or as a companion to this Chapter . Links back to Chapter 3, as well as other related Chapters are referenced throughout the rest of this Chapter as relevant.

2. Impact of Assetization of Digital Data into Data Assets

2.1 Why Should Digital Data be turned into Data Assets?

Unlike physical resources, digital data can be copied and transformed without losing the original raw material.
As a result, the same dataset can be used as raw materials or as intermediate resources to produce multiple types of revenue-generating Data Assets.

Within a Data Economy, or within a Data Economic Frame of Reference, instead of buying, selling, licensing data, we can therefore *buy, sell, license specific uses or utilities of data* that are packaged up as products: Data Assets.

This brings us to the important concept of "utility ownership of data".

- If a person sold a product—such as bottled water or extracted ore—from their land, they are not selling the land itself; they are selling the ownership of a useful product (what we will refer to as utility) generated from the land. Similarly, if they sell a Data Asset, they are selling the ownership of a specific type of utility of the data, not the data itself.

- Similarly, they can license or rent a specific utility of a data quantum packaged up as a Data Asset without losing ownership of the Data Asset. Think of this as renting out a car rather than selling it. The renter of the car can utilize (or use) the product to drive around for a defined period of time, but cannot, for example, sell it for parts.

So, as a baseline use case of Data Economics, consider any dataset or data stream that a company or an individual is generating. Instead of having to make the binary choice between "licensing or selling my data", or perhaps not being able to generate any revenue from the data despite its potential usefulness or value to third parties, the producers and owners of this data

can instead start designing specific types of Data Assets as *products* that can be individually packaged, licensed, and sold based on either existing or possible future markets for each type or class of Data Asset.

(Coming Soon) Diagram 2.1: "Data Asset Products increasing the value of underlying dataset"

As a result of such utilization, the value of the underlying dataset increases each time a new type of Data Asset is derived from it.

2.2 Examples of the Same Underlying Datasets Providing Raw Material for Different Data Asset Types

(Coming Soon) Diagram 2.2: "Creating Data Asset Products from Music Streaming App Data"

1. **Music Streaming Data Example:** Consider the example of a music streaming application that allows listeners to stream music and creators to upload and advertise their music. The company running this application is collecting data both on the listening habits of music lovers and music creators.
    a. The company can create different types of Data Asset products using these different types of datasets, sometimes even by combining them.
    b. For example, a Data Asset type could package up key analytics and insights about the habits and preferences of (anonymized or aggregated) music creators and be targeted at companies producing products for music creators.
    c. Another Data Asset type could be packaging up insights on the behavior of anonymized music listeners, and be targeted towards other companies catering to music fans.

Going further, let's say that a company such as SoundCloud decided to allow a competitor such as Spotify to have access to insights derived from the habits of music listeners. SoundCloud may

want to not only control the specific insights Spotify has access to, but also ensure that they get credit each time Spotify utilizes their data.

(Coming Soon) Diagram 2.3: "Creating Data Asset Products from Sports App Data"

2. **Sports Data Example:** Consider as another example a company collecting data from various professional and amateur sports leagues.
    a. Typically, if this company were to sell or license data, it would either have to sell / license datasets (and insights) exclusively to a set of users with no control over how the data is used or for what, or would have to risk the data and its related insights being devalued if made available to all potential customers.
    b. With a Data Economic Operating System (or DEOS), the company can instead design a set of products—or types of Data Assets—tailored to each of the markets they want to cater to without diluting the value of the underlying data.
    c. For example, they can design a set of products—or classes of Data Assets—that are tailored for analytics used by sports teams to analyze and improve their performance, and they can make these products available through a market (called a Data Asset Market) catering to teams.
    d. Similarly, they can design Data Assets optimized for the sports media and sports analysts that package up the underlying data with insights useful to the media and that are designed to be licensed, sold, and utilized by a different Data Asset Market.
    e. Another set of Data Asset classes could be products geared towards the sports betting community that package up insights that are interesting to people making books or placing bets.
        i. Furthermore, different products or Data Asset types could be developed that are targeted at bookmakers and at bettors.
        ii. It will be especially critical to control the scope and distribution of such insights due to the direct financial implications of the broad availability of such data. If a specific insight around betting is widely known, its value could be greatly reduced.

f. Instead of diluting the value of the underlying data, each type of Data Asset minted from a specific dataset ends up helping to appreciate the value of the underlying dataset, as value is derived from actual and potential utility.

(Coming Soon) Diagram 2.4: "Creating Data Asset Products from Anonymized Location Data"

3. **Anonymized Location Data Example:** Related to the above example, a reasonable question to ask is: "Why aren't the users of the music streaming application getting any credit for—or any share of—the significant revenue that is being generated for the music application through the creation of anonymized music consumption data?"

