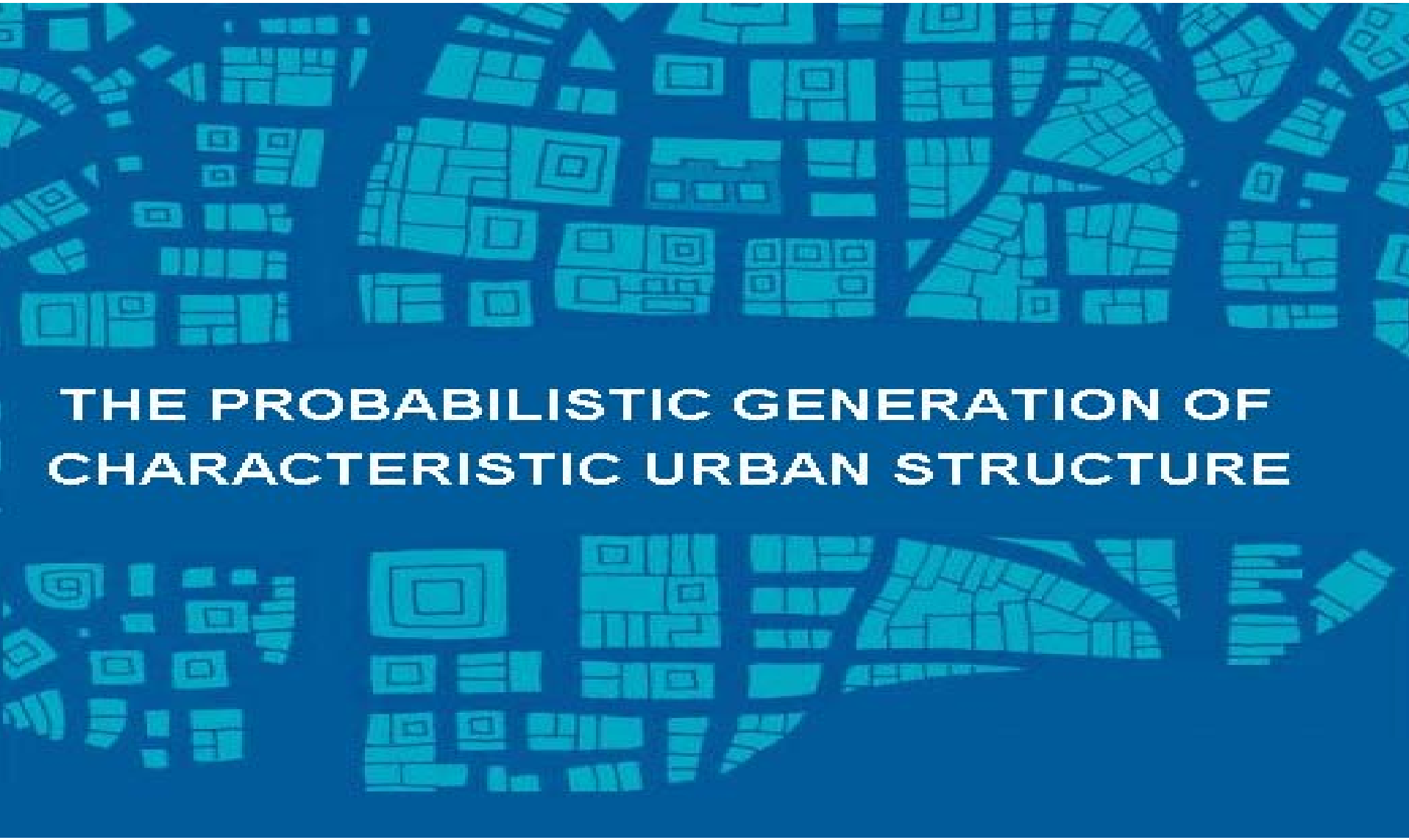


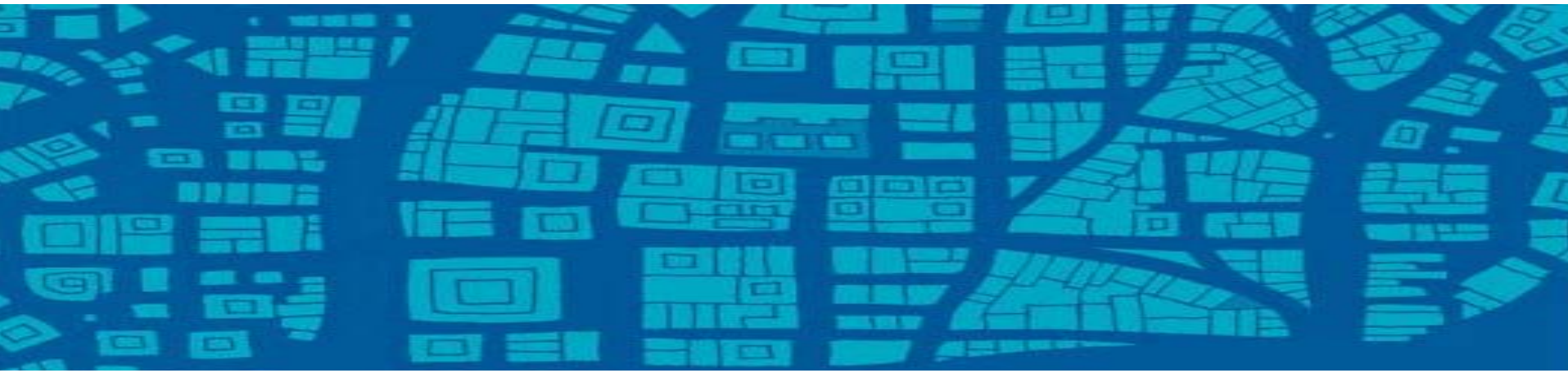
THE PROBABILISTIC GENERATION OF CHARACTERISTIC URBAN STRUCTURE

STEPHEN MARSHALL

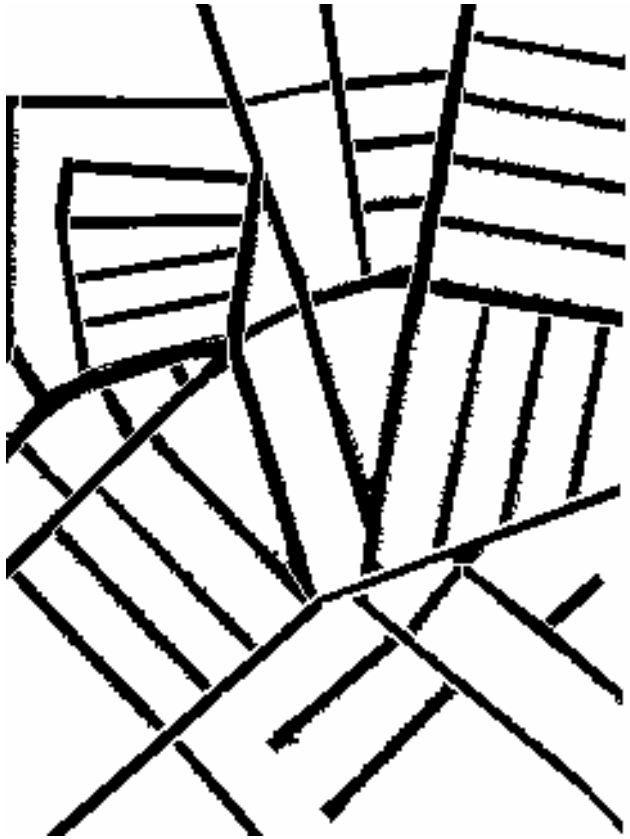
The Young Foundation

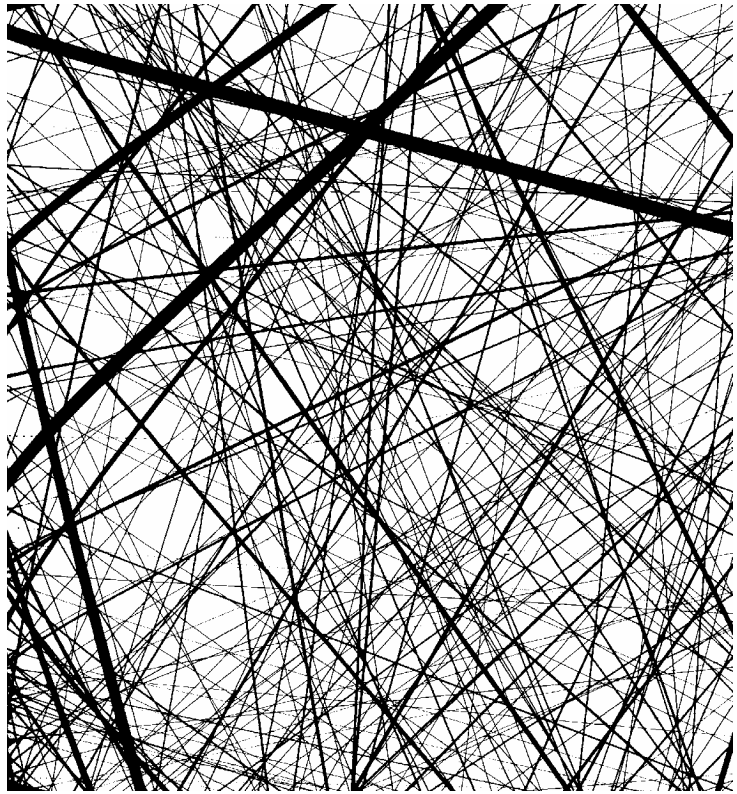
Bartlett School of Planning, UCL

The Urban Design Agenda



- Neo-traditional urbanism now in favour
- Traditional patterns now seen as ‘models’
- But these patterns were not ‘planned’
- How to plan or design these?





‘Chaotic’

(Keeble)

‘Random’

(Mandelbrot)

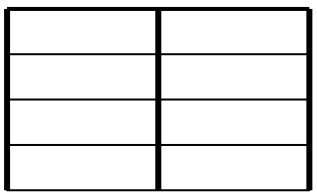
Characteristic Structure

Two senses:

- Typical distinctive character
