Object Oriented Design in Energy & Decision Management
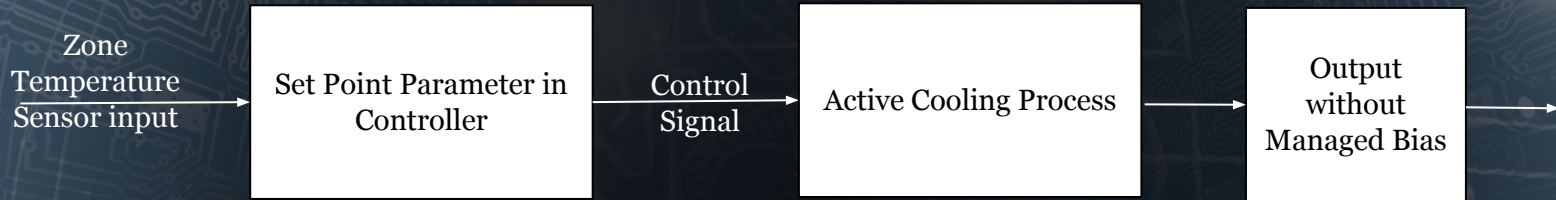
CalPlug 18th Workshop

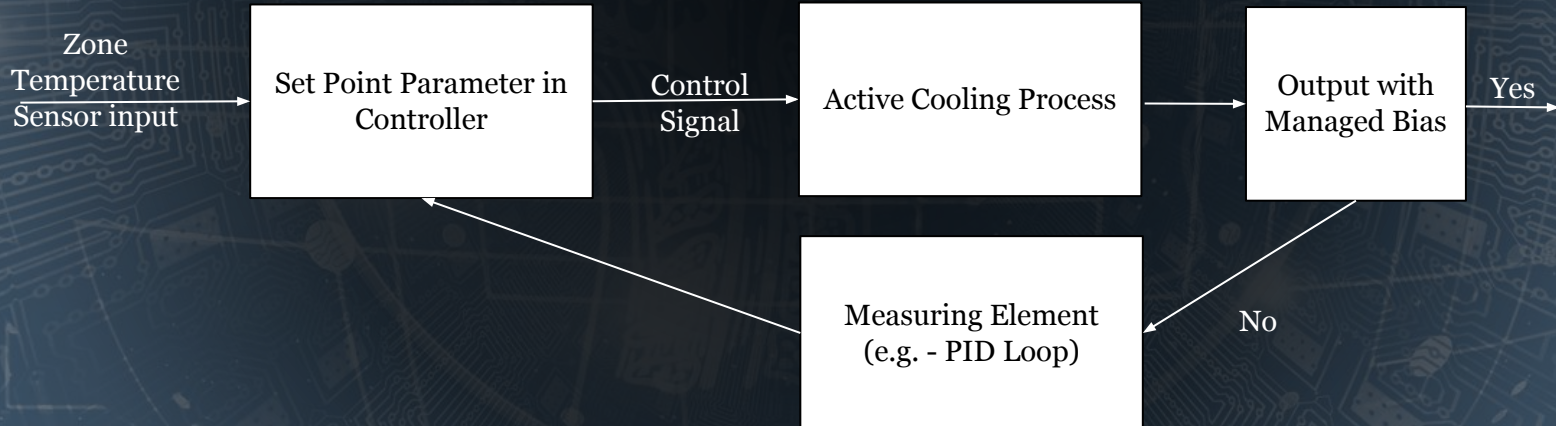October 18, 2021

Major Topics

- Control types
    - Open Loop Control
    - Closed Loop Control
        - PID Loops
        - False Promise of Simplifying PID Loops
    - Virtual Closed Loop Control
        - Context
        - Application