This question is relevant for all data that people and organizations generate through their digital devices. Their data is monetized by third parties, but none (or very little) of the credit and value typically flows back to the people generating the data.

As discussed in **Sections 4.3 and 4.4 of Chapter 3**, one of the most valuable types of data that our phones and tablets continuously generate and transmit is location data—GPS and related data—around where the device is physically located at any given time.

Cellular networks have access to (and, to a great extent, "own") the data that they are helping transmit through their networks, yet it is you, the user, who is doing the work to create those data assets by keeping your phone close by as your location changes and maintaining your network connection (typically by remembering to pay your network bill).

If a system existed that allowed you to control exactly who can use your anonymized location data (if you so choose, with your permission) and also to **receive credit** for this data being licensed or sold, the relationship between you and your cell phone company would look very different than it does today.

Not only would such a system potentially let the user (generator of the data) earn money from a share of revenue generated from your anonymized location data, but in such a world, the cell

phone companies would be competing with each other *to give value to the user (data generator) in exchange for the user giving them access to and permission to utilize the user's anonymized location data.* This value could include almost anything: cell phone services, handset upgrades, or other incentives potentially unlocked by your data. **The user might effectively be paying for their cell phone service, handsets, and much more with their data when it is turned into Data Asset products.**

2.3 Capabilities of "Assetized Data" or Lydion Data Assets

The upcoming **Section 3** introduces the concept of a Data Economic Operating System (DEOS) and Data Economic Frames of References (or Data Economic Frame) that a DEOS can help implement.

Data Assets of any given type, as we will learn, must exist within a single, well-defined Data Economic Frame in order for their utility and value to be expressed, transferred, or otherwise utilized.
Existing within a Data Economic Frame imbues the digital data packaged up as the Data Asset several unique features. These features, common to all "Data Assets," are defined and examined throughout Section 3.

Section 1 of Chapter 5, which comes in sequence just after Section 3 of the current Chapter 4, introduces the Lydion Data Economic Operating System, which implements the specific Lydion Methodology for turning datasets and data streams into Lydion Data Assets.

The Lydion DEOS imbues Lydion Data Assets with a superset of the features defined for Data Assets in general (in Section 3). Most notably, the manufacturer of a Lydion Data Asset using the Lydion DEOS can:

1. Define the rules for interpreting the meaning or "context" of each data quantum packaged up as a Data Asset—the reasons for the Data Asset existing.

2. Define the rules governing what each unit—or quantum—of data packaged up as a Data Asset can be used (or utilized) for. These "utilization" rules are typically dependent on the "context" rules, or the "meaning" of the Data Asset.

3. Define the rules around exactly who can access and utilize each Data Asset, as well as for what purposes, when, and under what conditions.

4. Define rules around evaluating each Data Asset to express its "value" in terms of money or other Data Assets.

5. Define the rules around the credit that the manufacturer wants to receive for each utilization (use) of each Data Asset, and the method for distributing such credit back to the manufacturer.

6. Track and audit the journey of their Data Assets throughout the Data Economic Frame—creating the ability to examine exactly who accesses or utilizes the Data Asset.

7. Enforce the above rules to ensure that the Data Asset is being accessed and utilized exactly as intended, and that credit due to its utilization—as monetary or other forms of value—flows back to the manufacturer and others as defined in the rules.

8. Track and audit Data Assets and enforce the above rules independently, without having to depend on any central source of information or authority.

(Coming Soon) Diagram 2.5: "Capabilities of 'Assetized Data'"

The upcoming Section 3 in this paper will explore details of how Data Economic Operating Systems in general can imbue Data Assets with features, and Chapter 5 will focus specifically the methodology that the Lydion DEOS adopts to enable the features described above into Lydion Data Assets.

3. Introduction to Data Economic Frames of Reference and Data Economic Operating Systems (DEOS)

3.1 Introduction to Data Economic Frames of Reference and Key Properties of Data Assets as "Utilizable Products"

The “how” of manufacturing Data Assets is the heart of Data Economics. To have the ability to define a methodology of turning digital data into Data Assets, a software system needs expose a system to implement two primary concepts common to all Data Economic Methodologies:

1. A Data Economic Frame of Reference

2. A set of features common to most “Utilizable Products” — Identity, Context, Utility, and Value

The most fundamental concept in Data Economics is that of a *"Data Economic Frame of Reference," which we shorthand as a "Data Economy":*

1. Much like we need an origin and a frame of reference for any coordinate system to make sense, we need a Data Economic Frame of Reference for Data Assets and their related properties, features, and other concepts to exist.