- Likely

Characteristic Structure

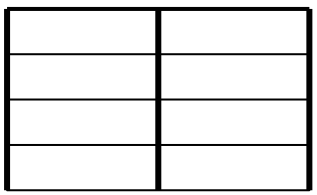
- Typical distinctive character
- Means the quintessential ‘street pattern shape’



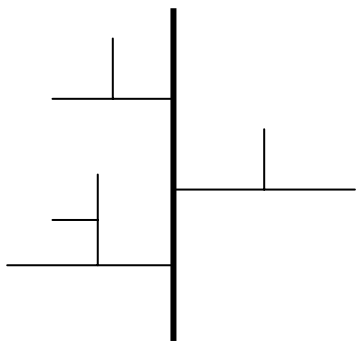
Not ‘*like* a gridiron’

Characteristic Structure

- Typical distinctive character
- Means the quintessential ‘street pattern shape’



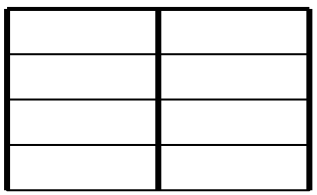
Not ‘*like* a gridiron’



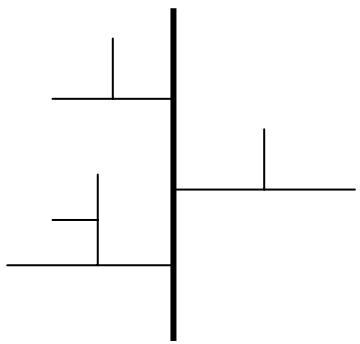
Not ‘*like* a tree’

Characteristic Structure

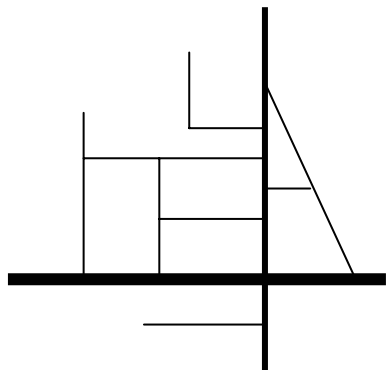
- Typical distinctive character
- Means the quintessential ‘street pattern shape’



