



*Supplement of*

## **BuildingSense: a new multimodal building function classification dataset**

**Pengxiang Su et al.**

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Section S1. Supplementary figures



Figure S1 Supplementary example of each building function category

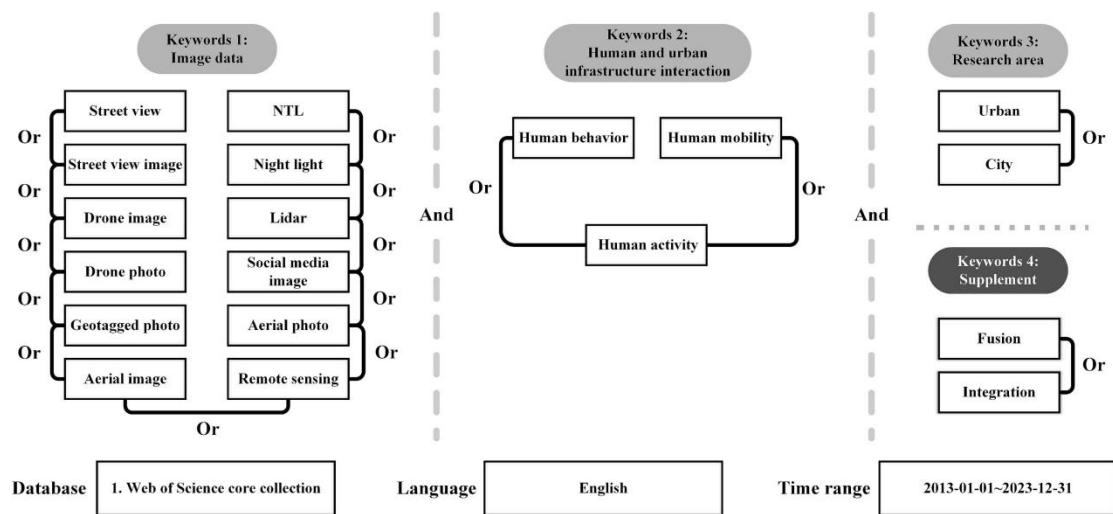


Figure S2 Keywords group used for human and urban infrastructure-related paper searching

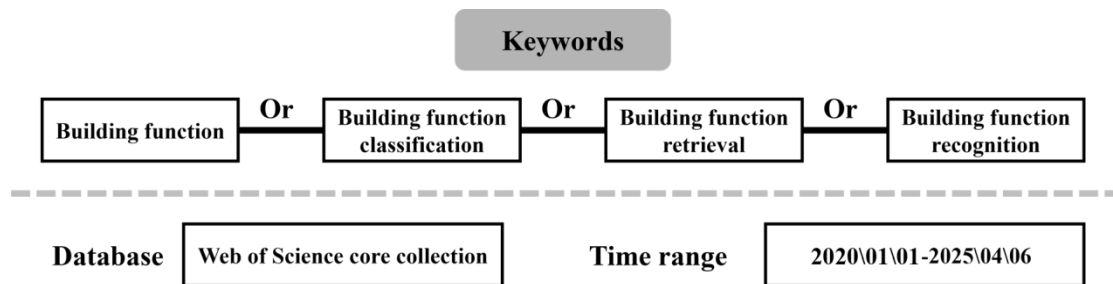


Figure S3 Keywords group used for building function-related paper searching

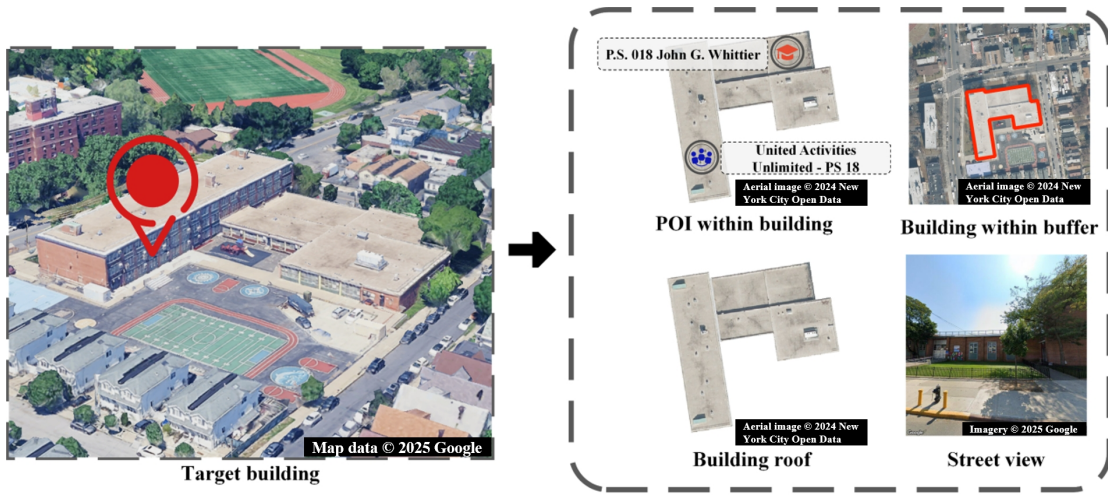
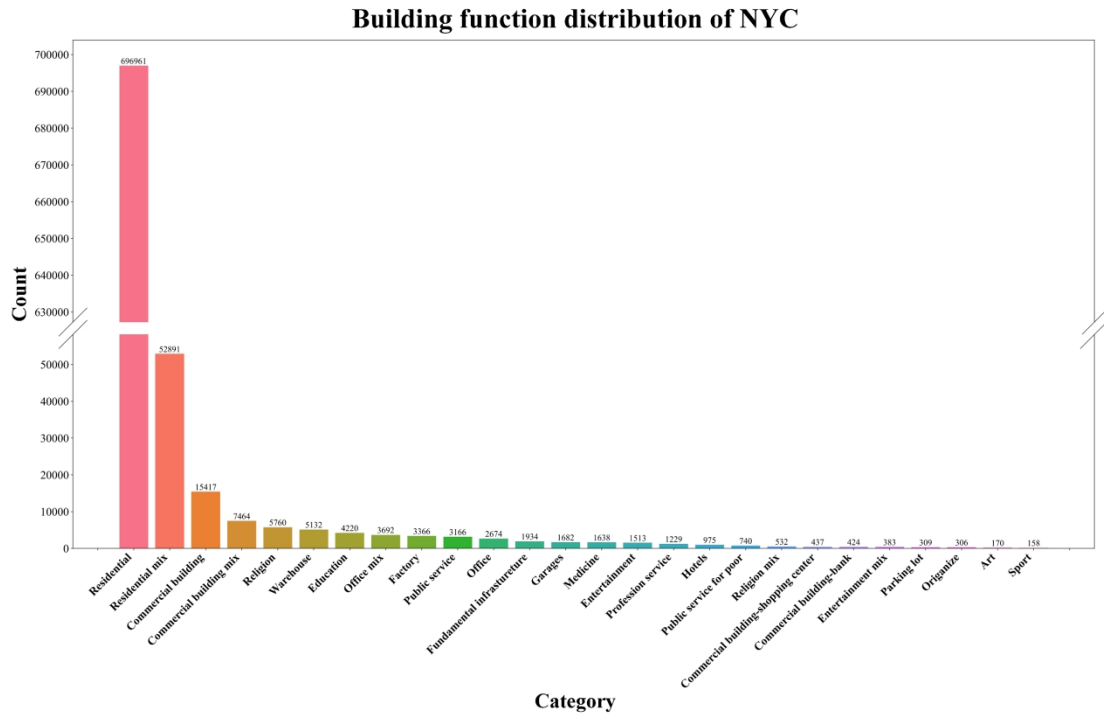