2. As far as the "products"—Data Assets built using digital data as raw material—are concerned, their existence, utility, and value are limited to participants (people, groups, organizations, or even computers/machines) within a specific Data Economic Frame. So, we'll take it for granted that whenever we talk about a Data Asset, Data Asset Market, etc., that they exist within a frame of reference, or within a Data Economy.

3. Outside of its Data Economic Frame, a Data Asset is just an ordered set of 1s and 0s.

The second key concept of Data Economics is that in order to be used as a standalone product, a Data Asset needs to have a set of features common to most "utilizable products":

1. **Identity:** How the package of data representing the product, or Asset, can be identified within the Data Economy (and be distinguished from its copies).

2. **Context** (**Meaning**)**:** What the package of data within the product (or Asset) means to others.
3. **Utility:** Exactly how the Asset can be utilized, when, by whom, and under what conditions.

4. **Value:** Methods to evaluate the Data Asset to express its "value" represented as some form of money or as other Data Assets.

Therefore, the manufacturer of a Data Asset type needs to define and control at least these features, as well as express them to all Participants within the Data Economic Frame.

3.2 Deep Dive into "Familiar" Data Economic Frames of Reference

The concept of a Data Economic Frame where we are able to pay with digital data-based products may sound alien, but we actually operate within Data Economies a fair bit already in our day-to-day lives and are even able to pay for things with Data Assets. Some examples of "everyday" data economies that may be familiar:

Data Asset Type	**Participants in Data Economic Frame**
Coffee Shop Loyalty Card	Coffee Shop, Customers
Credit Card "Miles"	Credit Card Co., Airlines, Customers
Money eg. US Dollar	US Treasury, All Entities trading in USD
Bitcoin	Bitcoin Network, Bitcoin Miners, Bitcoin Users

(Coming Soon) Diagram 3.1: "Data Economic Frames - "Everyday" Data Economic Frames Examples - Coffee Shop, CC Miles, Bitcoin - Show "Work" Being Done to Generate"

1. **Coffee Shop:** For example, a Local Coffee Shop gives their customers a free coffee with every 10 purchases of any type of coffee on their menu. When a customer first visits the shop, they give the customer a blank Loyalty Card. Each time the customer buys a coffee, the barista stamps their Loyalty Card, recording the purchase. When the customer has a Loyalty Card with 10 stamps on it, they can exchange that card for a coffee.
    - In this case, the customer just paid for their 11th coffee with a piece of information, or data. To be more specific, the customer (with the help of the Coffee Shop) *created a product using data.* The product in this case is the Loyalty Card with 10 stamps, where each stamp is data representing a transaction between the customer and the coffee shop.
    - The Coffee Shop and the customer in this case are Participants in a common Data Economic Frame of Reference (let's call it the Coffee Shop Data Economic Frame)
    - The Loyalty Card the customer creates using coffee transactions is a type of product—or Data Asset—that can be utilized by them within the Coffee Shop Data Economic Frame to generate new outcomes they value—that is, access to a new cup of coffee.
    - Also important here is that the Loyalty Card has no meaning—it lacks necessary "Context"—outside of the Coffee Shop DE Frame of Reference, and can't be utilized, say, at Walmart or even at a Starbucks.

2. **Credit Card "Miles":** Similarly, let's say that a person has a credit card that lets them earn "miles" as a reward for making purchases using that credit card. These programs are not very different from coffee shop Loyalty Cards in concept. The customer earn a certain number of miles for each transaction using the card (just like they earned a stamp for a coffee purchase on their Loyalty Card), and after accumulating a certain amount of points or "miles," they can exchange them for airline tickets (or other things of value that the credit card company might offer), much as a person can exchange a completed coffee Loyalty Card for a coffee.

- Here, a Data Economic Frame gets created between the customer, the Credit Card Company, and the airlines wherein the credit card user can redeem their Miles for tickets. In almost all cases, the credit card miles will be canonically represented and transacted as digital data.
- The Miles are the Data Assets that get generated as a result of the customer's credit card transactions and that can then be utilized to purchase plane tickets and related benefits (such as access to hotel rooms or other perks).
- Again, the credit card miles only have "Context" (or meaning) and "Utility" within the Data Economic Frame of Reference of the Credit Card Company. The credit card user can't redeem their Miles at an airline that isn't within the Data Economy, nor earn them with, say, transactions on an unaffiliated card.