Not ‘*like* a gridiron’



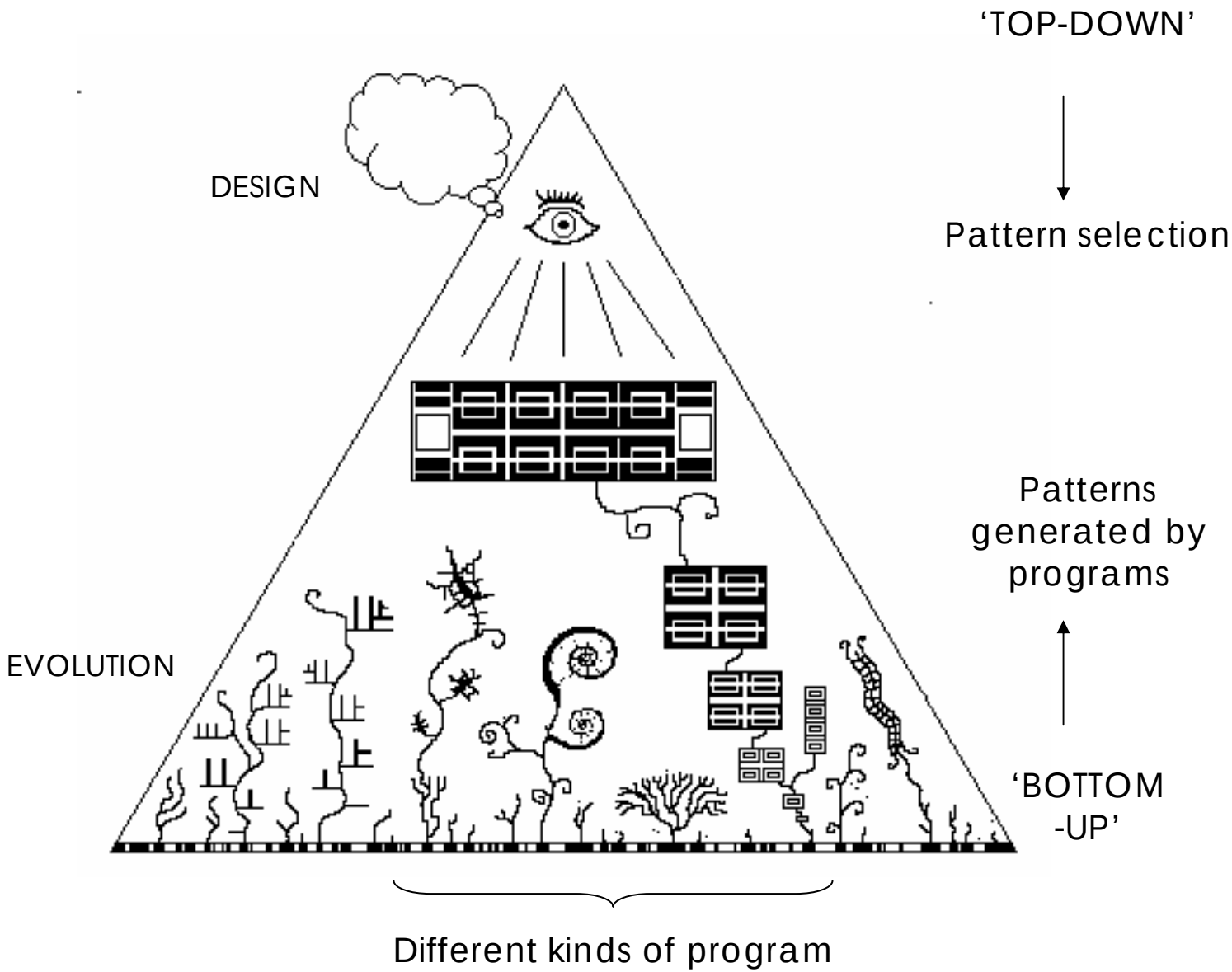
Not ‘*like* a tree’



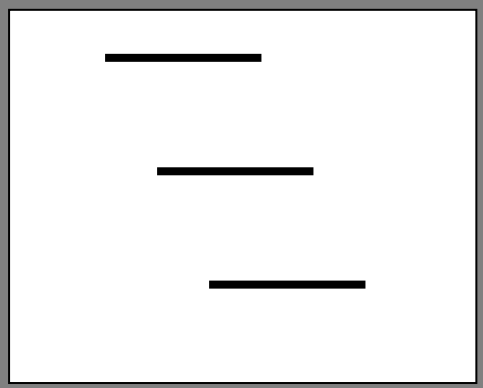
But like nothing other than a street pattern

Characteristic structure of street patterns

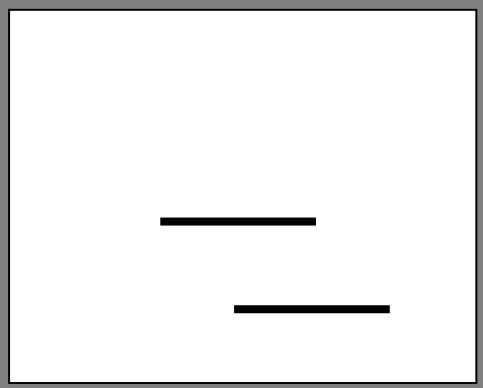
- a mixture of short and long routes, and more and less connective routes;
- some differentiation of routes by depth, but overall not too great a depth;
- three-way junctions are typically in the majority, but likelihood of at least some crossroads and culs-de-sac;
- a medium or ‘semi-griddy’ level of connectivity, with a relative connectivity (X) of around 0.35-0.45;
- a relatively high degree of irregularity and complexity, with complexity (Ω)
- typically in the range 0.35 to 0.6.

