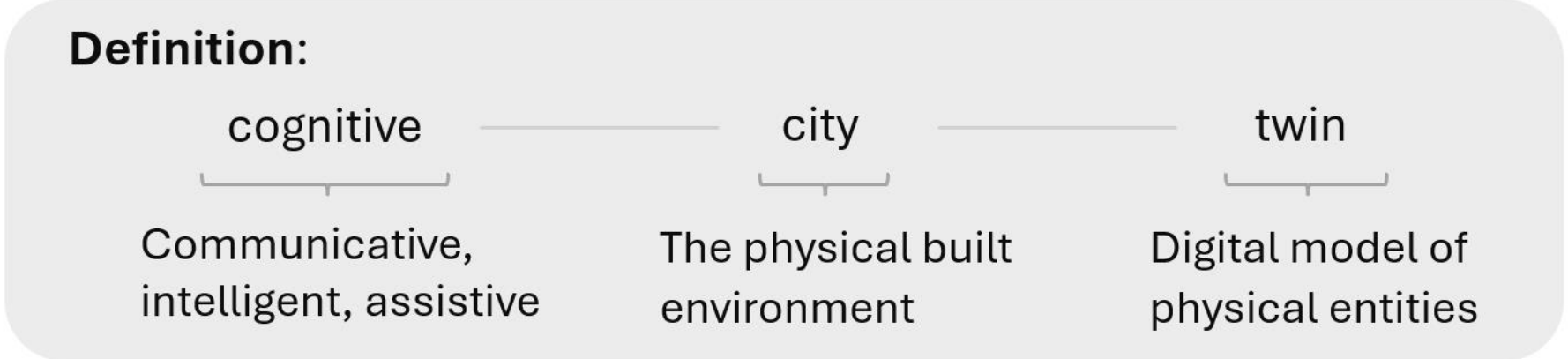


Cognitive City Twins

Digitizing urban spaces.

As AI and scale computing rapidly evolve, data-intensive applications are essential for leveraging new technologies, enabling innovative use cases that optimize efficiency and benefits. **Cognitive city twins** (CCT) integrate AI, data visualization, and spatial computing to effectively convey information and ideas.



→ **Cognitive City Twins:** Digital simulations of physical environments, leveraging innovative human-computer interactions and AI to create intelligent, communicative, and supportive systems, enhancing user experiences and improving decision-making.

Keywords: data science, real estate, urban design, urban digitalization, IoT, AI, digital twins



Outline:

- 1

USP 175 Project – H2 Hillcrest

Property modeling and urban space simulation for planners & designers
- 2

Internship – Cognitive City Twins

Two CCT platforms: one of New York City for commercial real estate & one for UC San Diego
- 3

DSC 190 Project – Internet-of-Things

Ways CCTs get data, work with AI and interact with the built environment

Property Modeling

Your imagination in the real world.



Inspiration floorplan courtesy of Vive on The Park | Application developed at UC San Diego
Building model built in & imported from SketchUp Pro w/ Datasmith plugin

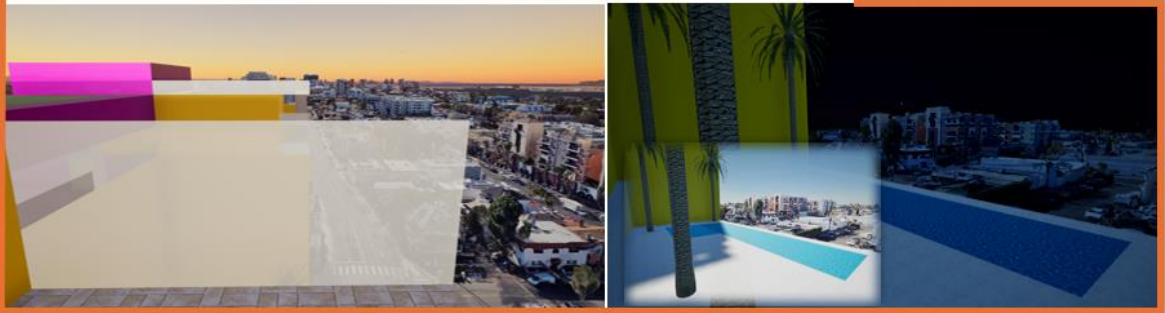
At 3775 Sixth Ave, **H2 Hillcrest** envisions a state-of-the-art urban infill, mixed-use redevelopment project to address housing needs, support pedestrian-oriented environments, and celebrate the history and culture of Hillcrest.

