graph_home_hunter_demo

June 24, 2025

1 Graph-Stop Home Hunter — Guided Notebook Tour

This notebook is a **hands-on companion** to the codebase (`graph_home_hunter.py`).
You'll train, evaluate, and *peek inside* a three-stage pipeline that turns raw real-estate listings into **actionable buy/wait advice**.

Stage	What you'll do	Why it matters
1 Graph Encoder	Train a 2-layer **GAT** (or swap in GraphSAGE) on a **buyer → listing → suburb** graph.	Captures relational cues—price clusters, suburb similarity, CBD distance—that flat features miss.
2 Tabular Head	Feed embeddings + **one-hot features** through a Gaussian NB or Logistic Reg head, optionally keeping only the top-k features by mutual information.	Blends learned context with interpretable/calibrated probabilities.
3 Decision Logic	Apply a threshold and a **Bayesian Option-Value Planner** (wait-cost vs regret-cost) to decide *"Bid now"* vs *"Hold for better stock."*	Converts probabilities into real decisions, balancing confidence against future opportunity.

1.0.1 Notebook flow

1. **Synthetic data** Generate or load 10 weekly CSV snapshots **plus** a larger train/test table.

2. **Train & validate** • Graph-only GNN • Stacked head with calibration.

3. **Threshold sweep** Find the F1-optimal (or F- for a precision/recall tilt).

4. **Week-by-week simulation** Replay snapshots and watch the Option-Value Planner decide when to pull the trigger.

5. **Explainability** Inspect per-listing feature contributions to understand each recommendation.

Ready? Let's hunt some homes

[23]:
```
import os, sys, math, random, copy, json, itertools, types, warnings, joblib,␣
 ↪subprocess
```

```
from pathlib import Path

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches

import torch, torch.nn as nn
from torch_geometric.data import Data
from torch_geometric.loader import NeighborLoader
from torch_geometric.nn import GATConv

from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report, confusion_matrix
from sklearn.naive_bayes import GaussianNB
from sklearn.linear_model import LogisticRegression
from sklearn.calibration import CalibratedClassifierCV
from sklearn.feature_selection import mutual_info_classif

# local source (assumes notebook lives next to graph_home_hunter.py)
from graph_home_hunter import (
    ListingGraphTG, GCN, IntentHead, GraphTrainer,
    Metrics, _safe_torch_load, set_seed
)

# put this once, near the top of the notebook
import warnings
from sklearn.exceptions import ConvergenceWarning

warnings.filterwarnings("ignore", category=ConvergenceWarning)

set_seed(42)
print(torch.__version__)
```

```
2.3.0+cu118
```

1.1 1. Prepare synthetic training & test CSVs

[2]:

```
# If the CSVs don't exist yet, generate them with make_training_data_v3.py
if not Path('train_listings.csv').exists():
    !python make_training_data_v3.py

df_train = pd.read_csv('train_listings.csv')
df_test  = pd.read_csv('test_listings.csv')
print(df_train.shape, df_test.shape)
df_train.head()
```