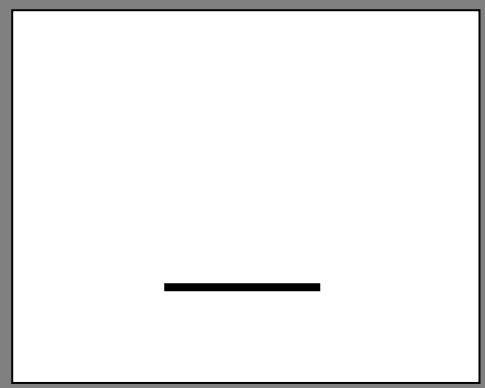

'TOP-DOWN'
DESIGN
Pattern selection
Patterns generated by programs
EVOLUTION
'BOTTOM -UP'
Different kinds of program

Kit of identical parts



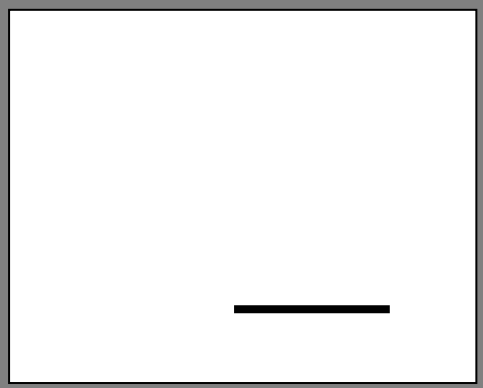
Kit of identical parts

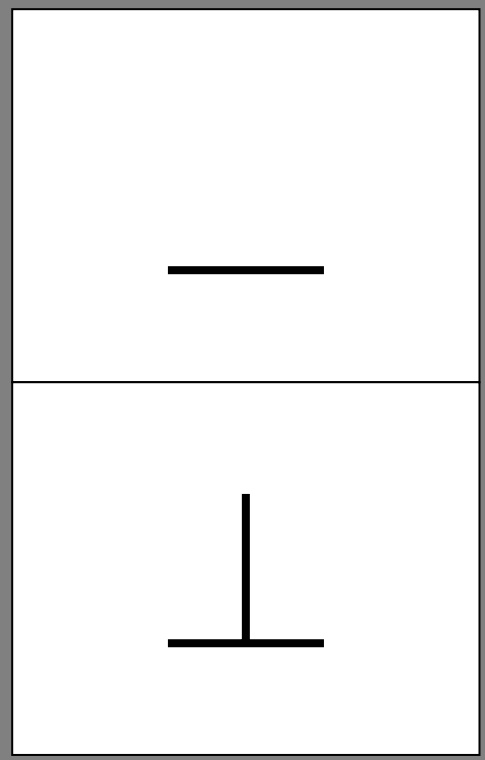




(i) generation 1

Kit of identical parts

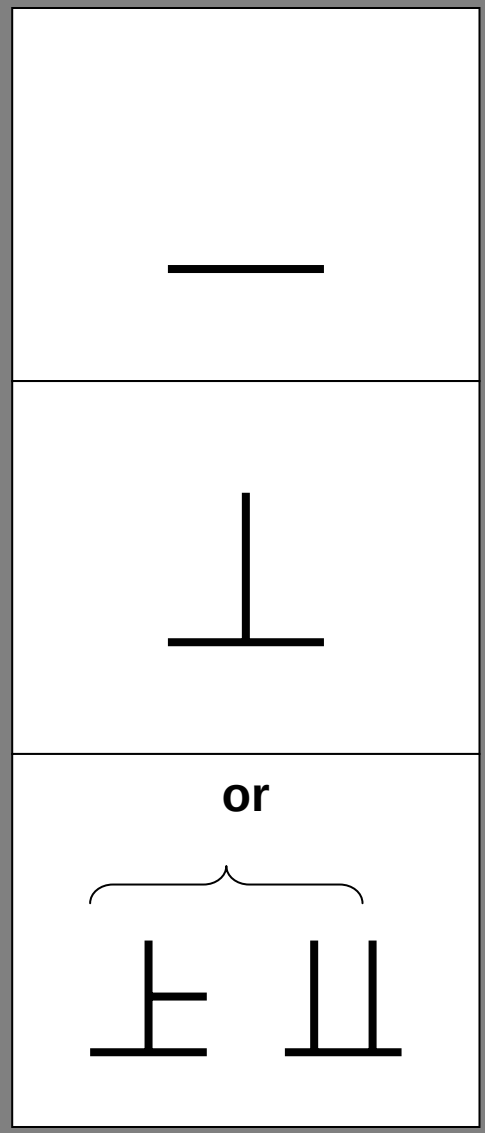




(i) generation 1

(ii) generation 2

Kit of identical parts



(i) generation 1

(ii) generation 2

(iii) generation 3

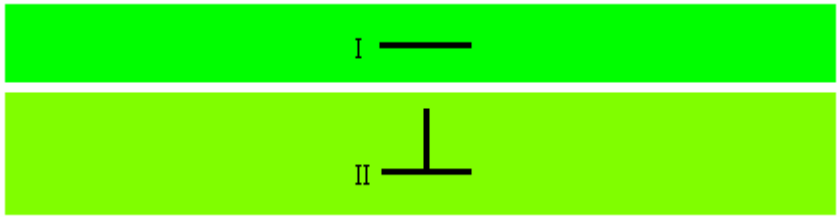
The T-tree program

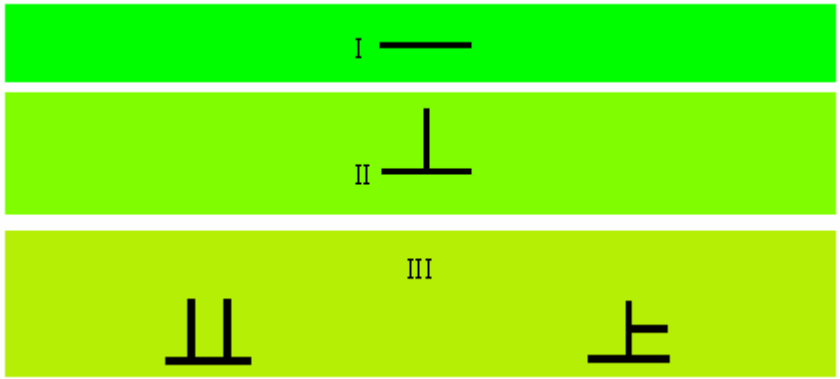
1) Each constituent element is identical.