- Influence of Object Oriented Design
    - Energy Management
        - Extreme Tagging
    - Decision Management
        - Decision as a Class of Object
    - Speed to Decision: Object Workflow
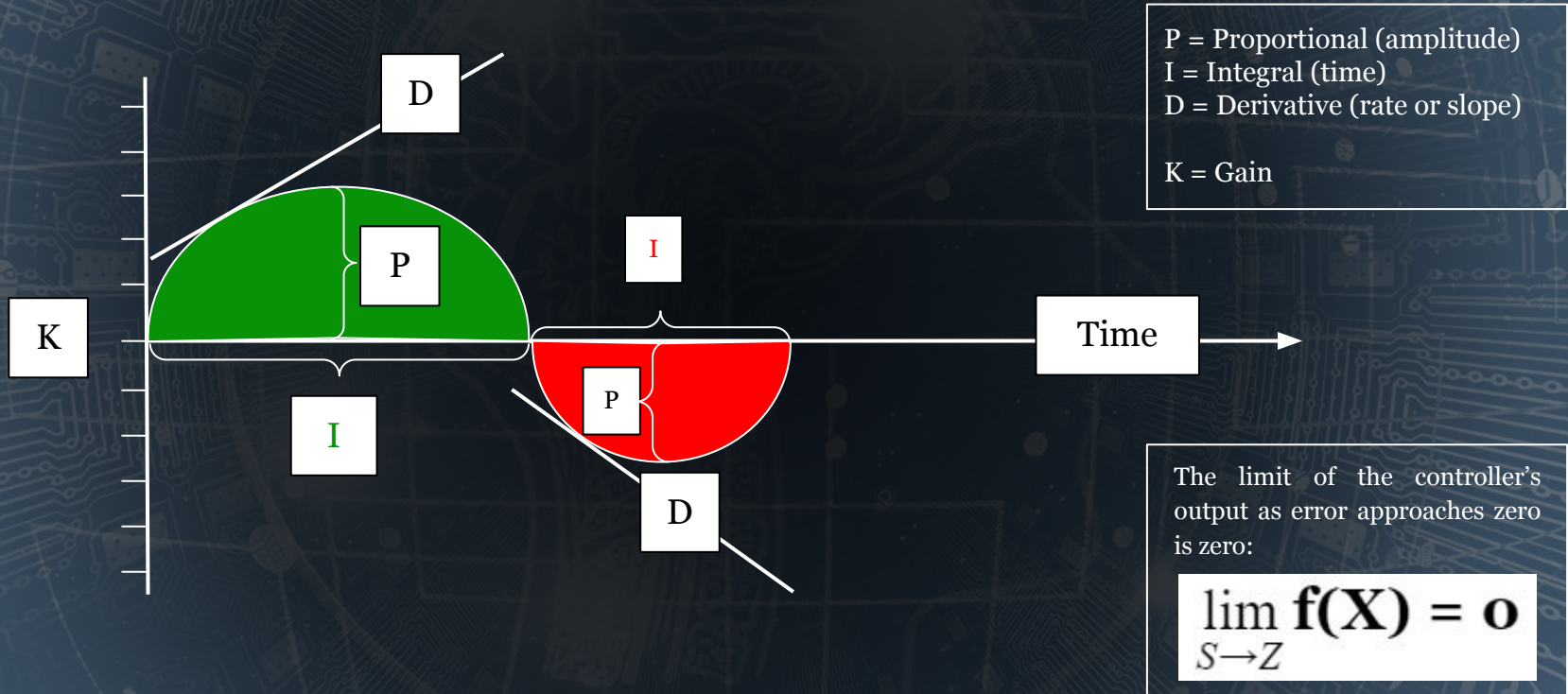   - CRSP-DM: Cross-Industry Standard Process for Data Mining

Open Loop Control

Zone Temperature Sensor input → **Set Point Parameter in Controller** → Control Signal → **Active Cooling Process** → **Output without Managed Bias** →

Closed Loop Control

Zone Temperature Sensor input → **Set Point Parameter in Controller** → Control Signal → **Active Cooling Process** → **Output with Managed Bias** → Yes

Measuring Element (e.g. - PID Loop) → No

The PID Loop & Full Expression of Error

P = Proportional (amplitude)
I = Integral (time)
D = Derivative (rate or slope)