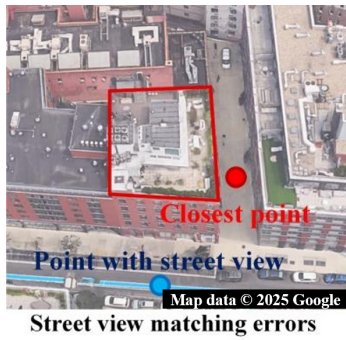
Figure S4 Example of raw data



Figure S5 Taxi zones in New York City (NYC)



**Figure S6** Building function distribution of NYC



**Figure S7** Example of errors

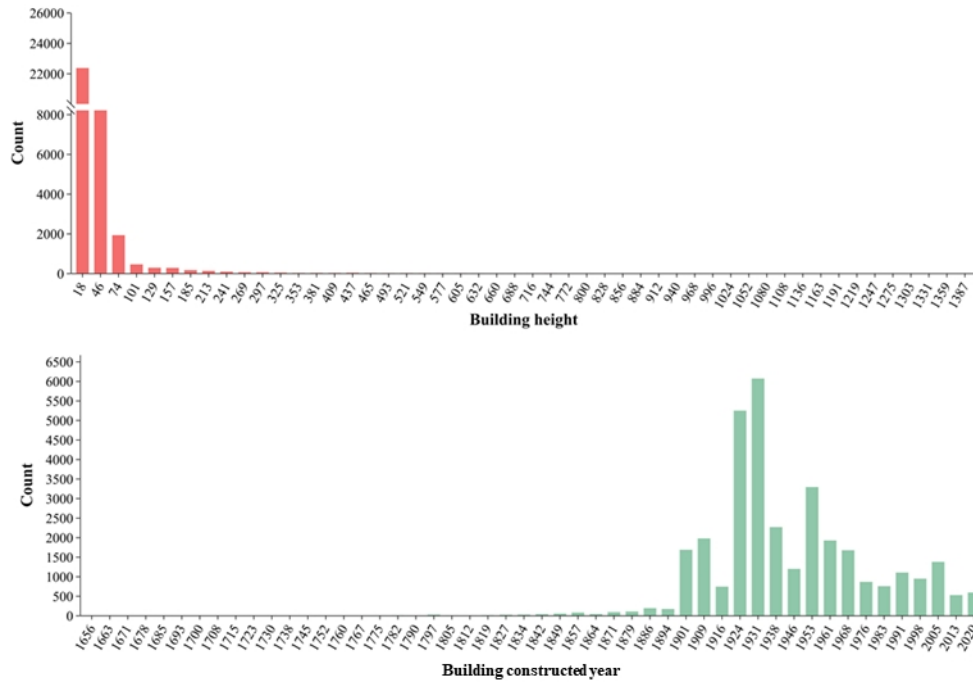


Figure S8 Distribution of building height and constructed year

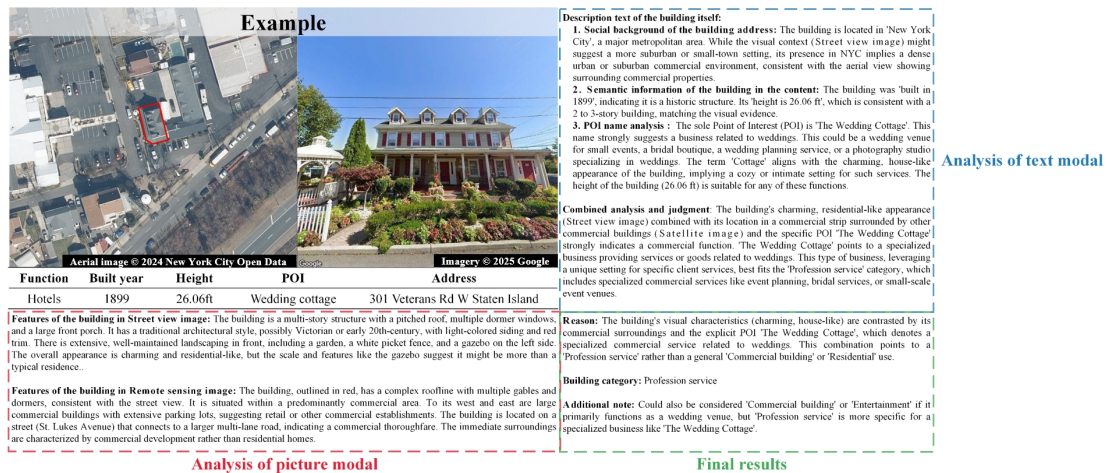


Figure S9 Example of large model output

## Section S2. Methodology

**Table S1. Definition of building function (26)**

<b>Building code</b>	<b>Description</b>	<b>Category</b>	<b>Building category</b>
E1	GENERAL WAREHOUSE	Warehouses	Warehouse
E2	CONTRACTORS WAREHOUSE	Warehouses	Warehouse
E7	SELF-STORAGE WAREHOUSES	Warehouses	Warehouse
RS	NON-BUSINESS STORAGE SPACE	Condominiums	Warehouse
RW	WAREHOUSE FOR INDUSTRIAL	Condominiums	Warehouse
Q3	OUTDOOR POOL	Outdoor recreational facilities	Sport
Q5	GOLF COURSE	Outdoor recreational facilities	Sport
Q7	TENNIS COURT	Outdoor recreational facilities	Sport
Z0	TENNIS COURT; POOL; SHED; ETC.	Misc. Building classifications	Sport
C7	WALK-UP APT. OVER SIX FAMILIES WITH STORES	Walk up apartments	Residential mix
D6	ELEVATOR APT; FIREPROOF WITH STORES	Elevator apartments	Residential mix
D7	ELEVATOR APT; SEMI-FIREPROOF WITH STORES	Elevator apartments	Residential mix
L8	LOFT; WITH RETAIL STORES OTHER THAN TYPE ONE	Lofts	Residential mix
L9	MISCELLANEOUS LOFT	Lofts	Residential mix
RD	MIXED RESIDENTIAL CONDO BUILDING CLASSIFICATION CODES	Condominiums	Residential mix
RM	MIX COMMERCIAL	Condominiums	Residential mix
RX	MIXED RESIDENTIAL, COMMERCIAL & INDUSTRIAL	Condominiums	Residential mix
RZ	MIXED RESIDENTIAL & WAREHOUSE	Condominiums	Residential mix
R7	CONDO; COMML.UNIT OF 1-3 UNIT BLDG-ORIG CLASS 1	Condominiums	Residential mix
