Procedural website generation via WFC noise generation, deterministic layout denoising and LLM text synthesis

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Project Idea & Use-Case

Generate synthetic, brandless webpage layouts for design exploration and phishing-detection research.

NLP is used here for text region fills

Dataset and models

For data wrangling YOLOv8 and my own dataset is used to train for semantic band detection

For NLP text gen Qwen/Qwen2.5-7B-Instruct:together via API call to Hugging Face.

Local LLM hosting with 6 GB is not ideal, colab integration into pipeline would slow down debugging

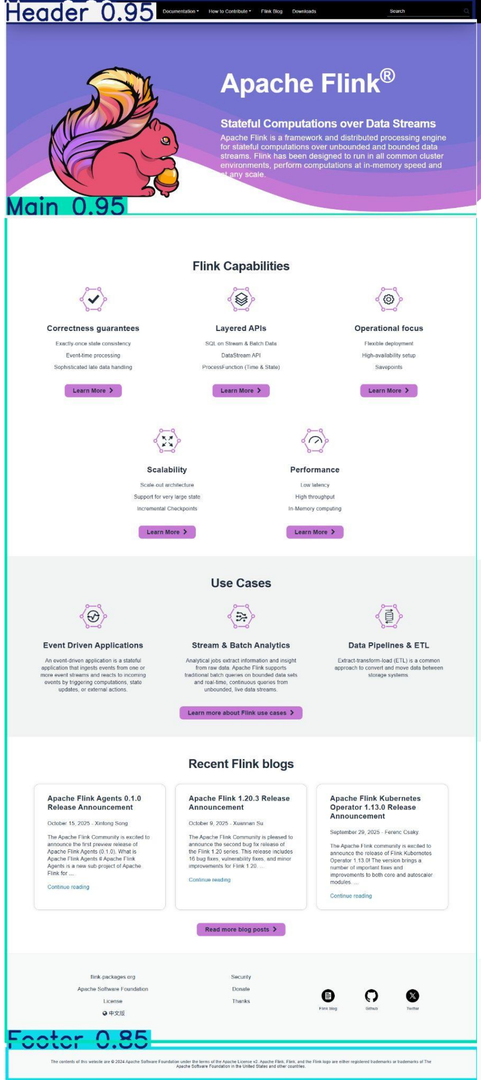
Bias/Balance

P1 data wrangling was mostly tech adjacent english websites, P2 RAG is based off of 50 of P1’s 200 site’s texts

Pipeline P1-overview

For data-wrangling:

Website semantic band is detected with CV, individual elements with RG based encoding



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Stateful Computations over Data Streams

Apache Flink is a framework and distributed processing engine for stateful computations over unbounded and bounded data streams. Flink has been designed to run in all common cluster environments, perform computations at in-memory speed and at any scale.

Flink Capabilities

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Event-time processing
Sophisticated late data handling
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SQL on Stream & Batch Data
DataStream API
ProcessFunction (Time & State)
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High-availability setup
Savepoints
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Scalability
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Support for very large state
Incremental Checkpoints
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High throughput
In-Memory computing
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Use Cases

Event Driven Applications
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Stream & Batch Analytics
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Data Pipelines & ETL
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Recent Flink blogs