K = Gain

D

P

I

K

Time

I

P

D

The limit of the controller's output as error approaches zero is zero:

$$\lim_{S \to Z} f(X) = 0$$

PID Loops in Control Theory

Zone Temperature Sensor input → Set Point Parameter in Controller

Set Point Parameter in Controller → Control Signal → Active Cooling Process → Output with Managed Bias → Yes

PID Loop

K_P

K_I / s

$K_D xs$

Full Expression of Error
(LaPlace Transform):
$L(s) = [K_P + (K_I/s) + (K_D xs)]$

No

The limit of the controller's output as error approaches zero is zero:

$$\lim_{S \to Z} f(X) = 0$$

P = Proportional (amplitude)
I = Integral (time)
D = Derivative (rate or slope)

K = Gain
S = complex frequency

The False Promise of Simplifying PID Loops

Virtual Closed Loop Control

Zone Temperature Sensor input → **Set Point Parameter in Controller** → Control Signal → **Active Cooling Process** → **Output with Managed Bias** → Yes

EDGE DEVICE IN THE FIELD

GATEWAY

ADVANCED SUPERVISORY CONTROL

GATEWAY

No

Zone Temperature Set Point Bias Adjustment via Machine Learning

facil.ai EdgeBMS™

Contextualizing Virtual Closed Loop Control for Energy Management

Enterprise
Energy
Management

The 3 V's:
Volume
Velocity
Variety

Building
as a
Battery

Gateway
Technology

*Virtual
Closed Loop
control*

Machine Learning

Energy Control
Measures

Adaptive
Energy
Management

Temperature

Humidity

Indoor Air Quality

Pressure

Light
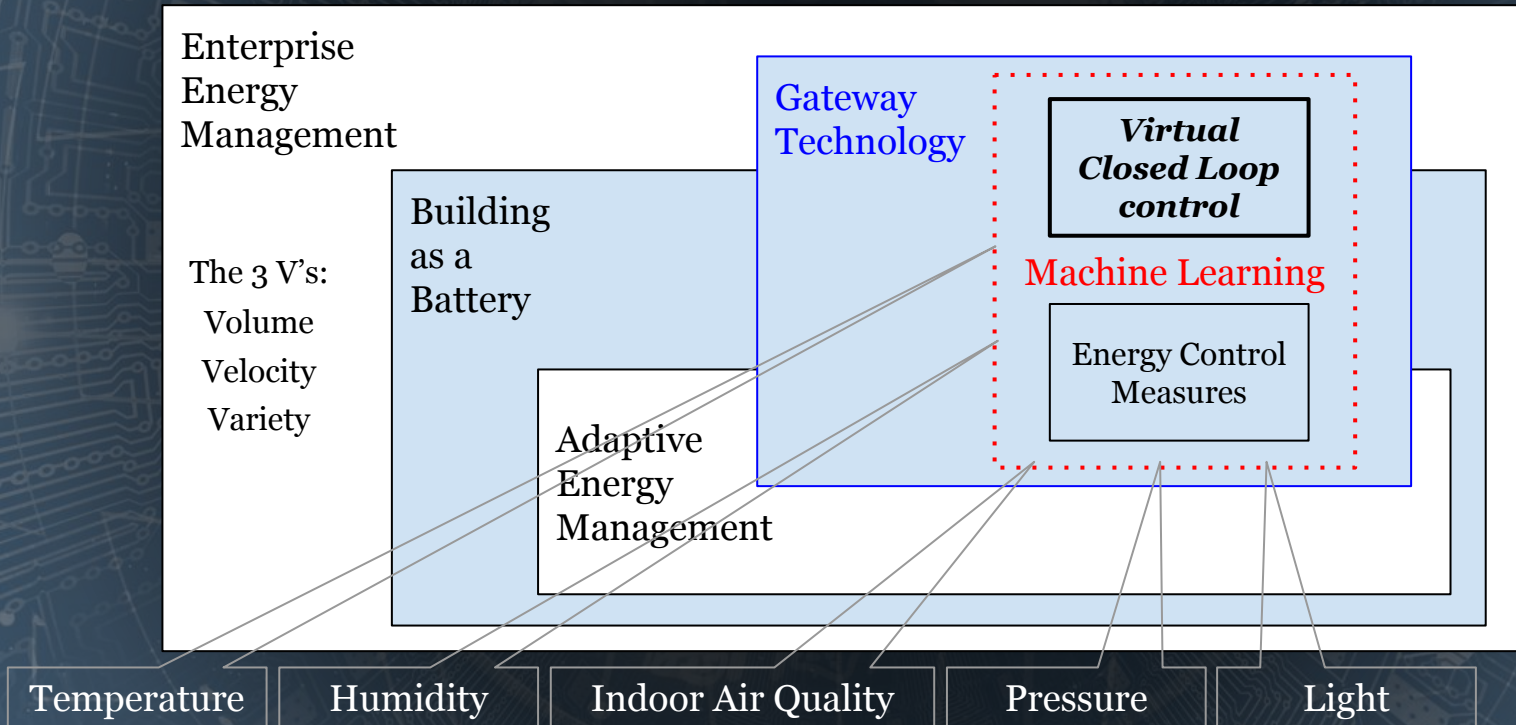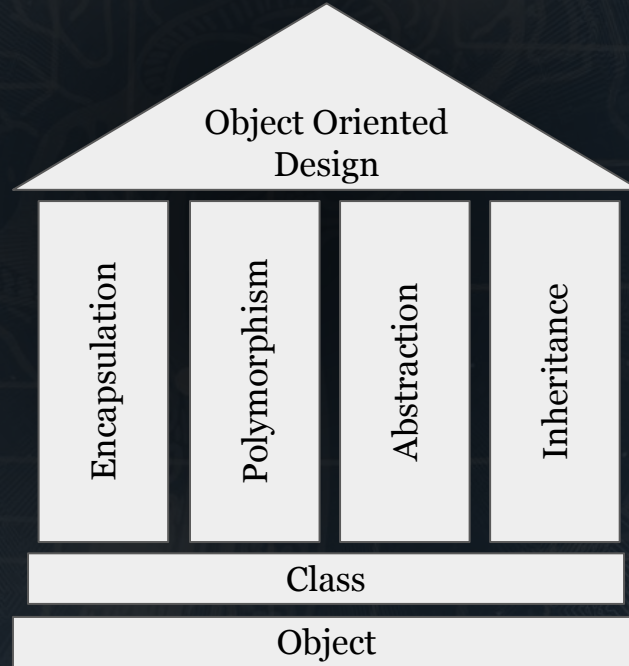
Extreme Tagging

Database **(repository only, NOT OUR SOURCE OF TRUTH)**

#temperature | #saTemp | #zone | #setpoint | #los_angeles | #california | #united_states | #zip_code | #geo_code | #ASHRAE_zone | #commandable | #range | #unreasonable | #reasonable | #comfort | #demand_response | #edison | #utility | #pressure_ dependent |#pressure_independent | …

Application of tags

Informed by Discovery

Vendor & Standards compatibility:
—> #saTemp   —> Novar auxTemp
—> #saTemp   —> jciSA_T
—> #saTemp   —> haystack dischAirTemp
—> #saTemp   —> brick, Google