3. **Cryptocurrency (and Utility Tokens):** In fact, the idea of paying for things and working with pure digital data instead of money seems even more possible now than it did even a decade ago due to the advent of digital cryptocurrencies and utility tokens circulating within networks typically powered by blockchain databases. We can now not only imagine how data could represent value exchange, but can also pay for things with Bitcoin and Ether, and we can even build digital applications that power and are powered by the value of corresponding markets represented by cryptocurrency exchanges.
    - In the case of Bitcoin, a Data Economic Frame of Reference is created among the participants in the Bitcoin Network and among those who accept Bitcoin for payments, with the quantities of Bitcoin in each Participant's account serving as a Data Asset.
    - As before, Participants can generate new Bitcoin by doing "work" for the Network (recording transactions in a distributed ledger, and "mining" new Bitcoin as a result, and can utilize the Bitcoin within the Network for goods, services, and currency.
    - Also, as before, you can't typically use Bitcoin at your local grocery store (unless they are really at the cutting-edge of grocery stores) to buy milk; you have to utilize it within the DE Frame of the Bitcoin Network. (Similarly, you can't use Euros or British Pounds at a store that doesn't accept those currencies; they are

only useful for purchases—a utilization—within a specific DE Frame. Outside of that frame, they may only have one utilization—exchange for a different type of currency.)

4. **Money:** Even money, whether hard currency, fiat currency, or cryptocurrency, can be conceptualized as units of data. Each unit of money represents a piece of information, usually about how and why it was minted, and has an understood utility in an economy regarding what it can be used for, and how. A gold coin represents a quantity of a difficult-to-produce metal, minted into a coin specifically to allow it to pay for other things. A US dollar represents a unit of credit that the US government owes the bearer (or owner) of the dollar.
    - A Data Economic Frame of Reference is hence created among all Participants who are willing to utilize the US dollar, or the gold coin, and exchange goods and services for it.
    - If a person goes outside the Data Economic Frame—somewhere where the US Dollar isn't recognized or accepted—their dollars don't really have any utility.

5. **Location or other User Data:** We discussed earlier that anonymized location data for devices and their users has lucrative financial markets associated with them. The utility of the data that users are generating through their devices goes far beyond just financial compensation. See **Sections 4.3 and 4.4 of Chapter 3** for details.

3.3 Introduction to Data Economic Operating Systems (DEOS)

As discussed earlier, in order to be utilizable as a standalone Data Asset product, a package (or quantum) of data needs, the manufacturer of such a Data Asset has to define:

1. A Data Economic Frame of Reference, and

2. A Methodology for injecting properties into the data quantum that are needed for it to be a "utilizable product".

(Coming Soon) Diagram 3.2: "Properties of a 'Product' that can be 'Utilized'"

As discussed earlier, the properties that a Data Asset needs in order to be a "Utilizable Product" are as follows:

1. **Identity:** How the package of data representing the product, or Asset, can be identified with the Data Economy (and be distinguished from its copies).

2. **Context** (**Meaning**)**:** What the package of data within the product (or Asset) means to others.

3. **Utility:** Exactly how the Asset can be utilized, when, by whom, and under what conditions.

4. Value: Methods to evaluate the Data Asset to express its "value" as money or other Data Asset(s).

The system that the manufacturer of a Data Asset Type uses to transform digital data into Data Assets is a *Data Economic Operating System.*

Using the "Familiar" Data Economic Frames of Reference from Section 6.1 as examples, we can identify the various DEOS that are used to manifest and control each of these Data Economies:

(Coming Soon) Diagram 3.3: "Everyday DE Frames Mapped to Corresponding DEOS"

Data Economic Frame of Reference	Corresponding Data Economic Operating System
Coffee Shop - Data Economy	Is presumably run using some combination of digital accounting and digital Loyalty system which serves as its DEOS.
Credit Card Miles - Data Economy	The software infrastructure enabling your credit card transactions, recording of miles generated, and enabling the

	utilization of the Miles through various airlines in this case serves as a DEOS.
Cryptocurrency and Utility Tokens - Data Economy	The blockchain-backed digital network—including computers serving as Nodes in the network running the necessary software (Bitcoin or Ethereum code, for example)—serves as the DEOS.
Location or other User Data - Data Economy	The infrastructure allowing you to send out your data (usually a Telecom network) and receive services in exchange acts as a DEOS in this case.

In order for a quantum (or package) of data to be converted into a Data Asset, that data package needs to carry and convey: 1) Identity, 2) Context (Meaning), 3) Utility, 4) Value.