R8	CONDO; COMML.UNIT OF 2-10 UNIT BLDG.	Condominiums	Residential mix
S0	PRIMARILY 1 FAMILY WITH 2 STORES OR OFFICES	Primarily res. - mixed use	Residential mix
S1	PRIMARILY 1 FAMILY WITH 1 STORE OR OFFICE	Primarily res. - mixed use	Residential mix

S2	PRIMARILY 2 FAMILY WITH 1 STORE OR OFFICE	Primarily res. - mixed use	Residential mix
S3	PRIMARILY 3 FAMILY WITH 1 STORE OR OFFICE	Primarily res. - mixed use	Residential mix
S4	PRIMARILY 4 FAMILY WITH 1 STORE OR OFFICE	Primarily res. - mixed use	Residential mix
S5	PRIMARILY 5-6 FAMILY WITH 1 STORE OR OFFICE	Primarily res. - mixed use	Residential mix
S9	SINGLE OR MULTIPLE DWELLING WITH STORES OR OFFICES	Primarily res. - mixed use	Residential mix
A0	CAPE COD	One family dwellings	Residential
A1	TWO STORIES - DETACHED SM OR MID	One family dwellings	Residential
A2	ONE STORY - PERMANENT LIVING QUARTER	One family dwellings	Residential
A3	LARGE SUBURBAN RESIDENCE	One family dwellings	Residential
A4	CITY RESIDENCE ONE FAMILY	One family dwellings	Residential
A5	ONE FAMILY ATTACHED OR SEMI-DETACHED	One family dwellings	Residential
A6	SUMMER COTTAGE	One family dwellings	Residential
A7	MANSION TYPE OR TOWN HOUSE	One family dwellings	Residential
A8	BUNGALOW COLONY - COOPERATIVELY OWNED LAND	One family dwellings	Residential
B1	TWO FAMILY BRICK	Two family dwellings	Residential
B2	TWO FAMILY FRAME	Two family dwellings	Residential
B3	TWO FAMILY CONVERTED FROM ONE FAMILY	Two family dwellings	Residential
C0	THREE FAMILIES	Walk up apartments	Residential
C1	OVER SIX FAMILIES WITHOUT STORES	Walk up apartments	Residential
C2	FIVE TO SIX FAMILIES	Walk up apartments	Residential
C3	FOUR FAMILIES	Walk up apartments	Residential
C4	OLD LAW TENEMENT	Walk up apartments	Residential