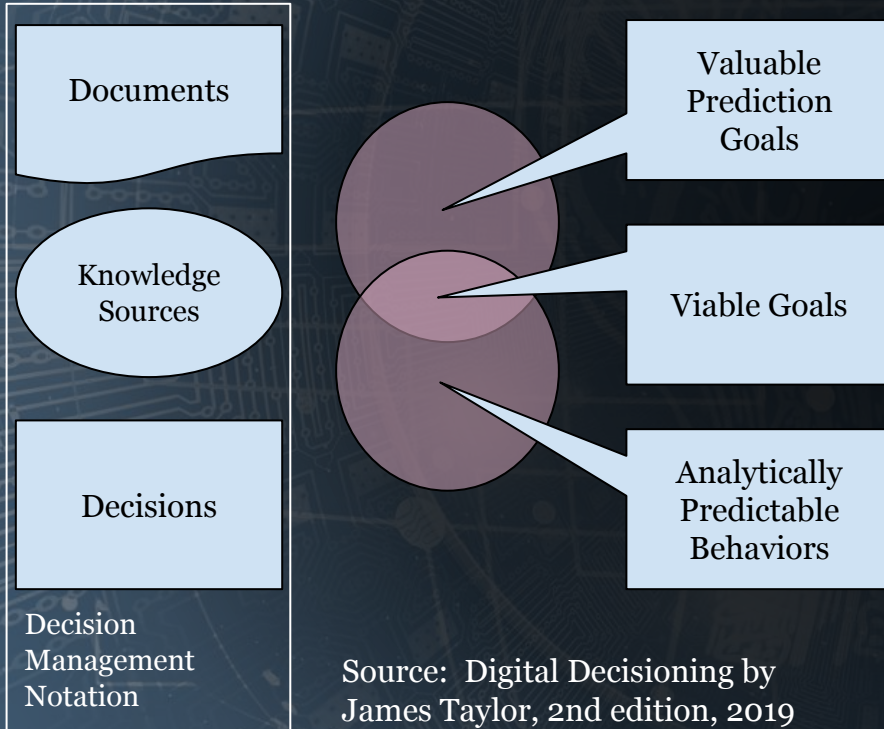| Queue	Attributes					Status
	Command	Entity Type	Entity	Param 1	Param 2	***(* - subject to four hour validation period)***
Los Angeles Gateway	Command	A point	Occupied Setpoint	78	-	-Queued
						-Cmd ack
Point of Sale Gateway	Edit	Schedule	Schedule32 RTU1	20:00 2	22:00	***-Pending****
						-Executed*
Point of Sale Gateway	Edit	Schedule	Schedule32 RTU1	2:00	08:00	***-Success****
						-Deleted
← Cloud	Gateway **(THIS IS OUR SOURCE OF TRUTH)** →					Returned to Queue

OUTBOUND

INBOUND
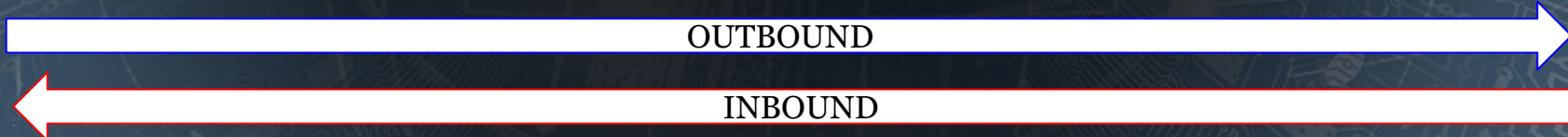
Decision Management & Object Oriented Design

Decision Requirements

The Four Pillars of OOD

Gathering

Understanding

Documents

Knowledge Sources

Decisions

Decision Management Notation

Valuable Prediction Goals

Viable Goals

Analytically Predictable Behaviors

Object Oriented Design

Encapsulation

Polymorphism

Abstraction

Inheritance

Class (or Decision)