Thus, a DEOS needs to be able to take data packages, or data quanta, from the datasets being used to design the Data Economy and inject these four properties or qualities into that package. A DEOS typically does this as follows:

1. **Inject Identity via Metadata:** Give each such package of data (or Data Quantum) a unique identity, using additional metadata such as a unique identifier, such that any participant in the Data Economic Frame is able to recognize and verify the specific package/quantum making up the Data Asset—including being able to tell it apart from other copies of that data quantum.

2. **Inject Context, Utility and Value via Rules Encoded as Digital Programs:** Inject a set of rules into the data quantum that allows a Participant in the Data Economic Frame, using digital programs, to:
    a. **Define Context Rules:** what the Data Asset means—its Context or reason for existing.
    b. **Define Utility Rules**: how the Data Asset can be used or what it can be utilized for, and the conditions and parameters that need to be met for such utilization.
    c. **Define Evaluation Rules:** how the value of the Data Asset can be measured using other things (currency, goods and services, or other Data Assets.)

3.4 A DEOS Injects Features into Digital Data to Transform it into a "Utilizable Product" through an "Assetization" Process

There are several methodologies and approaches for a DEOS such as the ones described above to inject identity, context, utility, and value into the digital data that needs to be assetized, or turned into Data Assets.

The process of turning a digital data quantum (of any size—from a small data "packet" to large data "sets") into a utilizable Data Asset is called "Assetization." Correspondingly, the methodology that a DEOS uses to inject the properties required by a "utilizable product" into a digital data quantum is called its **Assetization Process** or **Assetization Methodology.**

The Assetization Methodology of a DEOS is specific to the Data Economic Frame of Reference that it implements, but the goal remains the same—to inject at least the properties of Identity, Context, Utility, and Value into a digital data quantum and turn it into a type of Data Asset.

Regardless of the specific Data Economic Frame(s) that a DEOS implements, as long as the DEOS deals with digital data, there are some standard frameworks to define these key properties for a data quantum:

1. **Injecting IDENTITY via Metadata**

2. **Injecting CONTEXT via Digital Programs**

3. **Injecting UTILITY & VALUE via Digital Programs**

(Coming Soon) Diagram 3.4: "High level Assetization Process: Data Quantum + Wrapped in Identity/metadata + Wrapped in Context + Wrapped in Utility and Value -> Data Asset"

3.4.1 Injecting Identity via Metadata

The ability for a specific package or quantum of digital data to be uniquely identified within a closed digital network is not really very novel, and there are a number of different ways to attach metadata to a digital data package/quantum to achieve this:

1. Most networking protocols including TCP/UDP/IP that run the Internet define ways to package and transit digital data in uniquely identifiable packages.

2. Persistent packets of data that can be uniquely identified, transmitted and audited/tracked can also exist within closed digital networks without a central authority/control cloud—as long as the computers, or nodes, making up the network have a distributed consensus algorithm for building, identifying, and verifying these packets.
    a. Good examples of this are cryptocurrency and utility tokens generated and circulated within blockchain-backed digital networks, where any participant in such a network has the apparatus to uniquely identify and verify each unit of value—units of cryptocurrency, utility tokens controlling flow of cryptocurrency, and more.
    b. Note that we use cryptocurrency / utility token networks just as an example here—there are many other ways beyond blockchain databases and related algorithms to implement such digital networks and distributed consensus algorithms.

As long as there is a digital network with consensus algorithms to agree (or disagree, if needed) on the identity of specific quanta / packages of data, the ability to inject identity into such a package of data via metadata is trivial.

3.4.2 Injecting *Context* via Digital Programs

The idea of "Context" or meaning of a digital data set or quantum. Digital data by itself is just 1s and 0s in a specific order. What gives this digital data meaning, or context, is our ability to

define rules—Digital programs—that in turn help define the meaning of that digital data (that is, give it context).

This process in turn means that as long as the digital data is available, any Context or meaning that can be expressed by a digital program can be imposed upon it.

We in fact do this all the time—none of us really has the ability to interpret the binary digital data that's constantly flowing through our devices without a gazillion digital programs doing their jobs to translate that data for human consumption (give it context).

3.4.3 Injecting *Utility and Value* via Digital Programs

This brings us to the concepts of Utility and Value:

1. **The "Utility" of a thing is its ability to generate new Outcomes, or results, when put through a process of utilization.** To put it simply, utility of a thing is "the ways (Utilization Processes) that it can be used, and the results (Outcomes) that can be produced when the thing is used in one of those ways."