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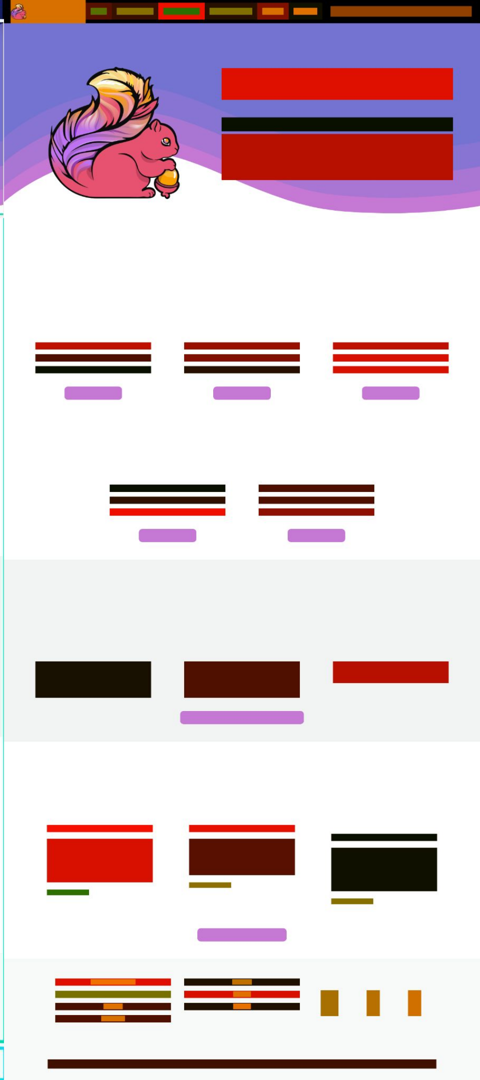
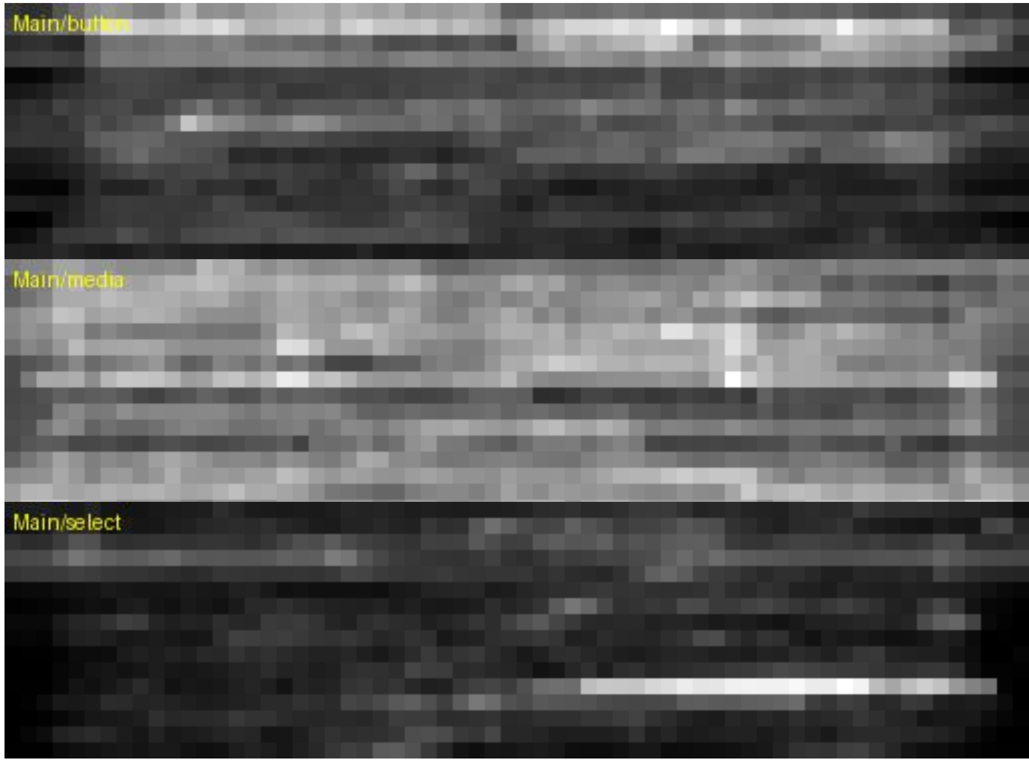


Pipeline P1-overview

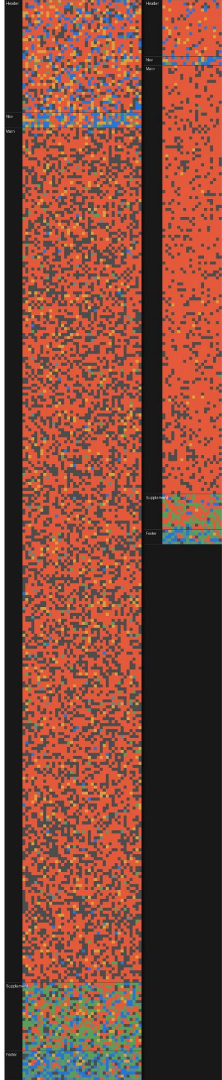
By aggregating the data I was able to procure element type density per band, as well as adjacency rules for WFC



P2-Generation

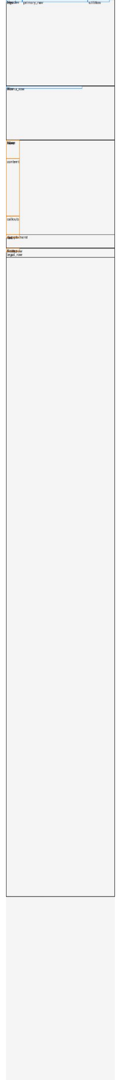
Wave Function Collapse based off of data from normalized wrangled data produced unusable noise on the left