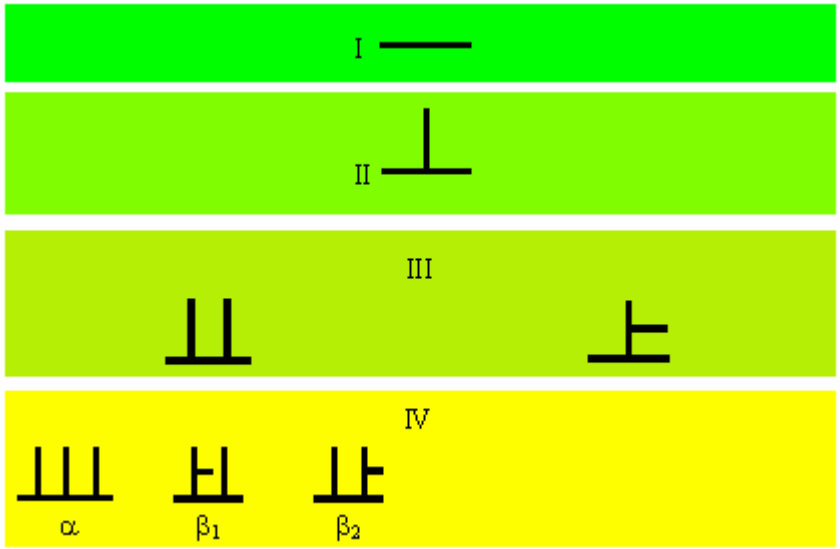
2) Each element is added to form structure one at a time.

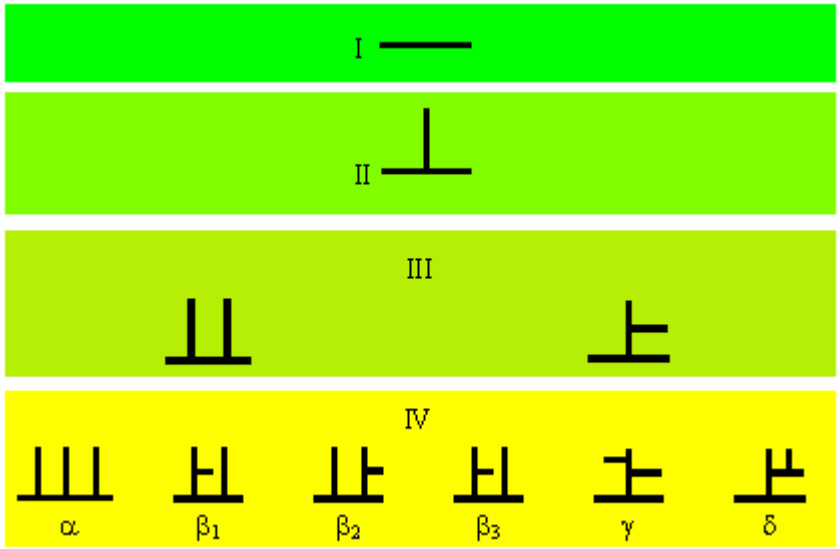
3) Each new element occupies a position on the structure that is chosen at random.

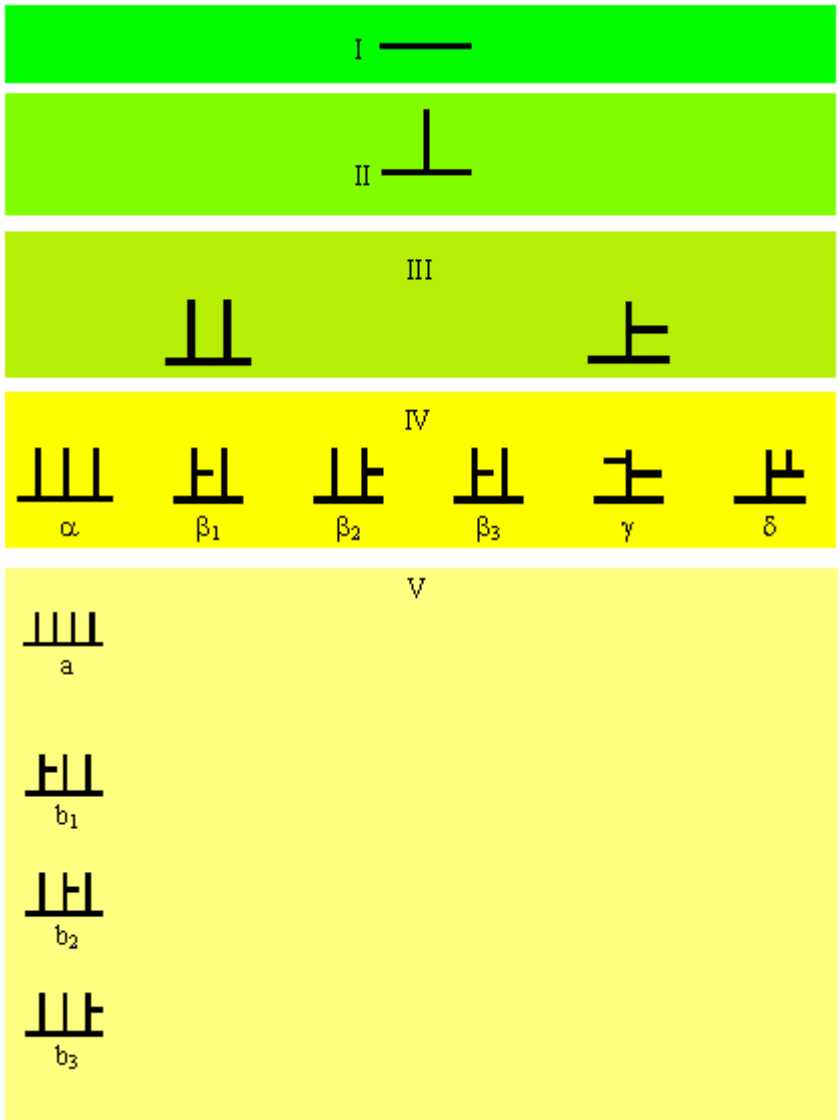
4) Each new element joins the existing structure at only one of its ends, to form a 3-way connection (T-junction), such that the overall structure is a ‘T-tree’.