2. **The "Value" of a thing is simply a measurement of the utility of that thing.** The same thing can have many values, when put through different "Evaluation Processes."
    a. For example, the value of a gallon of water could be equal to the nourishment received if it is utilized for drinking. *("**A Utility Value**")*
    b. The value of the gallon of water could also be due to its utility to irrigate crops and the related outcomes: the crops grow better, healthier etc. *("**Another Utility Value**")*
    c. The value of the same gallon could be X dollars, if exchanged through a market. *("**An Exchange Value**").*

As long as the rules of these processes can be translated into digital programs, both Utilization and Evaluation Processes can also be expressed as digital programs that operate on the data quantum.

Therefore Context, Utility, and Value can all be expressed via rules encoded and enforced by digital programs that operate on the digital data package or quantum making up the Data Asset.

In addition to the inherent properties of Identity, Context, Utility, and Value, products usually have some external state carried as metadata:

1. **Ownership** (**and other States**)**:** Methods to allow the product / Asset to be "owned," and for this "ownership" to be transferred from one participant in the Data Economic frame to another. Now, being a piece of digital data, the Data Asset can carry a "state" that goes beyond simple "Ownership" which can be defined by the manufacturer of the Data Asset type.

2. **Auditing and Tracking:** Ensure that each quantum of data—packaged up as a Data Asset—can be tracked by its manufacturer (or owner) to ensure that it's being used exactly as they intended, and that any credit due to the utilization flows back to them, whether as money or as another form of value.

Therefore a DEOS, in addition to having the ability to inject Identity, Context, Utility, and Value into a digital data quantum, should ideally provide the rules and infrastructure to:

1. Track the ownership of the data quantum once it is turned into a Data Asset (once it is assetized).

2. Track other states (or metadata) relevant to the data quantum once it is assetized.

3. Track the utilization of the Data Asset, including transfers of ownership and other state changes.

In the remainder of this Chapter 4 and throughout Chapter 5, we will examine the above concepts in more detail:

1. In **Section 3.5 and Section 3.6**, we will build up to a general framework for turning raw data into Data Assets by the injection of Context, Utility, and Value functions into it.

2. In **Section 1.1 of Chapter 5 of** *Introduction to Data Economics*, we will examine how this generic framework for designing Data Assets translates to a specific methodology called the "Lydion Methodology for Data Assetization" which can be used to convert any combination of datasets and data streams into Data Assets using the Lydion DEOS.

3. In **Section 2.3 of Chapter 5**, we examine the methodology that the Lydion DEOS uses to enforce Auditability and Tracking of Data Assets within their Data Economic Frame of Reference.

3.5 Atomic Data Economic Concepts—*The Relationship Among Context, Utility, Value, and Data Assets*

*(**Author's Note: This Section 3.5** is more technical than the rest of this paper. Section 3.5 provides technical background for the conclusions in **Section 3.6**, but it can be skipped if desired, and the reader can proceed directly to Section 3.6 after **Section 3.4**)*

We have seen some examples of how data quanta can be imbued with utility and value—Coffee Shop Loyalty Card, Credit Card Miles, Cryptocurrency etc.—and turned into Data Assets that exist within a Data Economic Frame of Reference.

From these examples, we can arrive at some general conclusions about the relationship among Identity, Context, Utility, and Value.

By extension, can also examine the relationship of these concepts to another key economic concept—that of "Scarcity."

What is common across these examples, and in fact every single product that we can imagine with utility and value, is the following:

3.5.1. The Utility (and, therefore, the Value) of a thing (or action, or thought) is based on its *history or past state.*

In other words: ***The Utility of a product is dependent on its Context (meaning) and Identity.***

To be more specific, in order for a product to have Utility, it needs to be able to tell a "Story of Utility" based on its "context"—which includes its meaning and origin:

- *"I mean X, hence I can be utilized for Y"*

Any quantum of data, in order to be a Data Asset, *needs to be able to convey a Story of Utility to the Participants in its market* based on its Context or meaning of the form:

1. "I mean X, hence I can be utilized for Y"

2. In a bit more detail: "I mean X due my Context C, hence I can be utilized to create the set of new Outcomes Y through a Utilization Process U."

This means that from a mathematical (and computer science) perspective, Utility is a function of Context. That is, there exists a function "Utility-Function" such that:

New Outcomes *= Utility-Function(Data-With-Context)*

Where Data-With-Context is the digital data quantum being turned into a product—that is, the Data Asset. So, we can rewrite the above as:

New Outcomes *= Utility-Function(Data Asset)*

In order for the Utility-Function to recognize the specific instance of the data quantum making up Context-Data, it needs to carry within it metadata that acts as an identifier, allowing Utility-Function to uniquely distinguish that specific instance of the data quantum from other copies.