Taking inspiration from Stable Diffusion, I used a 2×2 pooling step to smooth the WFC noise by collapsing tiny one-pixel fluctuations into more stable regions before semantic denoising



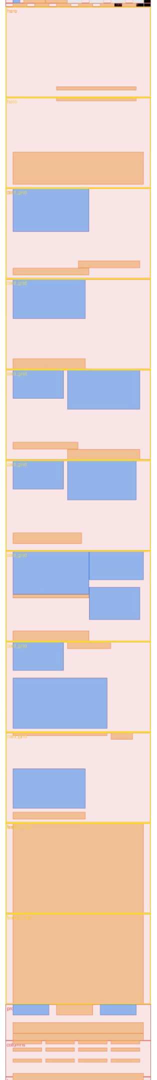
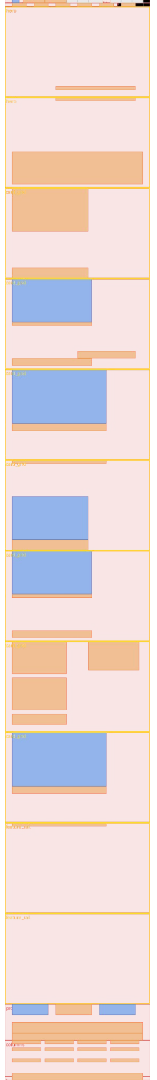
P2-Generation

The zone system detects large-scale patterns in the pooled WFC grid and assigns each region a semantic role like hero, card grid, or footer column based on dataset derived rules.



P2-Generation

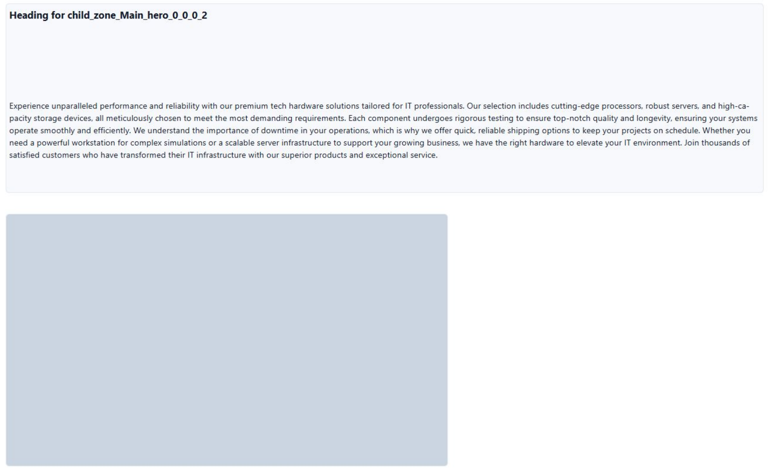
By applying design rules such as grids and view port restraints, and cross referencing the previously mentioned zones map I was able to achieve a somewhat realistic wireframe

P2-Generation

The character budget is calculated from grid area, not from browser font metrics.

Since text wraps naturally in CSS grid, area-based budgets are sufficient to keep the text visually contained



Heading for child_zone_Main_hero_0_0_0_2

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Prompt Engineering

A staged LLM pipeline:

1. Generate site name
2. Use site name as context to generate title and subtitle
3. Using site name and hero output to generate section plan and text take away
4. For each section I pass the previous section takeaway section num and intent and some RAG snippets
5. Return paragraph and split locally

Problem and solutions

Problem: Inconsistent, Nonsensical Text
Early runs with the LLM produced disconnected sections

Attempted Solution: Recursive, Context-Passing Generation
Recursively pass the previous context to the next generation to keep consistency with staged chains

New Problem: API Cost & Compounded Hallucination
Every stage is a new LLM call and feeding LLM calls into each other is worsening entropy

Stop gap solution:
Switch to an offline, neutral text corpus for most elements.
Use the staged LLM generator only as a design prototype / corpus builder, not as a per-element live dependency.

Final Discussion

Overall Project: To augment mass watering hole / phishing campaigns, to assist in cybersecurity research

NLP Model specific: Generate placeholder text for vertical slice/ MVP websites for fast demos and iterations

Data collected from both P1 and P2 as well as ROG corpus are tech hardware / software vendors, pipeline performs only on imitating said websites.