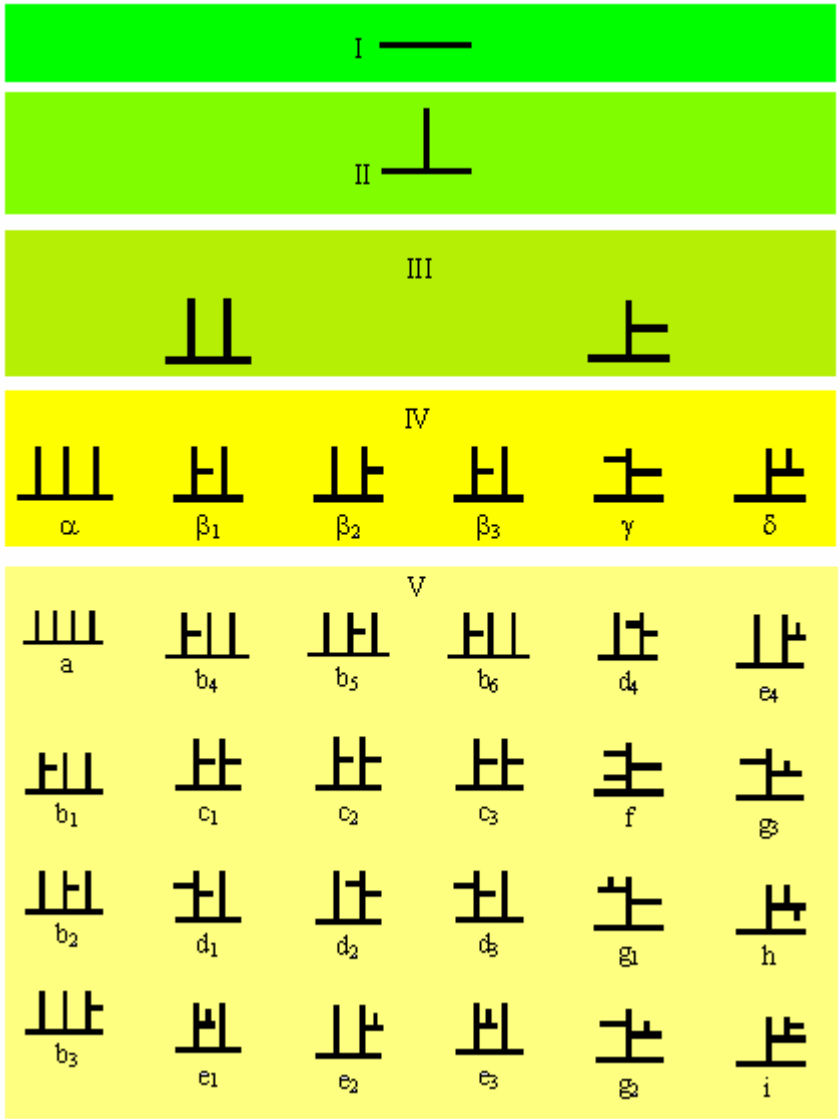

I
II

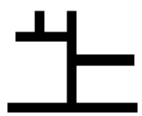

I
II
III

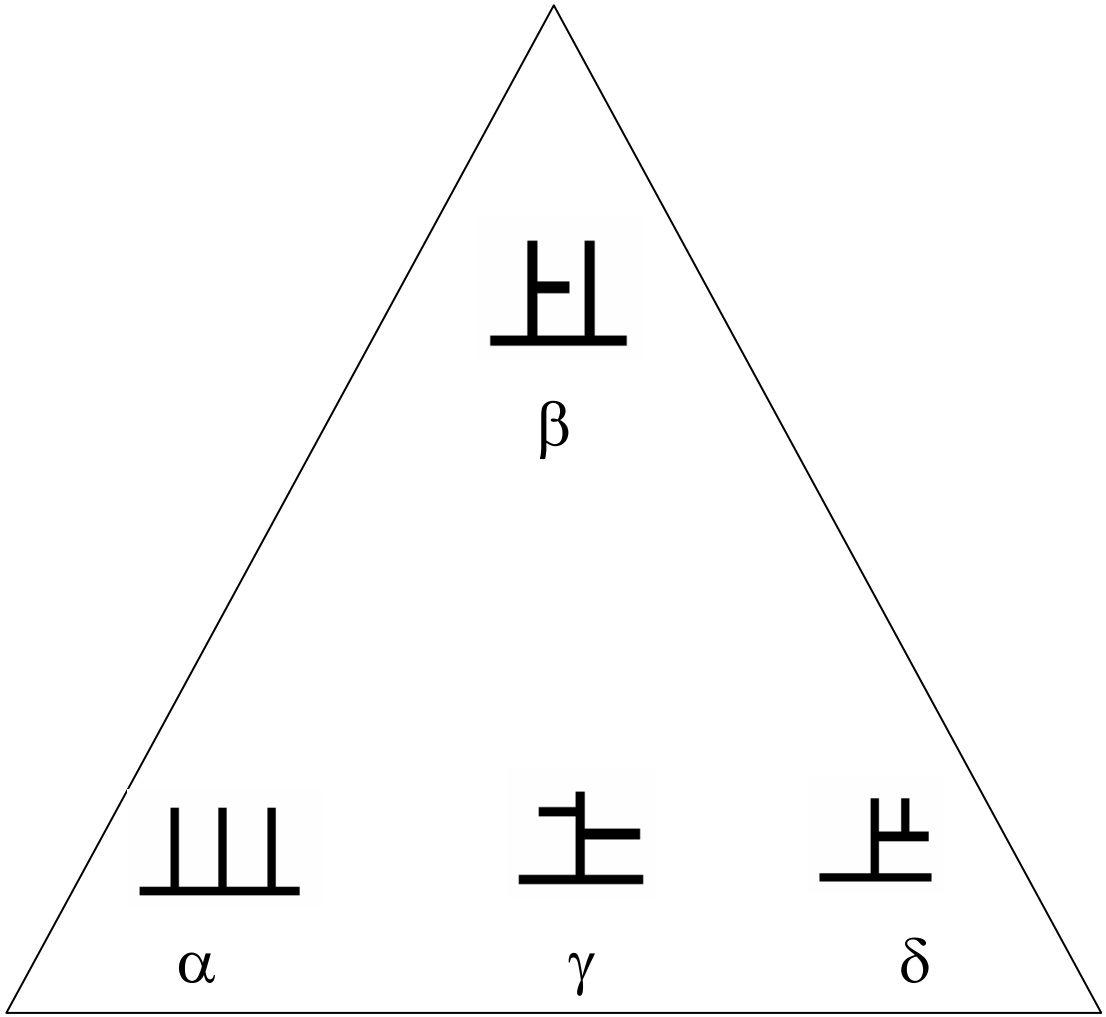

I
II
III
IV
α
β1
β2


I
II
III
IV
α
β1
β2
β3
γ
δ


I
II
III
IV
α
β1
β2
β3
γ
δ
V
a
b1
b2
b3


I
II
III
IV
α
β1
β2
β3
γ
δ
V
a
b4
b5
b6
d4
e4
b1
c1
c2
c3
f
g3
b2
d1
d2
d3
g1
h
b3
e1
e2
e3
g2
i

Case		Frequency	Probability
a		1	4%
b_{1-6}		6	25%
c_{1-3}		3	12.5%
d_{1-4}		4	17%
e_{1-4}		4	17%
f		1	4%
g_{1-3}		3	12.5%
h		1	4%
i		1	4%
Total		24	100%



More frequent
(three variants)

Typicality

Less frequent
(each a singular
type)

Comb Irregulars Fractal

Type

The ‘X-cell’ program.

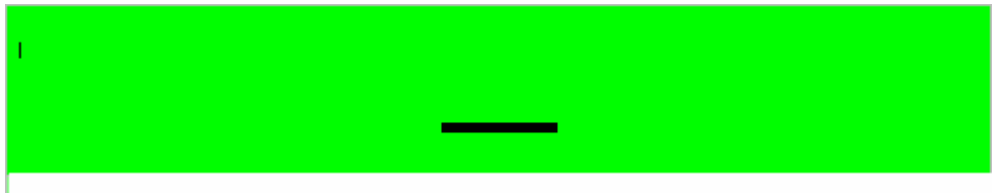
+ + + + + +

1) Each constituent element is identical.