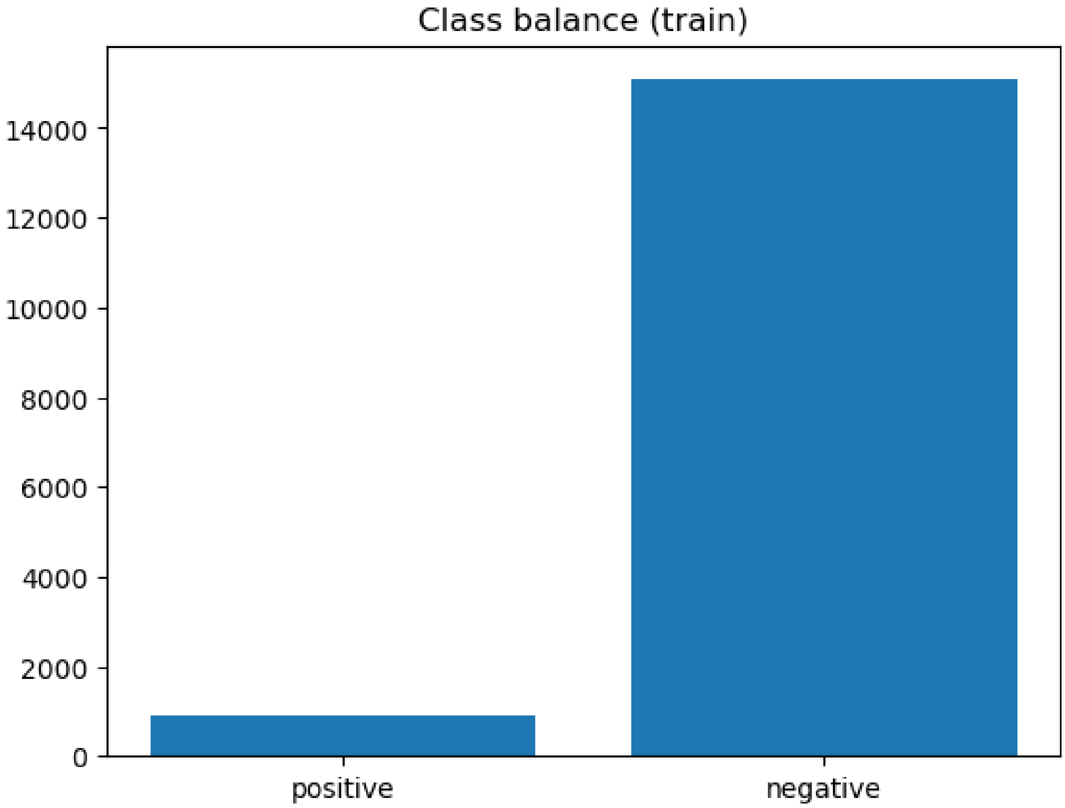
```
(16000, 19) (4000, 19)
```

```
[2]:       id  asking_price  body_corp  internal_m2  balcony_m2  beds     suburb  \
     0  10651        634000       1809           74         1.0     2  Footscray
     1   2042        557000       1894           86        17.7     2    Sunbury
     2   8669        601000       1406          109        17.7     3   Werribee
     3   1115        616000       2517          116         8.2     2  Footscray
     4  13903        639000       2303           84         6.6     2   Richmond

        livability condition  has_cladding  travel_time_mins  sold_date  \
     0          10       new         False                 5        NaN
     1           9      good         False                61        NaN
     2           8      good         False                45        NaN
     3          10      good         False                14        NaN
     4          16       new         False                21        NaN

       has_parking has_storage has_solar north_facing near_shops outdoor_space  \
     0         NaN       False     False        False      False         False
     1       False        True     False        False       True         False
     2       False         NaN       NaN        False       True          True
     3        True       False     False         True      False          True
     4       False       False     False          NaN       True         False

        label
     0      0
     1      0
     2      0
     3      0
     4      0
```

1.2 2. Build a PyG graph from the training CSV

```
[3]: g_train = ListingGraphTG().from_csv('train_listings.csv')
     pos = int(g_train.y[g_train.listing_idx].sum())
     neg = len(g_train.listing_idx) - pos
     print(f'Positives: {pos}   Negatives: {neg}')

     plt.bar(['positive','negative'], [pos,neg])
     plt.title('Class balance (train)')
     plt.show()
```

```
Positives: 920   Negatives: 15080
```



1.3 3. Train the GNN encoder

[4]:

```
ckpt = Path("gnn_v1.pt")

if ckpt.exists():
    print("  found", ckpt, "- loading checkpoint …")
    gnn = GCN(); gnn.load(ckpt); gnn.eval()
else:
    print("  checkpoint not found - training from scratch …")
    !python graph_home_hunter.py --train-graph train_graph.pt gnn_v1.pt␣
  ↪--epochs 150 --patience 50 --lr 1e-3
    gnn = GCN(); gnn.load(ckpt); gnn.eval()
```

```
 found gnn_v1.pt - loading checkpoint …
```