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C5	CONVERTED DWELLINGS OR ROOMING HOUSE	Walk up apartments	Residential
C6	WALK-UP COOPERATIVE	Walk up apartments	Residential
C8	WALK-UP CO-OP; CONVERSION FROM LOFT/WAREHOUSE	Walk up apartments	Residential
C9	GARDEN APARTMENTS	Walk up apartments	Residential
CB	WALKUP APT LESS THAN 11 UNITS RESIDENTIAL	Walk up apartments	Residential
CC	WALKUP CO-OP APT LESS THAN 11 UNITS RESIDENTIAL	Walk up apartments	Residential
CM	MOBILE HOMES/TRAILER PARKS	Walk up apartments	Residential
D0	ELEVATOR CO-OP; CONVERSION FROM LOFT/WAREHOUSE	Elevator apartments	Residential
D1	ELEVATOR APT; SEMI-FIREPROOF WITHOUT STORES	Elevator apartments	Residential
D3	ELEVATOR APT; FIREPROOF WITHOUT STORES	Elevator apartments	Residential
D4	ELEVATOR COOPERATIVE	Elevator apartments	Residential
D5	ELEVATOR APT; CONVERTED	Elevator apartments	Residential
D8	ELEVATOR APT; LUXURY TYPE	Elevator apartments	Residential
DB	ELEVATOR APT LESS THAN 11 UNITS RESIDENTIAL	Elevator apartments	Residential
DC	ELEVATOR CO-OP APT LESS THAN 11 UNITS RESIDENTIAL	Elevator apartments	Residential
H6	APARTMENT HOTEL	Hotels	Residential
H7	APARTMENT HOTEL - COOPERATIVELY OWNED	Hotels	Residential
H8	DORMITORY	Hotels	Residential
L1	LOFT; OVER 8 STORIES (MID MANH. TYPE)	Lofts	Residential
L2	LOFT; FIREPROOF AND STORAGE TYPE WITHOUT STORES	Lofts	Residential
L3	LOFT; SEMI-FIREPROOF	Lofts	Residential
RR	CONDOMINIUM RENTALS	Condominiums	Residential
R1	CONDO; RESIDENTIAL UNIT IN 2-10 UNIT BLDG.	Condominiums	Residential
R2	CONDO; RESIDENTIAL UNIT IN WALK-UP BLDG.	Condominiums	Residential

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R3	CONDO; RESIDENTIAL UNIT IN 1-3 STORY BLDG.	Condominiums	Residential
R4	CONDO; RESIDENTIAL UNIT IN ELEVATOR BLDG.	Condominiums	Residential
R6	CONDO; RESID.UNIT OF 1-3 UNIT BLDG-ORIG CLASS 1	Condominiums	Residential
M3	PARSONAGE; RECTORY	Religious facilities	Religion mix
M1	CHURCH; SYNAGOGUE; CHAPEL	Religious facilities	Religion
M2	MISSION HOUSE (NON-RESIDENTIAL)	Religious facilities	Religion
M4	CONVENT	Religious facilities	Religion
M9	MISCELLANEOUS RELIGIOUS FACILITY	Religious facilities	Religion
N1	ASYLUM	Asylums and homes	Public service for poor
N2	HOME FOR INDIGENT CHILDREN; AGED; HOMELESS	Asylums and homes	Public service for poor
N3	ORPHANAGE	Asylums and homes	Public service for poor
N4	DETENTION HOUSE FOR WAYWARD GIRLS	Asylums and homes	Public service for poor
N9	MISCELLANEOUS ASYLUM; HOME	Asylums and homes	Public service for poor
P5	COMMUNITY CENTER	Indoor public assembly & cult. Facilities	Public service
P8	LIBRARY	Indoor public assembly & cult. Facilities	Public service
T1	AIRPORT; AIRFIELD; TERMINAL	Transportation facilities	Public service
T2	PIER; DOCK; BULKHEAD	Transportation facilities	Public service
T9	MISCELLANEOUS TRANSPORTATION FACILITY	Transportation facilities	Public service
Y1	FIRE DEPARTMENT	Government/city departments	Public service
Y2	POLICE DEPARTMENT	Government/city departments	Public service
Y3	PRISON; JAIL; HOUSE OF DETENTION	Government/city departments	Public service

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Y4	MILITARY AND NAVAL INSTALLATION	Government/city departments	Public service
Y5	DEPARTMENT OF REAL ESTATE	Government/city departments	Public service
Y6	DEPARTMENT OF SANITATION	Government/city departments	Public service
Y7	DEPARTMENT OF PORTS AND TERMINALS	Government/city departments	Public service
Y8	DEPARTMENT OF PUBLIC WORKS	Government/city departments	Public service
Y9	DEPARTMENT OF ENVIRONMENTAL PROTECTION	Government/city departments	Public service
Z1	COURT HOUSE	Misc. Building classifications	Public service
Z3	POST OFFICE	Misc. Building classifications	Public service
Z7	EASEMENT	Misc. Building classifications	Public service
Z8	CEMETERY	Misc. Building classifications	Public service
O7	PROFESSIONAL BUILDINGS/STAND ALONE FUNERAL HOMES	Office buildings	Profession service
G6	LICENSED PARKING LOT	Garages	Parking lot
G7	UNLICENSED PARKING LOT	Garages	Parking lot
RG	INDOOR PARKING	Condominiums	Parking lot
RP	OUTDOOR PARKING	Condominiums	Parking lot
Z2	PUBLIC PARKING AREA	Misc. Building classifications	Parking lot
P2	LODGE ROOM	Indoor public assembly & cult. Facilities	Organization
P3	YWCA; YMCA; YWHA; YMHA; PAL	Indoor public assembly & cult. Facilities	Organization
Z4	FOREIGN GOVERNMENT	Misc. Building classifications	Organization
Z5	UNITED NATIONS	Misc. Building classifications	Organization
O5	OFFICE WITH COMM - 1 TO 6 STORIES	Office buildings	Office mix
O6	OFFICE WITH COMM 7 - 19 STORIES	Office buildings	Office mix
O8	OFFICE WITH APARTMENTS ONLY (NO COMM)	Office buildings	Office mix
J6	TELEVISION STUDIO	Theatres	Office