So the question then becomes: How does this identifier get packaged into the Context-Data quantum? This leads to a more fundamental question: how is the Context-Data quantum generated?

The injection of Context-related metadata into a data quantum can also be modeled as a mathematical or programmatic function—the Context-Function. The Context-Function takes as its input the data quantum being assetized and injects the metadata (such as a unique identifier) required to turn it into a Data Asset (or Data-With-Context).

Data Asset *= Context-Function(Raw Data Quantum)*

Which implies that:

New Outcomes *= Utility-Function(Context-Function(Raw Data Quantum))*

We therefore see that:

1. The Utility of any product, including a digital Data Asset, is dependent on its Context and Identity (which itself is embedded within its Context).

2. Utility can be expressed as a set of digital data representing "New Outcomes" created as a result of a Data Asset being put through a Utility-Function (or Utilization Process).

3. The Data Asset itself is the result of the raw Data Quantum being processed by a Context-Function (or being put through a "Generation / Manufacturing Process.")

4. As a result, Utility can also be expressed as "New Outcomes" created as a function of the raw Data Quantum when put through a Context-Function and a Utility-Function in serial order (one after the other.)

3.5.2. The Value of a product is therefore also dependent on its Context and Identity, since Value is a measurement of Utility.

In addition, the Value of a product is also dependent on the entity evaluating it (or putting it through the Process of Evaluation) since different entities may use different evaluation processes to arrive at different expressions of value for the Product.

Here again, an agent (a person, organization, computer etc.) can express Value (as a digital data set output) as a result of an Evaluation-Function that evaluates a Data Asset, typically based on its utility—or its ability to produce new outcomes that the agent finds "valuable":

Value *= Evaluation-Function(Data Asset, Utility-Function)*

Presumably, the Evaluation-Function provides the means for the agent to predict the New Outcomes generated by running the Utility-Function on the Data Asset without actually running the Utility-Function (and utilizing the Data Asset). From the above result, this implies =>

Value *= Evaluation-Function(Context-Function(Raw Data Quantum), Utilization-Function)*

3.5.3. The key takeaway is that to create a Data Asset, the following are needed, in order:

1. **A Raw Data Quantum**—Packaging up the raw digital data representing the contents or "material" that the Data Asset will be “manufactured” from.

2. **A Context-Function** (**or Generation-Function**) that imbues Identity (and Scarcity) into the Raw Data Quantum, along with other metadata required for the resulting Data Asset to fully express its meaning and reason for existence:
    1. The Context-Function turns a Raw Data Quantum into a Data Asset by injecting metadata such as "identifiers" into it.
    2. The Context-Function is also called the "Generation-Function" of the Data Asset type, as it creates the Data Asset from the underlying data.

3. Consequently, the Raw Data Quantum contained with the Data Asset is called its "Generation Context".

3. **A Utility-Function** that takes a Data Asset as input and outputs a digital data set expressing the New Outcomes created as a result of the Data Asset being utilized through a Utilization Process.
    1. The Utility-Function turns a Data Asset into New Outcomes.
    2. There can be an infinite number of Utility-Functions that can be defined to take the same Data Asset (type) and generate different sets of New Outcomes from it.

4. **An Evaluation-Function** that outputs a "Value" that "measures the utility" of a Data Asset and takes as input a Data Asset and an associated Utilization Function:
    1. The "Value" can be in the form of a scalar value (such as a quantity of currency) or a "Vector" value—a combination of one or more Data Asset Types.
        1. **Example of Scalar Value: 10 USD** = Evaluation-Function(Data Asset, Utilization-Function)
        2. **Example of Vector Value:** [**10 Data Asset Type-A, 15 Data Asset Type-B**] = Evaluation-Function(Data Asset, Utilization-Function)
    2. There can be an infinite number of Evaluation-Functions that can be defined to take the same Data Asset (type) and generate different Values from it.

The mathematical treatment of these atomic Data Economic concepts are referred to in **Chapter 2: Fundamental Concepts** and explored in much more detail in **Chapter 3: Types and Examples of Data Economies**.

3.6 General Methodology for Data Assetization—*Converting Digital Datasets (Data Quanta) into Data Assets*

Based on the insights gained in **Sections 3.4 and 3.5**, we can extrapolate a general framework for turning any piece, or quantum, of digital data into a Data Asset:

The agent manufacturing the Data Asset via the DEOS needs to be able to define Context, Utilization, and Evaluation Functions to enable the creation of a Data Asset from the underlying Data Quantum.