1.4 4. Pure-GNN performance on the held-out test set

[5]:

```
g_test = ListingGraphTG().from_csv('test_listings.csv', add_masks=False)
with torch.no_grad():
    prob_gnn = torch.sigmoid(gnn(g_test)).numpy()[g_test.listing_idx]
pred_gnn = (prob_gnn>=0.5).astype(int)
```

```
Metrics.report('GNN only', g_test.y[g_test.listing_idx].int().numpy(), pred_gnn)
```

```
GNN only acc=0.953  prec=0.57  rec=0.87  f1=0.69
confusion: TP 207 | FP 157 | FN 30 | TN 3606
```

1.5 5. Train tabular head on top of frozen GNN embeddings

[6]:

```
head_ckpt = Path("logreg_head.pkl")

if head_ckpt.exists():
    print("  found", head_ckpt, "– loading calibrated head …")
else:
    print("  head checkpoint not found – training now …")
    !python graph_home_hunter.py --train-stack train_listings.csv gnn_v1.pt␣
 ↪logreg_head.pkl --stack-model logreg --calib sigmoid

head = IntentHead.load(head_ckpt)
```

```
  found logreg_head.pkl – loading calibrated head …
```

1.6 6. Stacked model performance

[7]:

```
!python graph_home_hunter.py --predict-stack test_listings.csv gnn_v1.pt␣
 ↪logreg_head.pkl
```

```
stack metrics:
stack acc=0.991  prec=0.94  rec=0.90  f1=0.92
confusion: TP 213 | FP 14 | FN 24 | TN 3749

OVP decision:     **PLACE OFFER NOW**
  • current best posterior  : 0.999
  • P(better next week)     : 0.68%
  • Δ(Expected regret)      : -0.0193
```