O1	OFFICE ONLY - 1 STORY	Office buildings	Office
O2	OFFICE ONLY 2 - 6 STORIES	Office buildings	Office
O3	OFFICE ONLY 7 - 19 STORIES	Office buildings	Office
O4	OFFICE ONLY WITH OR WITHOUT COMM - 20 STORIES OR MORE	Office buildings	Office
RB	OFFICE SPACE	Condominiums	Office
I1	HOSPITAL; SANITARIUM; MENTAL INSTITUTION	Hospitals and health facilities	Medicine
I2	INFIRMARY	Hospitals and health facilities	Medicine
I3	DISPENSARY	Hospitals and health facilities	Medicine
I4	HOSPITAL; STAFF FACILITY	Hospitals and health facilities	Medicine
I5	HEALTH CENTER; CHILD CENTER; CLINIC	Hospitals and health facilities	Medicine
I6	NURSING HOME	Hospitals and health facilities	Medicine
I7	ADULT CARE FACILITY	Hospitals and health facilities	Medicine
I9	MISCELLANEOUS HOSPITAL; HEALTH CARE FACILITY	Hospitals and health facilities	Medicine
HB	BOUTIQUE: 10-100 ROOMS; W/LUXURY FACILITIES; THEMED; STYLISH; W/FULL SVC ACCOMMODATIONS	Hotels	Hotels
HH	HOSTELS- BED RENTALS IN DORMITORY-LIKE SETTINGS W/SHARED ROOMS & BATHROOMS	Hotels	Hotels
HR	SRO- 1 OR 2 PEOPLE HOUSED IN INDIVIDUAL ROOMS IN MULTIPLE DWELLING AFFORDABLE HOUSING	Hotels	Hotels
HS	EXTENDED STAY/SUITE: AMENITIES SIMILAR TO APT; TYPICALLY CHARGE WEEKLY RATES & LESS EXPENSIVE THAN FULL-SERVICE HOTEL	Hotels	Hotels
H1	LUXURY HOTEL	Hotels	Hotels
H2	FULL SERVICE HOTEL	Hotels	Hotels
H3	LIMITED SERVICE; MANY AFFILIATED WITH; NATIONAL CHAIN	Hotels	Hotels
H4	MOTEL	Hotels	Hotels
H5	HOTEL; PRIVATE CLUB; LUXURY	Hotels	Hotels

	TYPE		
RH	HOTEL/BOATEL	Condominiums	Hotels
G0	GARAGE; RESIDENTIAL TAX CLASS 1	Garages	Garages
G1	ALL PARKING GARAGES	Garages	Garages
U0	UTILITY COMPANY LAND AND BUILDING	Utility bureau properties	Fundamental infrastructure
U1	BRIDGE; TUNNEL; HIGHWAY	Utility bureau properties	Fundamental infrastructure
U2	GAS OR ELECTRIC UTILITY	Utility bureau properties	Fundamental infrastructure
U3	CEILING RAILROAD	Utility bureau properties	Fundamental infrastructure
U4	TELEPHONE UTILITY	Utility bureau properties	Fundamental infrastructure
U5	COMMUNICATION FACILITY OTHER THAN TELEPHONE	Utility bureau properties	Fundamental infrastructure
U6	RAILROAD - PRIVATE OWNERSHIP	Utility bureau properties	Fundamental infrastructure
U7	TRANSPORTATION - PUBLIC OWNERSHIP	Utility bureau properties	Fundamental infrastructure
U8	REVOCABLE CONSENT	Utility bureau properties	Fundamental infrastructure
U9	MISCELLANEOUS UTILITY PROPERTY	Utility bureau properties	Fundamental infrastructure
F1	FACTORY; HEAVY MANUFACTURING - FIREPROOF	Factories and industrial buildings	Factory
F2	FACTORY; SPECIAL CONSTRUCTION - FIREPROOF	Factories and industrial buildings	Factory
F4	FACTORY; INDUSTRIAL SEMI-FIREPROOF	Factories and industrial buildings	Factory
F5	FACTORY; LIGHT MANUFACTURING	Factories and industrial buildings	Factory
F8	FACTORY; TANK FARM	Factories and industrial buildings	Factory
J5	THEATRE IN MIXED-USE BUILDING	Theatres	Entertainment mix
Q2	PLAYGROUND	Outdoor recreational	Entertainment mix