2) Each element is added to form structure one at a time.

3) Each new element occupies a position on the structure that is chosen at random.

4) Each new element joins the existing structure at one or both of its ends (but not along its middle); the resulting structure can have multi-spoked nodes and form ‘circuits’.



I

II

I

II

III

a

b

c

d

I

II

III


a


b


c


d

IV


a


e_1


b_3


l_1


i_3


o


e_3


s_2


b_1


e_2


c


n


j


r


f_2


s_3


b_2


i_1


d


q


k


s


f_3


h


p


i_2


f


u_1

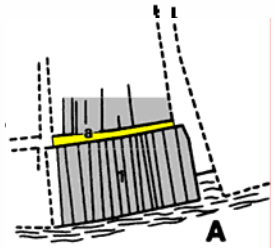
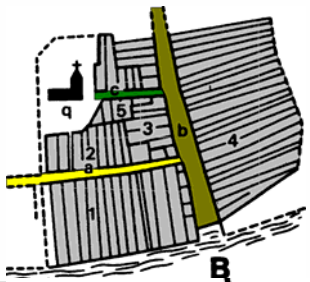
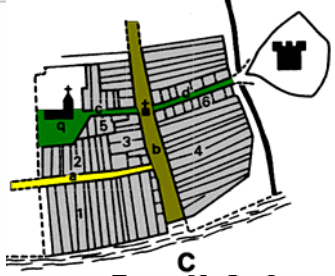
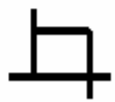