Leveraging UE 5's purpose as a game engine, users can be in 1st or 3rd person to tour a project in a CCT. Project information is conveniently displayed on widgets, simplifying the home search process and improving user experience.

Project – USP 175: Site Analysis

Advisor: Susan Pearson, FAICP

Virtual Views
CCTs visualize future views, in any climate & time. The unit shown offers an *unparalleled* view of Downtown SD, the coastline, and 6th Ave at sunset.
→ *Informing value to owners and helping potential tenants make rental decisions*



Envisioning Public Spaces
CCTs let planners test ideas in the real world. Sophisticated CCTs can be dynamic simulations.
→ *Allowing users to test different busyness levels, traffic flow, commercial & public uses*

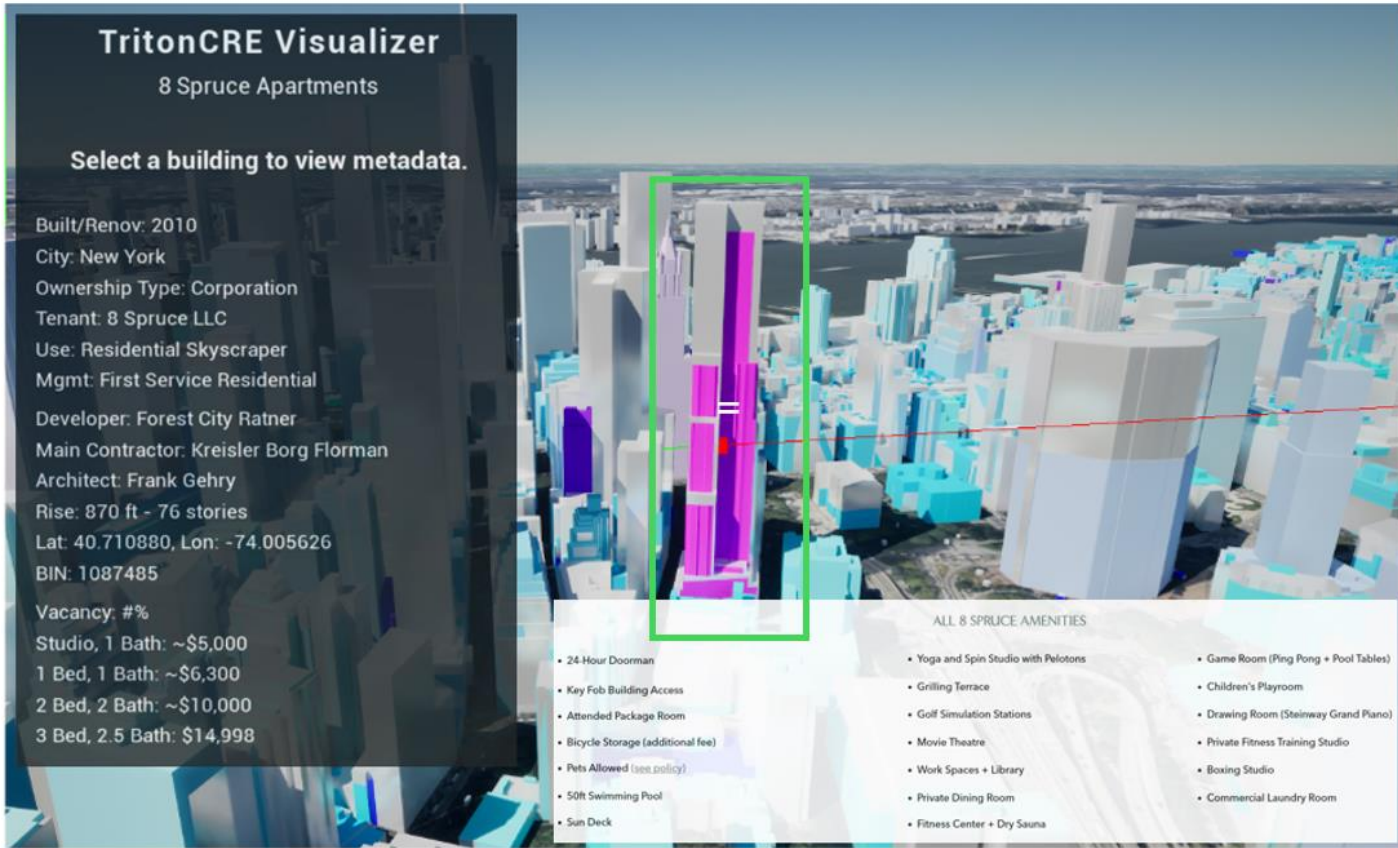
Fast Facts

Scope: 3 projects showcasing different, related applications of CCTs & the data acquisition workflow
Primary tools: Unreal Engine 5, Cesium, SketchUp Pro, Python, C/C++
Additional reference: *Occupancy Prediction Using Building Operation Data* (paper) and more details on the projects covered at pndang.com
Design inspiration: Perkins&Will

Community Engagement
Implementing higher densities will raise issues of structural cohesion and shadows over surrounding properties, CCTs visualize such impacts.
→ *Allowing developers to take action*

Urban Development

Redefining data access and visualization.



Property information courtesy of 8 Spruce | Application developed at UC San Diego

TritonCRE: a digital model (CCT) of New York City for commercial real estate professionals. With a single click, users can access all relevant property information in one place, eliminating the need for tedious, sporadic data collection and juggling multiple tabs.

- Technical Details:
- Developed with the Cesium NYC tileset, features, and metadata
 - Line-tracing (red line) for the building selection mechanism
 - Selected property's information displayed on widgets

Project – AIP 197: Cognitive City Twins

Advisor: Neil Smith, Ph.D.