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		facilities	
Q6	STADIUM; RACE TRACK; BASEBALL FIELD	Outdoor recreational facilities	Entertainment mix
Q8	MARINA; YACHT CLUB	Outdoor recreational facilities	Entertainment mix
J1	THEATRE; ART TYPE LESS THAN 400 SEATS	Theatres	Entertainment
J2	THEATRE; ART TYPE MORE THAN 400 SEATS	Theatres	Entertainment
J3	MOTION PICTURE THEATRE WITH BALCONY	Theatres	Entertainment
J4	LEGITIMATE THEATRE; SOLE USE	Theatres	Entertainment
J7	OFF BROADWAY TYPE THEATRE	Theatres	Entertainment
J8	MULTIPLEX PICTURE THEATRE	Theatres	Entertainment
J9	MISCELLANEOUS THEATRE	Theatres	Entertainment
P4	BEACH CLUB	Indoor public assembly & cult. Facilities	Entertainment
P6	AMUSEMENT PLACE; BATH HOUSE; BOAT HOUSE	Indoor public assembly & cult. Facilities	Entertainment
Q0	OPEN SPACE	Outdoor recreational facilities	Entertainment
Q1	PARKS/RECREATION FACILITY	Outdoor recreational facilities	Entertainment
Q4	BEACH	Outdoor recreational facilities	Entertainment
W1	PUBLIC ELEMENTARY; JUNIOR OR SENIOR HIGH	Educational facilities	Education
W2	PAROCHIAL SCHOOL; YESHIVA	Educational facilities	Education
W3	SCHOOL OR ACADEMY	Educational facilities	Education
W4	TRAINING SCHOOL	Educational facilities	Education
W5	CITY UNIVERSITY	Educational facilities	Education
W6	OTHER COLLEGE AND UNIVERSITY	Educational facilities	Education

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W7	THEOLOGICAL SEMINARY	Educational facilities	Education
W8	OTHER PRIVATE SCHOOL	Educational facilities	Education
W9	MISCELLANEOUS EDUCATIONAL FACILITY	Educational facilities	Education
K4	PREDOMINANT RETAIL WITH OTHER USES	Store buildings	Commercial building mix
RC	MIX COMMERCIAL MIXED	Condominiums	Commercial building mix
RI	WAREHOUSE/FACTORY/INDUSTRIAL & COMMERCIAL	Condominiums	Commercial building mix
K6	SHOPPING CENTER WITH OR WITHOUT PARKING	Store buildings	Commercial building-shopping center
K7	BANKING FACILITIES WITH OR WITHOUT PARKING	Store buildings	Commercial building-bank
G2	AUTO BODY/COLLISION OR AUTO REPAIR	Garages	Commercial building
G8	CAR SALES/RENTAL WITH SHOWROOM	Garages	Commercial building
GU	CAR SALES OR RENTAL LOTS WITHOUT SHOWROOM	Garages	Commercial building
GW	CAR WASH OR LUBRITORIUM FACILITY	Garages	Commercial building
K1	ONE STORY RETAIL BUILDING	Store buildings	Commercial building
K2	MULTI-STORY RETAIL BUILDING (2 OR MORE)	Store buildings	Commercial building
K3	MULTI-STORY DEPARTMENT STORE	Store buildings	Commercial building
K5	STAND-ALONE FOOD ESTABLISHMENT	Store buildings	Commercial building
K8	BIG BOX RETAIL: NOT AFFIXED & STANDING ON OWN LOT W/PARKING; E.G. COSTCO & BJ'S	Store buildings	Commercial building
K9	MISCELLANEOUS STORE BUILDING	Store buildings	Commercial building
RK	RETAIL SPACE	Condominiums	Commercial building
R5	MISCELLANEOUS COMMERCIAL	Condominiums	Commercial building
P1	CONCERT HALL	Indoor public	Art

P7

MUSEUM

assembly & cult.

Facilities

Indoor public

assembly & cult.

Facilities

Art

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**Table S2. Prompt templates**

<b>Data combination</b>	<b>Promote</b>
Street view image	<p>'System': "You have to analyze the picture in the following sequences:</p> <ol style="list-style-type: none"> <li>1. Analyze the features of the building in front of the picture;</li> <li>2. Analyze its surroundings;</li> <li>3. Integrate the two analytical approaches above to determine the functional classification of the depicted building from (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)." <hr/> <p>'User': "Briefly summarize what your analysis is and specify your decision in JSON format, like</p> <pre>{'analysis':(the analysis process), 'reason': (briefly decision reason), 'building category': (only choose the category in the list (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)), 'additional note': possible category if other information is provided without other content}.</pre> </li></ol>
Satellite image	<p>'System': "You have to analyze the picture in the following sequences:</p> <ol style="list-style-type: none"> <li>1. Analyze the features of the building within the red line;</li> <li>2. Analyze its surroundings;</li> </ol>

3. Combine the two analysis and determine which category the building in the picture belongs to (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)."

'User': "Briefly summarize what your analysis is and specify your decision in JSON format, like

{'analysis':(the analysis process),

'reason': (briefly decision reason),

'building category': (only choose the category in the list (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)),

'additional note': possible category if other information is provided and without other content}"

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'System': "The user will provide the description text of the building, please follow the following sequences to infer its building function:

1. Infer the social background of the city according to the street and the semantic information of the building in the content;

2. Analyze the POI name of the building, analyze each POI name of the building, judge the corresponding function of each POI, and compare their possible size with the height of the building;

3. Based on the results of steps 1 and 2,

Building description text

determine which category the building belongs to (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)."

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'User': "Description text: (%s). Briefly summarize what your analysis and specify your findings in JSON format, like

{'analysis':(the analysis process),

'reason': (briefly decision reason),

'building category': (only the category (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)),

'additional note': possible category if other information is provided without other content."

---

'System': "You have to analyze the picture in the following sequences to infer its building function:

1. Analyze the features of the building in front of the picture and its surroundings;

2. Analyze the description text of the building itself

2.1, infer the social background of the city according to the street address;

2.2, infer the semantic information of the building in the content;

2.3, analyze each POI name of the building, judge the corresponding function of each POI, and compare their possible size

Street + Text

with the height of the building;

3. Combine the analysis above and then infer which category the building in the picture belongs to (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)."