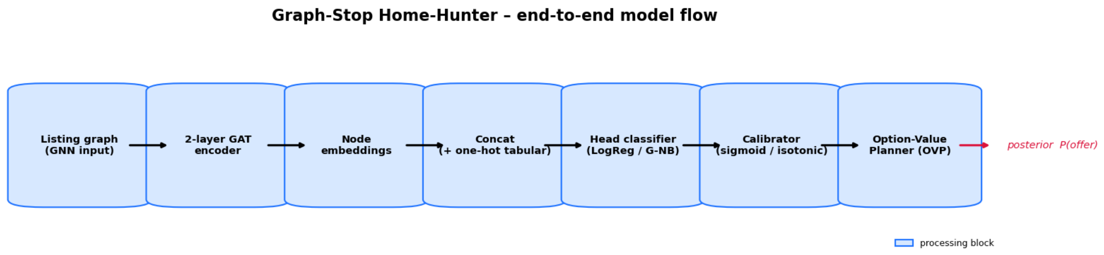
1.7 7. Model architecture schematic

[21]:

```
labels = [
    "Listing graph\n(GNN input)",
    "2-layer GAT\nencoder",
    "Node\nembeddings",
    "Concat\n(+ one-hot tabular)",
    "Head classifier\n(LogReg / G-NB)",
    "Calibrator\n(sigmoid / isotonic)",
    "Option-Value\nPlanner (OVP)"
]

#   styling ----------------------------------------------------
FACE, EDGE = "#d7e8ff", "#2074ff"
```

```
fs_title, fs_lbl = 16, 10.5
h_pad, v_pad = 0.04, 0.24          # figure-side padding
gap = 0.035                        # gap between blocks
arrow_kw       = dict(arrowstyle="-|>", lw=2.2, color="black")
arrow_final_kw = dict(arrowstyle="-|>", lw=2.2, color="crimson")

#    geometry ----------------------------------------------------
n = len(labels)
avail_w = 1 - 2 * h_pad
box_w   = (avail_w - gap * (n - 1)) / n
box_h   = 1 - 2 * v_pad
y0      = v_pad                    # bottom of blocks

fig, ax = plt.subplots(figsize=(16, 3.8))
ax.axis("off")
ax.set_title("Graph-Stop Home-Hunter - end-to-end model flow",
             fontsize=fs_title, fontweight="bold", pad=14)

centres = []

#    blocks ------------------------------------------------------
for i, txt in enumerate(labels):
    x0 = h_pad + i * (box_w + gap)
    centres.append(x0 + box_w / 2)

    ax.add_patch(
        mpatches.FancyBboxPatch(
            (x0, y0), box_w, box_h,
            boxstyle="round,pad=0.02,rounding_size=0.035",
            facecolor=FACE, edgecolor=EDGE, linewidth=1.5
        )
    )
    ax.text(x0 + box_w / 2, y0 + box_h / 2, txt,
            ha="center", va="center", fontsize=fs_lbl, fontweight="bold")

#    internal arrows (black) -----------------------------------
for cL, cR in zip(centres[:-1], centres[1:]):
    ax.annotate("",
        xy=(cR - box_w / 2 + 0.003, 0.5),
        xytext=(cL + box_w / 2 - 0.003, 0.5),
        arrowprops=arrow_kw
    )

#    final crimson arrow inside axes ---------------------------
right_edge_OVP = centres[-1] + box_w / 2
tail = (right_edge_OVP - 0.003, 0.5)
head = (min(0.99, right_edge_OVP + 0.03), 0.5)  # keep head   0.99
```

```python
ax.annotate("",
    xy=head, xytext=tail,
    arrowprops=arrow_final_kw,
    annotation_clip=False           # draw even if head slightly outside
)

#   posterior label ------------------------------------------
ax.text(head[0] + 0.015, 0.5, "posterior  P(offer)",
        fontsize=fs_lbl, va="center", fontstyle="italic", color="crimson")

#   legend ---------------------------------------------------
legend_patch = mpatches.FancyBboxPatch((0, 0), 1, 1,
                                       boxstyle="round,pad=0.02",
                                       facecolor=FACE, edgecolor=EDGE,
                                       linewidth=1.5)
ax.legend([legend_patch], ["processing block"],
          loc="lower right", frameon=False, fontsize=9)

plt.tight_layout()
plt.show()
```


Graph-Stop Home-Hunter – end-to-end model flow
Listing graph (GNN input)
2-layer GAT encoder
Node embeddings
Concat (+ one-hot tabular)
Head classifier (LogReg / G-NB)
Calibrator (sigmoid / isotonic)
Option-Value Planner (OVP)
posterior P(offer)
processing block

1.8 8. Week-by-week simulation

[9]:

```
!python simulate_weeks.py --gnn gnn_v1.pt --head logreg_head.pkl --thr 0.95␣
↪--wait-cost 0.02 --regret-cost 0.2 week_0.csv week_1.csv week_2.csv week_3.
↪csv week_4.csv week_5.csv week_6.csv week_7.csv week_8.csv week_9.csv
```

```
  Week 0: c:\Users\User\anaconda3\python.exe graph_home_hunter.py --predict-stack week_0.csv gnn_v1.pt logreg_head.pkl --thr 0.95 --wait-cost 0.02 --regret-cost 0.2 --k-next-week 10 --quiet-metrics


OVP decision:    WAIT
  • current best posterior  : 0.747
  • P(better next week)     : 17.13%
  • Δ(Expected regret)      : +0.0143
```

```
Week 1: c:\Users\User\anaconda3\python.exe graph_home_hunter.py --predict-stack week_1.csv gnn_v1.pt logreg_head.pkl --thr 0.95 --wait-cost 0.02 --regret-cost 0.2 --k-next-week 10 --quiet-metrics
```

```
OVP decision:    WAIT
  • current best posterior  : 0.747
  • P(better next week)     : 17.12%
  • Δ(Expected regret)      : +0.0142
```

```
Week 2: c:\Users\User\anaconda3\python.exe graph_home_hunter.py --predict-stack week_2.csv gnn_v1.pt logreg_head.pkl --thr 0.95 --wait-cost 0.02 --regret-cost 0.2 --k-next-week 10 --quiet-metrics
```

```
OVP decision:    WAIT
  • current best posterior  : 0.747
  • P(better next week)     : 17.11%
  • Δ(Expected regret)      : +0.0142
```

```
Week 3: c:\Users\User\anaconda3\python.exe graph_home_hunter.py --predict-stack week_3.csv gnn_v1.pt logreg_head.pkl --thr 0.95 --wait-cost 0.02 --regret-cost 0.2 --k-next-week 10 --quiet-metrics
```

```
OVP decision:    WAIT
  • current best posterior  : 0.747
  • P(better next week)     : 16.96%
  • Δ(Expected regret)      : +0.0139
```

```
Week 4: c:\Users\User\anaconda3\python.exe graph_home_hunter.py --predict-stack week_4.csv gnn_v1.pt logreg_head.pkl --thr 0.95 --wait-cost 0.02 --regret-cost 0.2 --k-next-week 10 --quiet-metrics
```

```
OVP decision:    WAIT
  • current best posterior  : 0.570
  • P(better next week)     : 20.45%
  • Δ(Expected regret)      : +0.0209
```

```
Week 5: c:\Users\User\anaconda3\python.exe graph_home_hunter.py --predict-stack week_5.csv gnn_v1.pt logreg_head.pkl --thr 0.95 --wait-cost 0.02 --regret-cost 0.2 --k-next-week 10 --quiet-metrics
```

```
OVP decision:    WAIT
  • current best posterior  : 0.570
  • P(better next week)     : 20.43%
  • Δ(Expected regret)      : +0.0209
```