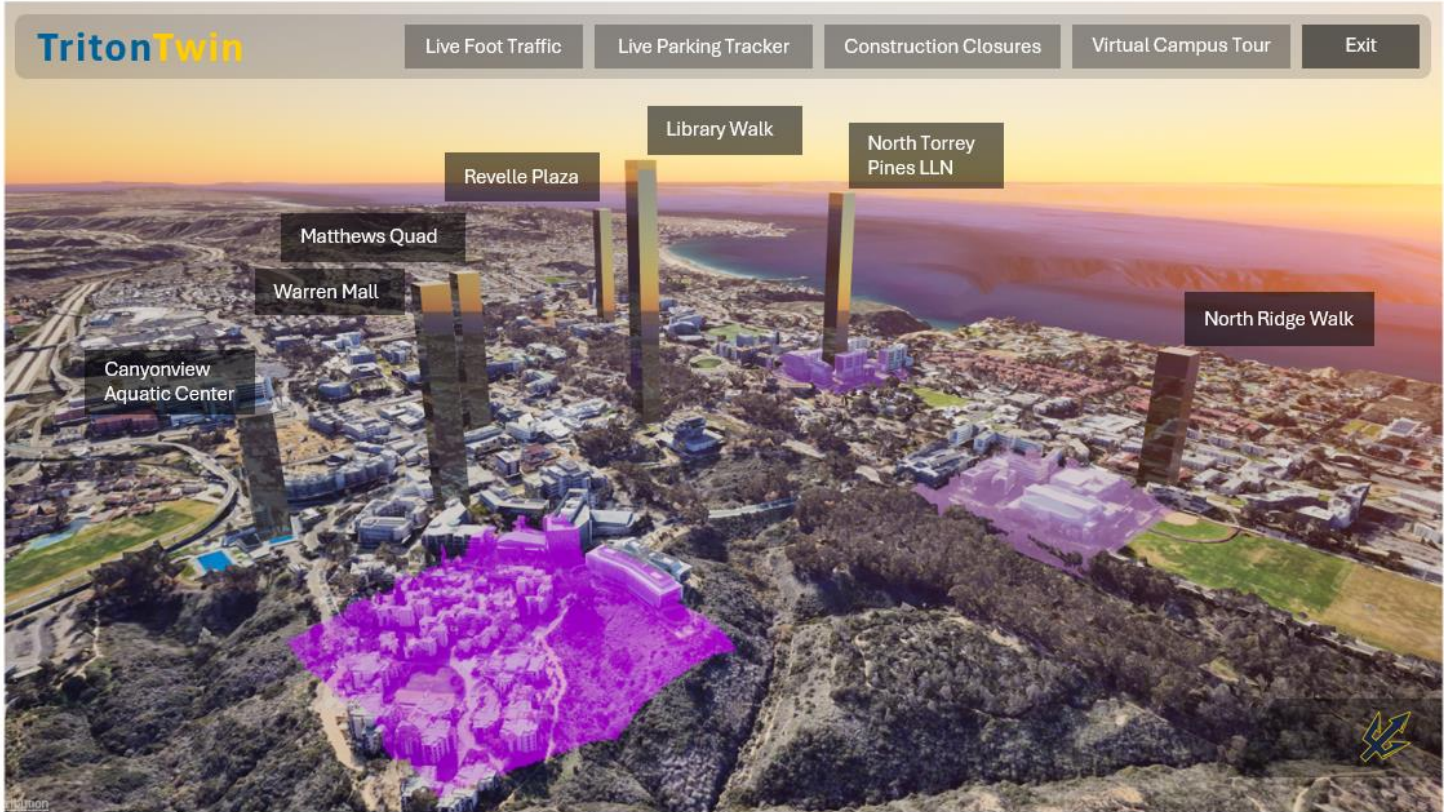
Teammates: Jack A., Sofia N., Garvit A., Hanzen S., Jessica Q., Derrick L., Giovanni V., Ghaida A.

TritonTwin: a digital model (CCT) of UC San Diego, designed to enhance information access for students, faculty, staff, and visitors.

Technical Details:

- Visualizes IoT metrics (e.g., busyness, noise, any sensor data)
- Vertical bars use UE5 instanced static meshes with dynamic spawning, scaling, and georeferencing
- Ground coloring uses Cesium cartographic polygons, raster overlays, and color blending across material layers