'User': "Building description (%s); Briefly summarize your analysis and specify your findings in JSON format, like

```
{'analysis':  
    {'features of the building':(step 1),  
     'description text of the building  
itself':(step 2),  
     'the combined analysis and  
judgment': (step 3)},  
    'reason': (briefly decision reason),  
    'building category': (only choose the  
category in the list (Art; Commercial building;  
Commercial building-bank; Commercial  
building-shopping center; Commercial  
building mix; Education; Entertainment;  
Entertainment mix; Factory; Garages; Hotels;  
Medicine; Office; Office mix; Organization;  
Parking lot; Profession service; Public service;  
Public service for poor; Religion; Religion  
mix; Residential; Residential mix; Sport;  
Warehouse; Fundamental infrastructure)),  
    'additional note': possible category if  
other information is provided without other  
content}."
```

---

'System': "You have to analyze the picture in the following sequences to infer its building function:

Satellite + Text

1. Analyze the features of the building within the red line and its surroundings;
2. Analyze the description text of the building itself

2.1, infer the social background of the city according to the street address;

2.2, infer the semantic information of the building in the content;

2.3, analyze each POI name of the building, judge the corresponding function of each POI, and compare their possible size with the height of building;

3. Combine the analysis above and then infer which category the building in the picture belongs to (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)."

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'User': "building description (%s); Briefly summarize your analysis and specify your findings in JSON format, like

{'analysis':

{'features of the building':(step 1),

'description text of the building itself':(step 2),

'The combined analysis and judgment': (step 3)},

'reason': (briefly decision reason),

'building category': (only choose the category in the list (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)),

'additional note': possible category if other information is provided without other content}"

'System': "You have to analyze the picture in the following sequences to infer its building function:

1. Analyze the features of the building in front of the picture and its surroundings (Picture 2);

2. Analyze the features of the building within the red line and its surroundings (Picture 1);

3. Combine the analysis above and then infer which category the building in the picture belongs to (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)."

Street + Satellite

'User': "Briefly summarize what your analysis is and specify your findings in JSON format, like

```
{'analysis':  
  {'features of the building in  
picture1':(step 1),  
  'features of the building in  
picture2':(step 2),  
  'the combined analysis and  
judgment': (step 3)},  
  'reason': (briefly decision reason),  
  'building category': (only choose the  
category in the list (Art; Commercial building;  
Commercial building-bank; Commercial  
building-shopping center; Commercial  
building mix; Education; Entertainment;  
Entertainment mix; Factory; Garages; Hotels;  
Medicine; Office; Office mix; Organization;  
Parking lot; Profession service; Public service;  
Public service for poor; Religion; Religion  
mix; Residential; Residential mix; Sport;  
Warehouse; Fundamental infrastructure)),  
  'additional note': possible category if
```

other information is provided without other content"

---

'System': "You have to analyze the picture in the following sequences to infer its building function:

1. Analyze the features of the building in front of the picture and its surroundings (Picture 2);

2. Analyze the features of the building within the red line and its surroundings (Picture 1);

3. Analyze the description text of the building itself

3.1, infer the social background of the city according to the street address;

3.2, infer the semantic information of the building in the content;

3.3, analyze each POI name of the building, judge the corresponding function of each POI, and compare their possible size with the height of the building;

4. Combine the analysis above and then infer which category the building in the picture belongs to (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)."

---

Street + Satellite + Text

'User': "Building description (%s);

Briefly summarize what your analysis is and specify your findings in JSON format, like

{'analysis':

'features of the building in picture1':(step 1),

'features of the building in picture2':(step 2),

'description text of the building itself':(step 3),

'the combined analysis and

judgment': (step 4)},

'reason': (briefly decision reason),

'building category': (only choose the category in the list (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)),

'additional note': possible category if other information is provided without other content."

---

'System': "You have to analyze the picture in the following sequences to infer its building function:

1. Analyze the features of the building in front of the picture and its surroundings;

2. Analyze the description text of the building itself

2.1, infer the social background of the city according to the street address;

2.2, infer the semantic information of the building in the content;

2.3, analyze each POI name of the building, judge the corresponding function of each POI, and compare their possible size with the height of building;

3. Combine the analysis above and then infer which category the building in the picture belongs to (Recreation; Commercial building; Mixed (the mixed used building); Education; Factory; Garages; Hospital; Office; Organization; Parking lot; Public service (including fundamental infrastructure); Religion; Residential)."

Street + Text (Land use)

---

'User': "building description (%s); Briefly summarize your analysis and specify your findings in JSON format, like

{'analysis':

{'features of the building':(step 1),

---

'description text of the building itself:(step 2),

'The combined analysis and judgment': (step 3)},

'reason': (briefly decision reason),

'building category': (only choose the category in the list (Recreation; Commercial building; Mixed(the mixed-use building); Education; Factory; Garages; Hospital; Office; Organization(including embassy); Parking lot; Public service(including fundamental infrastructure); Religion; Residential),

'additional note': possible category if other information is provided without other content"}  

---

'System': "You have to analyze the picture in the following sequences to infer its building function:

1. Analyze the features of the building in front of the picture and its surroundings (Picture 2);

2. Analyze the features of the building within the red line and its surroundings (Picture 1);

3. Analyze the description text of the building itself

3.1, infer the social background of the city according to the street address;

3.2, infer the semantic information of the building in the content;

3.3, analyze each POI name of the building, judge the corresponding function of each POI, and compare their possible size with the height of the building;

4. Combine the analysis above, read the category definition(%s), and then infer which category the building in the picture belongs to (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for

---

Street + Satellite + Text (Supplement)

---

poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)."