The test for whether a Data Quantum is a Data Asset is its ability to tell the following "Stories":

1. **Story of Generation (Identity and Scarcity), a.k.a. Context:** This story answers the following questions, using the Context-Function:
    - *"Who are you (how can you be identified?)"*
    - *"Why were you made?"*

As an extension, the Context-Function also helps the Data Asset tell a ***"Story of Scarcity,"*** which relays the amount of energy expended in generating this Data Asset.

2. **Story of (Past) Utility:** This story answers the following question, using a combination of its Context-Function and Utilization-Function:
    - *"What have you been utilized for in the past?"*

3. **Story of Value (Future Utility):** This story answers the following question, using the Context-Function, a Utility-Function, and an Evaluation-function:
    - *"What can you be used for in the future?"*

(Coming Soon) Diagram 3.5: "'Everyday' Data Economies Examples - Table with Context, Utility and Utilization Process"

Each of the Data Asset Types circulating within Data Economic Frames that we have examined earlier—Coffee Shop Loyalty Card, Credit Card Miles, Cryptocurrency, Money—**tells a *Story of Generation or Context* (including Identity and Scarcity), a *Story of Utility,* and a *Story of Value:***

Data Asset Type	**Participants in Data Economic Frame**	**Context -** *The Story of Identity, Scarcity, and History* **("I express that…"**	**Utilization Process - (or** Utilization-Function) **("When put through this process…")**	**Utility and Value -** *The Story of Utility and Story of Value* **("Hence I can be used to…" ("Hence my value is…"**
Coffee Shop Loyalty Card	Coffee Shop, Customers	The owner this Loyalty Card has purchased 10 coffees at the Coffee Shop	When transferred over to a Coffee Shop employee	This card can be utilized to gain access to a new cup of coffee *New Outcomes = Access to 1 Coffee* *(due to Utilization Process mentioned)* *Value = $Price-of-1-Coffee* *(calculated by an Evaluation Function: Cup of Coffee -> $)*
Credit Card "Miles"	Credit Card Co., Airlines, Customers	The owner of this Credit Card has performed sufficient transactions with the Card to earn X amount of "Miles"	When transferred to an Airline that is within the Credit Card company's network	These "Miles" can be utilized to gain access to Flights worth up to $Y *New Outcomes = Access to Flights* *(due to Utilization Process mentioned)* *Value = $Y* *(calculated by an Evaluation Function: CC Miles -> $)*

Money eg. US Dollar	US Treasury, All Entities trading in USD	I mean one unit of credit from United States Treasury (worth 1 Dollar)	When my ownership is transferred	This unit of USD can be utilized to gain access to goods and services "worth" 1 Dollar *New Outcomes = Access to Goods and Services (due to Utilization Process mentioned)* *Value = $1 (calculated by an Evaluation Function: Goods & Services -> $)*
A Bitcoin	Bitcoin Network, Bitcoin Miners, Bitcoin Users	I mean that a certain amount of computing energy was spent calculating a hard-to-find answer to a complex equation	When transferred to the Bitcoin account to the entity providing the goods and services	This amount of Bitcoin can be used as a form of currency to gain access to goods and services

For more details on the "Story of Utility" and related "Stories" that a Data Asset needs to relay, see **Chapter 2: Fundamental Concepts** and **Chapter 3: Types and Examples of Data Economies**.

Conclusion to Chapter 4: *Deeper Dive into Fundamental Concepts of Data Economics*

As mentioned in the Introduction to Chapter 4, this chapter introduced the concept of a Data Economic Frame of Reference, corresponding Data Economic Operating Systems capable of implementing such Data Economies, and the Data Assets that generate and circulate within them in a general framework that can be applied to Data Economic Frames ranging from Credit

Card Miles to Bitcoin and NFTs to a Local Coffee Shop and even money itself. Chapter 5 focuses specifically on the Lydion Data Economic Methodology for creating Lydion Data Assets representing the Outcomes of work done—or tasks completed—in the real world using the Lydion Data Economic Operating System.

In **Chapter 5**, all of the key concepts introduced in this Chapter 4 as well as in Chapter 2 are condensed into a tangible Data Economic Operating System—the Lydion DEOS—that can be used to convert any combination of datasets and streams into a set of Lydion Data Asset Markets. Each Lydion Data Asset Market is a specific combination of modular programs (called Data Asset Market Machines) capable of generating and managing all instances of a single type of Data Asset. Chapter 5 picks up directly following Chapter 4, building on the concepts introduced in Section 3 of Chapter 4 to describe the core functionality of the Lydion DEOS and the Lydion Methodology it uses to inject Context (Identity & Scarcity), Utility, and Value into digital data quanta to Data Assets, enabling the Data Asset to tell its "Story of Utility" and related Stories.