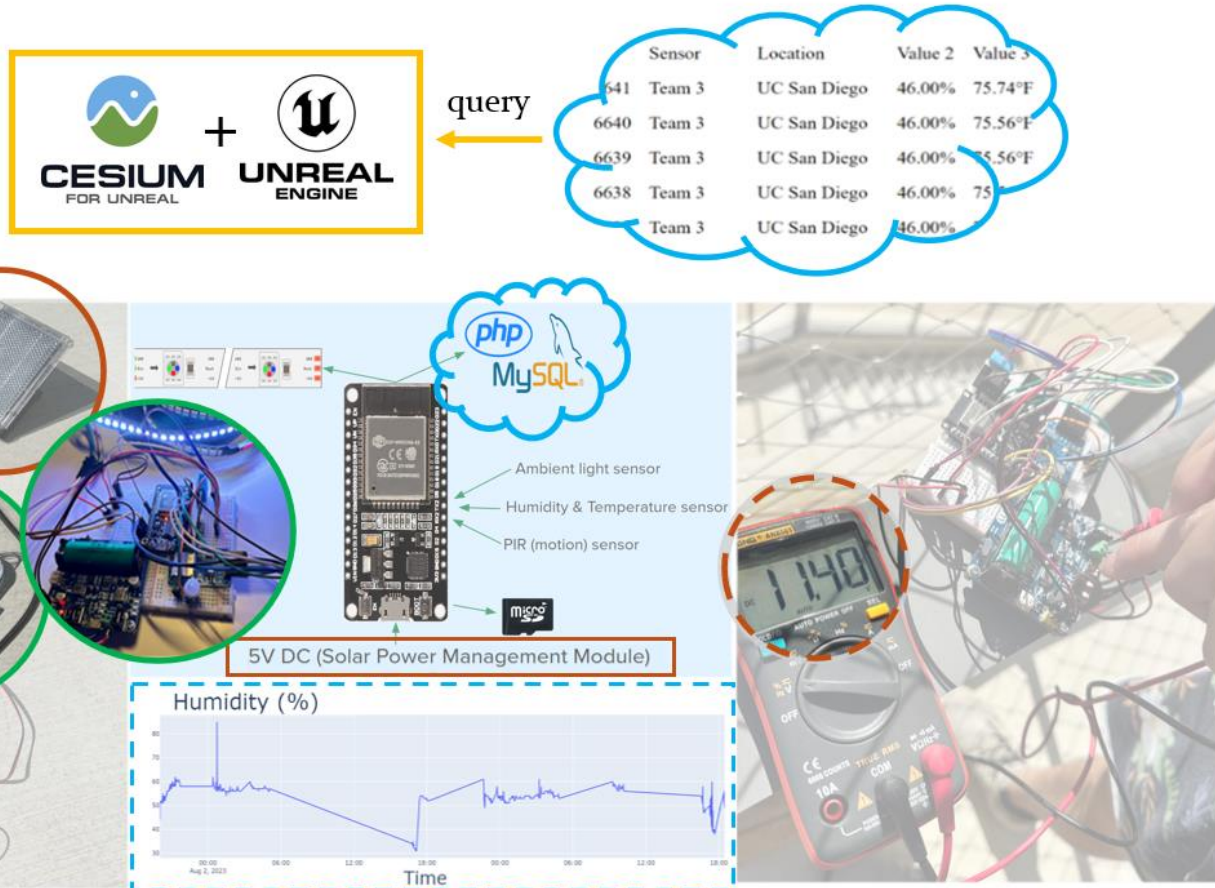
Synthetic data and prop navigation bar used for demo purposes | Application developed at UC San Diego



IoT, AI, Immersive Realities

Put the cognitive in cognitive cities.

- IoT Device (ESP32)**
A device that collects live sensor readings, transmits data to the cloud, and adjusts lighting dynamically for energy efficiency
- Solar Module**
The device is powered by a 5V DC solar panel connected via a power management module
Input voltage under bright sun
- Science the Data**
Sensor data are transmitted to an online MySQL database for storage and analysis
Humidity time-series graph
- Cognitive City Twins Integration**
CCTs query data from the server for processing and display in the digital world



Support from Raymond S. (TA) and Aidan R. (Teammate) | Device built at Makerspaces, UC San Diego

H2 Hillcrest site at Sixth & Pennsylvania – San Diego



AI Integration: Advanced object detection models allow CCTs to see (CV) and think (AI). Car-, foot-, cyclist- traffic can be monitored to identify in-, out-flows, congestion points, unique activities and behaviors.
→ *Helping planners design effective public infrastructures*
→ *Informing architects of prime spots to strategically place bldg. frontage*
→ *With a good understanding of value, backed by data, simulations, and demo in a user-friendly CCT, the property realizes its highest & best use*

Technical Details:

- Model: PyTorch + YOLOv5x
- In development: (1) run model on NVIDIA Jetson Nano + camera as an edge device (physically operate in the real world), (2) make CCTs VR-compatible for immersive UXs, (3) incorporate AI metahumans



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Data Science
Real Estate & Dev.
Urban S. & Planning