'User': "Building description (%s); Briefly summarize your analysis and specify your findings in JSON format, like

{'analysis':

'features of the building in picture1':(step 1),

'features of the building in picture2':(step 2),

'description text of the building itself':(step 3),

'the combined analysis and judgment': (step 4)},

'reason': (briefly decision reason),

'building category': (only choose the category in the list (Art; Commercial building; Commercial building-bank; Commercial building-shopping center; Commercial building mix; Education; Entertainment; Entertainment mix; Factory; Garages; Hotels; Medicine; Office; Office mix; Organization; Parking lot; Profession service; Public service; Public service for poor; Religion; Religion mix; Residential; Residential mix; Sport; Warehouse; Fundamental infrastructure)),

'additional note': (possible category if other information is provided)} without other content"

---

**Table S3. Definition of Land use (14)**

<b>Code</b>	<b>Building function</b>	<b>Land use</b>
1	Art	Recreation
2	Commercial building	Commercial building
3	Commercial building-bank	Commercial building
4	Commercial building-shopping center,	Commercial building
5	Commercial building mix	Mixed
6	Education	Education
7	Entertainment	Recreation
8	Entertainment mix	Mixed
9	Factory	Factory
10	Garages,	Garages,
11	Hotels	Commercial building
12	Medicine,	Medicine
13	Office	Office
14	Office mix	Mixed
15	Organization	Organization
16	Parking lot	Parking lot
17	Profession service	Office
18	Public service	Public service
19	Public service for poor	Public service
20	Religion	Religion
21	Religion mix	Religion

22	Residential	Residential
23	Residential mix	Mixed
24	Sport	Recreation
25	Warehouse,	Factory
26	Fundamental infrastructure	Public service

**Table S4. Modal input**

Modal	Data	Input type
Image	Street view image	URL
	Remote sensing image	URL
Text	Building address, building height, and building year	Structure text
	POI	Structure text

**Definition of Structure text:** This building is located in New York City, it is built in %(building year), its height is %(building height)ft, its address is %(building address), and the point of interest within it are [List of POI name]

**Table S5. Cost of each large model**

Large model	Input token cost/million	Output token cost/million
Deepseek-chat	0.07	1.14
QVQ-plus	0.03	0.07
Claude-sonnet-4	3	15
Gemini-2.5-flash (Thinking)	1	2.5

---

**Algorithm S1 Deep search**

---

**Input:** building footprint `b_shp`

**Output:** POIs `P`

**Function** `deep search poi (b_shp)`

`Boundary = b_shp.boundary;`

`Parts = Boundary.divide (4); // divide the boundary into four rectangle`

`P = []; // empty list to store the POIs`

**For** (`i = 0; i < len (Parts); i++`) **do**

`p = Algorithm S2 (Parts[i]); // the POIs within the divided part`

**if** (`len (p) ≥ 20`) **then**

`p = deep search poi (Parts[i]);`

`P.extend (p);`

**Return** `P`

`P = Algorithm S2 (b_shp)`

**if** (`len (P) ≥ 20`) **then**

`P = deep search poi (b_shp);`

`P = P.filter (place_id); // remove the POIs with the same place_id`

`P = P.filter (b_shp); // select the POIs within the building`

**Return** `P`

---

---

**Algorithm S2 Crawling POIs from Google Maps**

---

**Input:** building footprint `b_shp`

**Output:** POIs `P`

`Centroid = b_shp.centroid; // Compute the centroid of building footprint`

`Boundary = b_shp.boundary; // Compute the boundary of building footprint`

`Radius = Sqrt ( (Boundary.x)2 + (Boundary.y)2 ) / 2; // Compute the radius for crawling POI`

`P = Google Maps.place_api (Centroid, Radius)`

**Return** `P`

---

**Evaluation prompt**

**System prompt:** "Analyze the following building function categories and their descriptions, and determine if they are logically consistent. If they are not, please provide a brief explanation of the inconsistency."

**User prompt:** "Read the provided building function categories and their descriptions(%s), and return the results in the following JSON format: 'logical\_analysis': 'True' or 'False', 'reason': 'explanation of the inconsistency if False'."

## **Section S3. Evaluation criteria**

### **Criteria of the model's output evaluation**

Definition of accurate remote sensing descriptions: Whether the model can accurately describe the characteristics of the building in the red line and its surroundings, even though it can not capture all the important information.

Definition of accurate street view descriptions: Whether the model can accurately describe the characteristics of the building in the street view image, which is outlined in the aerial image, even though it can not capture all the important information.

Definition of accurate text descriptions: Whether the model can accurately understand the semantic information behind the building address, building height, building year, and the name of the POI within the building, and then combine the analysis of text information.

Definition of logic combination analysis: Whether the combination analysis is logical, judged by human and large language model (LLM)

Definition of conflicts between results and analysis: Whether the conclusion of the combination analysis and the final result of the model are discrepancy.

Definition of helpful additional information: Whether the additional information points out the potential category of the building, once the additional information is provided, or the other categories.

### **Definition of model errors**

Definition of category ambiguity: The building function categories output by the model are either semantically correct or exhibit ambiguity with the original annotations.

Definition of origin annotation error: The building function categories output by the model are more adherent to the original one.

Definition of insufficient evidence: The evidence is unable to infer the origin building function even if it is inferred by human.

Definition of recognition failure: The model is unable to recognize the building.

Definition of spatial relation errors: The model fails to accurately localize buildings across multi-view perspectives or comprehensively interpret their semantic information.

Definition of POI semantic misinterpretation: The model misinterprets the semantic meaning of the POI's name.