Object (an instance of a Class...or Decision)
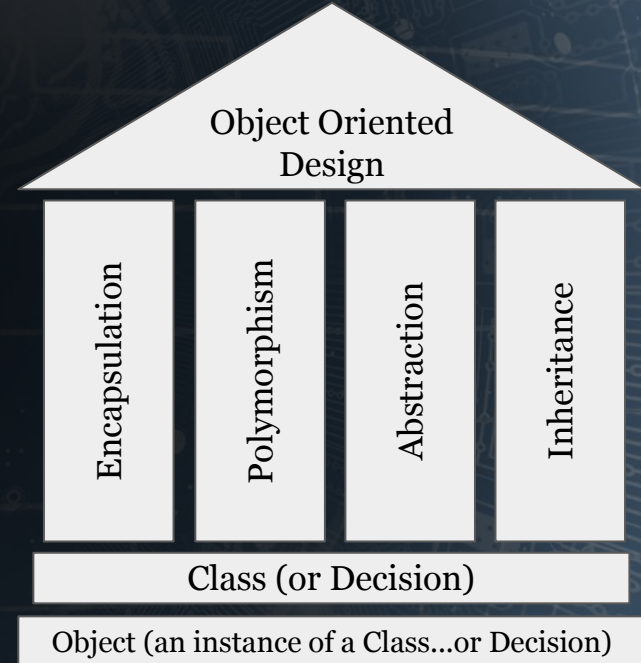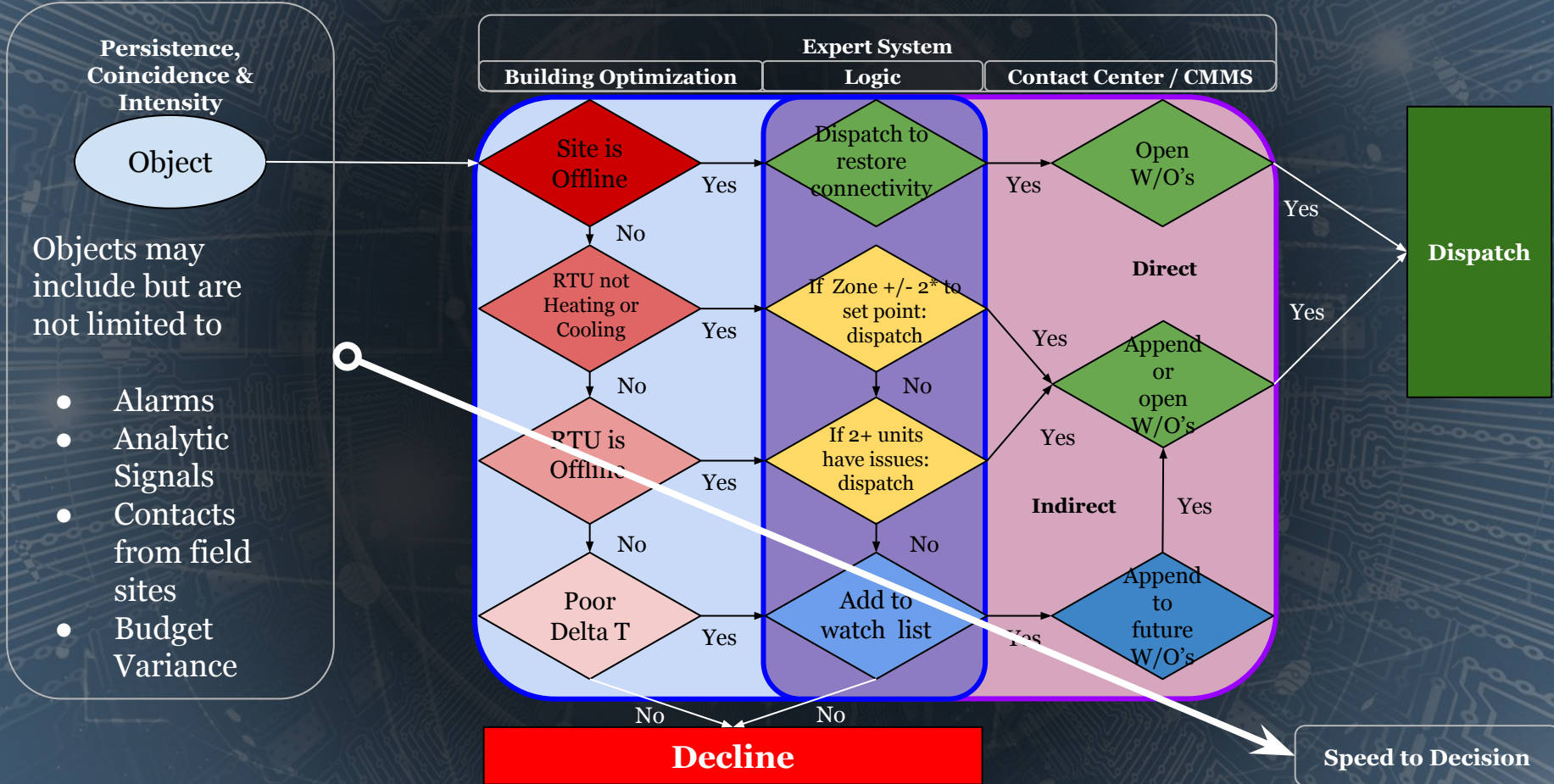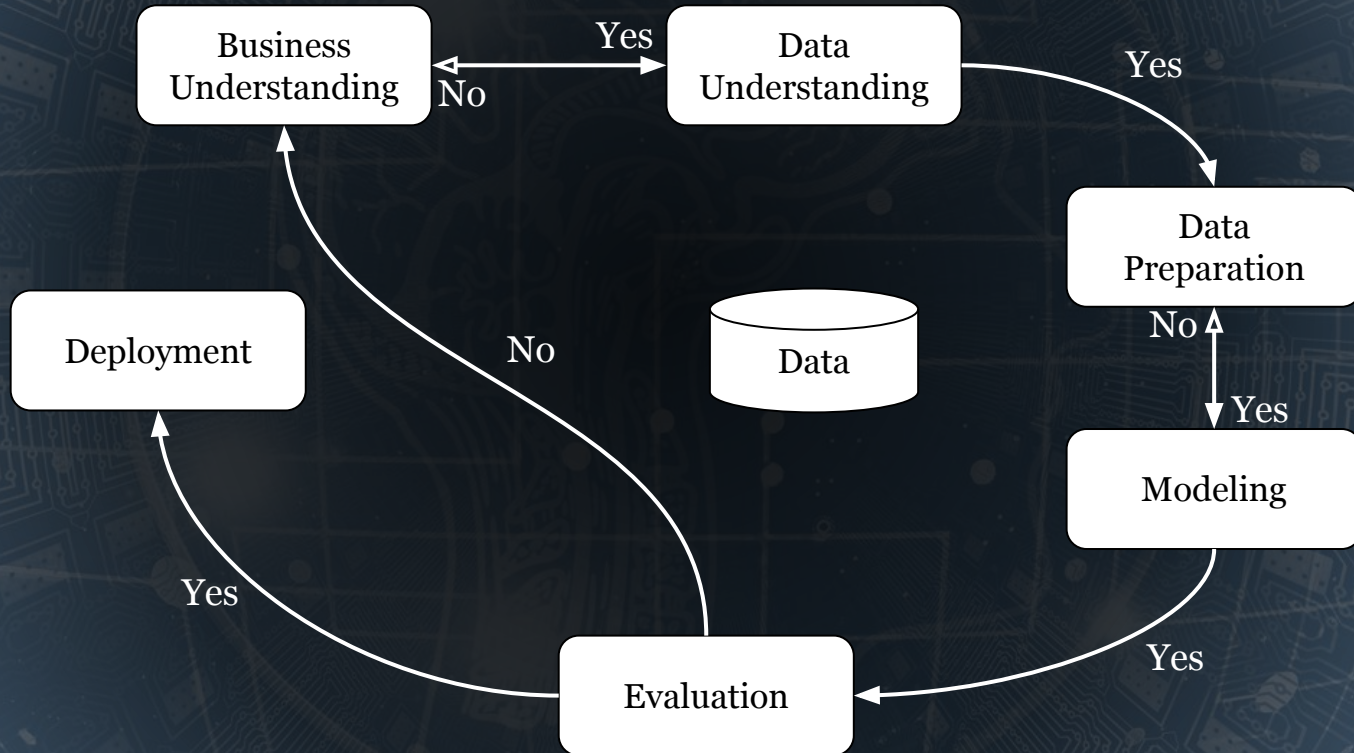
Source: Digital Decisioning by James Taylor, 2nd edition, 2019

Speed to Decision: Object Workflow

CRSP-DM: Cross-Industry Standard Process for Data Mining

Thank you

Contact Information

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Link to the original 2019 Virtual Closed Loop Control whitepaper