Week 6: c:\Users\User\anaconda3\python.exe graph_home_hunter.py --predict-stack week_6.csv gnn_v1.pt logreg_head.pkl --thr 0.95 --wait-cost 0.02 --regret-cost 0.2 --k-next-week 10 --quiet-metrics

```
OVP decision:    WAIT
  • current best posterior  : 0.934
  • P(better next week)     : 10.94%
  • Δ(Expected regret)      : +0.0019
```

Week 7: c:\Users\User\anaconda3\python.exe graph_home_hunter.py --predict-stack week_7.csv gnn_v1.pt logreg_head.pkl --thr 0.95 --wait-cost 0.02 --regret-cost 0.2 --k-next-week 10 --quiet-metrics

```
OVP decision:    WAIT
  • current best posterior  : 0.946
  • P(better next week)     : 10.47%
  • Δ(Expected regret)      : +0.0009
```

Week 8: c:\Users\User\anaconda3\python.exe graph_home_hunter.py --predict-stack week_8.csv gnn_v1.pt logreg_head.pkl --thr 0.95 --wait-cost 0.02 --regret-cost 0.2 --k-next-week 10 --quiet-metrics

```
OVP decision:    **PLACE OFFER NOW**
  • current best posterior  : 0.954
  • P(better next week)     : 9.96%
  • Δ(Expected regret)      : -0.0001
```

Week 9: c:\Users\User\anaconda3\python.exe graph_home_hunter.py --predict-stack week_9.csv gnn_v1.pt logreg_head.pkl --thr 0.95 --wait-cost 0.02 --regret-cost 0.2 --k-next-week 10 --quiet-metrics

```
OVP decision:    WAIT
  • current best posterior  : 0.566
  • P(better next week)     : 21.80%
  • Δ(Expected regret)      : +0.0236
```

1.9 9. Explain why the best listing was chosen in Week 8

[10]:

```
!python graph_home_hunter.py --predict-stack week_8.csv gnn_v1.pt logreg_head.pkl --thr 0.95 --explain-id 161
```

```
stack metrics:
stack acc=0.972  prec=1.00  rec=0.17  f1=0.29
confusion: TP 1 | FP 0 | FN 5 | TN 175

OVP decision:    WAIT
  • current best posterior  : 0.954
  • P(better next week)     : 26.94%
  • Δ(Expected regret)      : +0.0069

Top feature contributions for listing 161:
  near_shops_True           +4.516
  condition_new             +3.104
  north_facing_True         +0.343
  outdoor_space_True        -0.312
  has_storage_False         -0.236
```

1.10 10. Run the Streamlit GUI (opens a browser tab)

1.10.1 To run the interactive simulations in the GUI, please upload:

1) The model: gnn_v1.pt
2) The model head: logreg_head.pkl and
3) The mock weekly listings data: week0-9.csv files

[11]:

```
!streamlit run home_hunter_app.py
```

```
^C
```