l_2

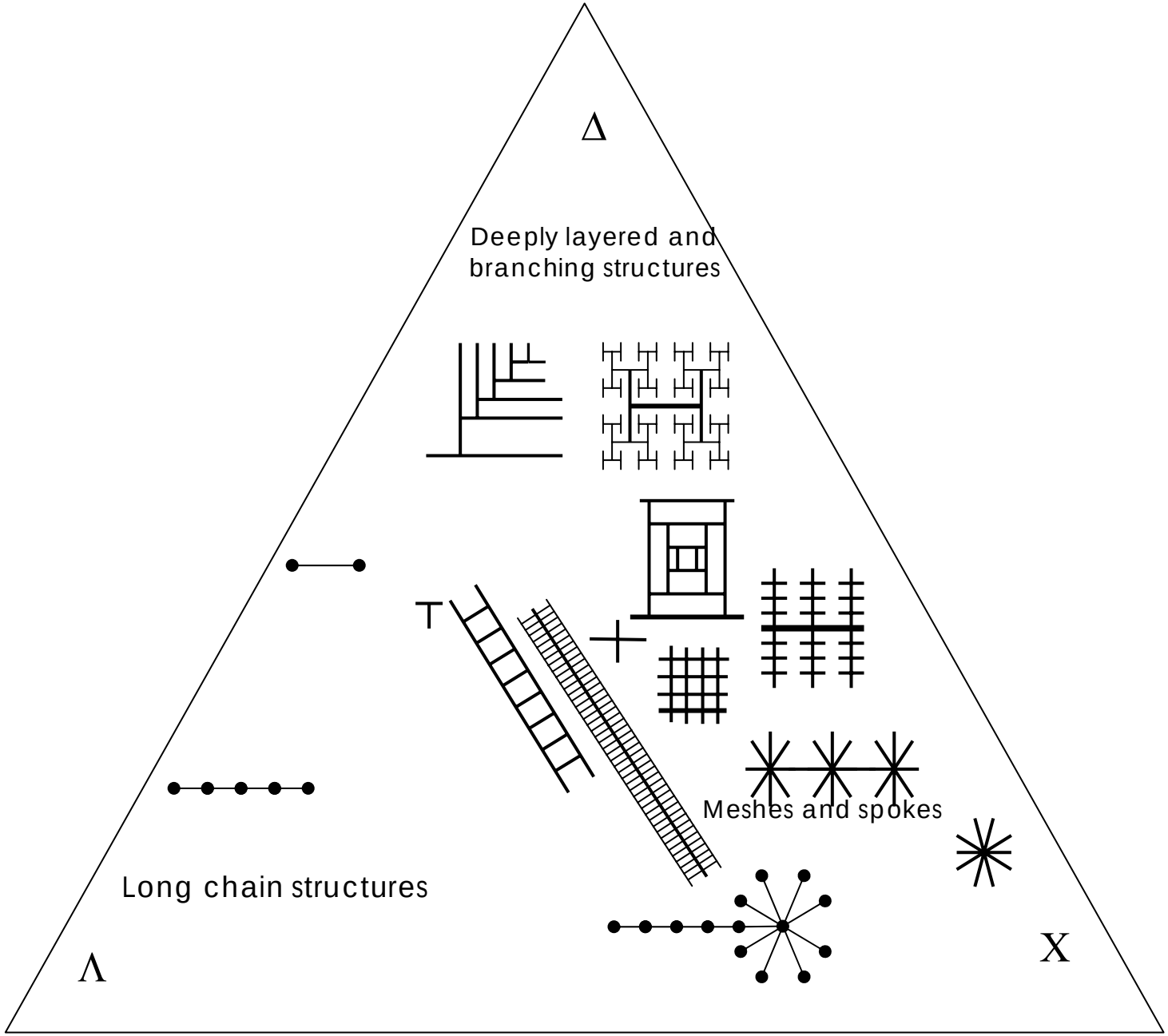

t

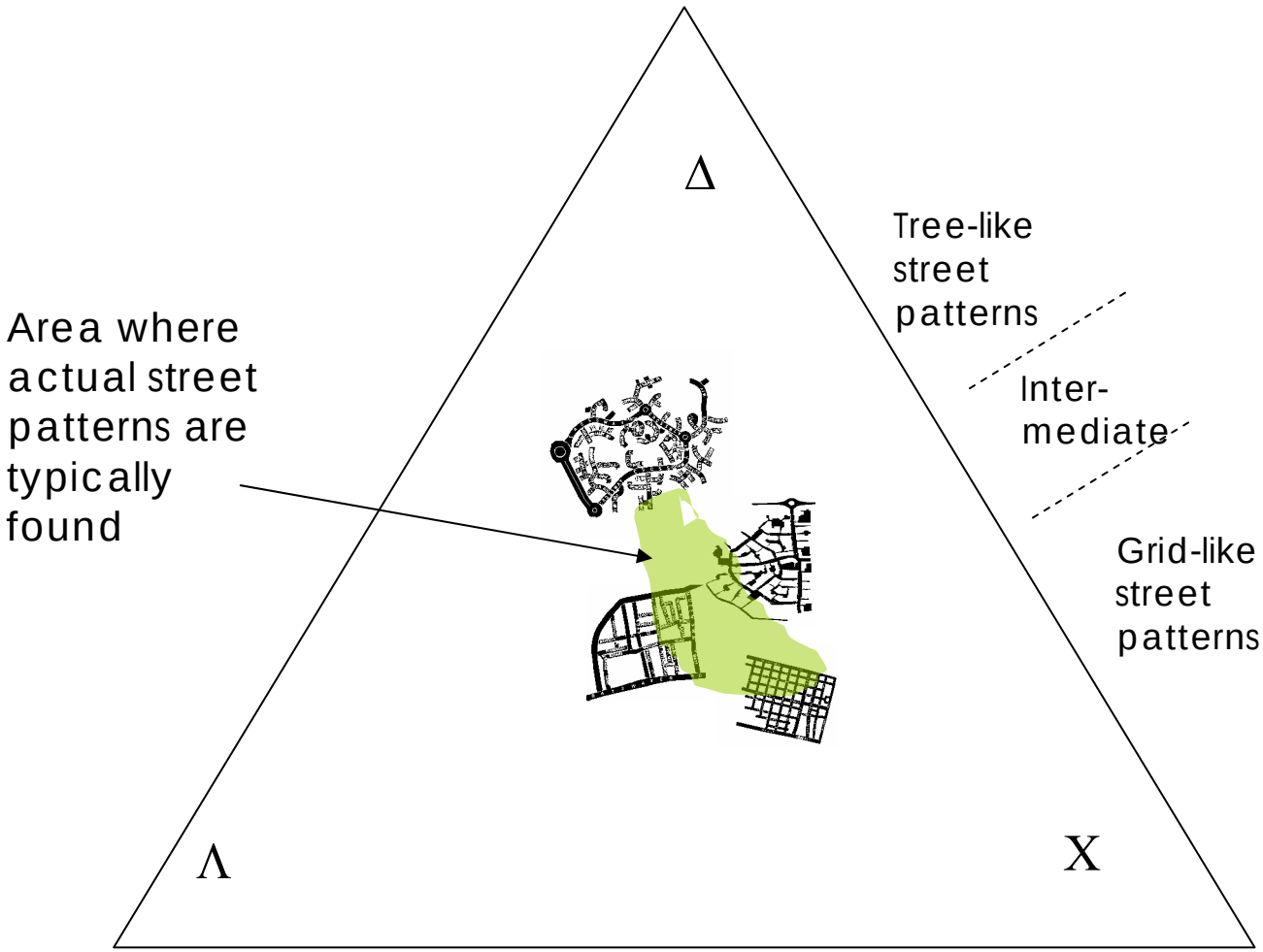

g

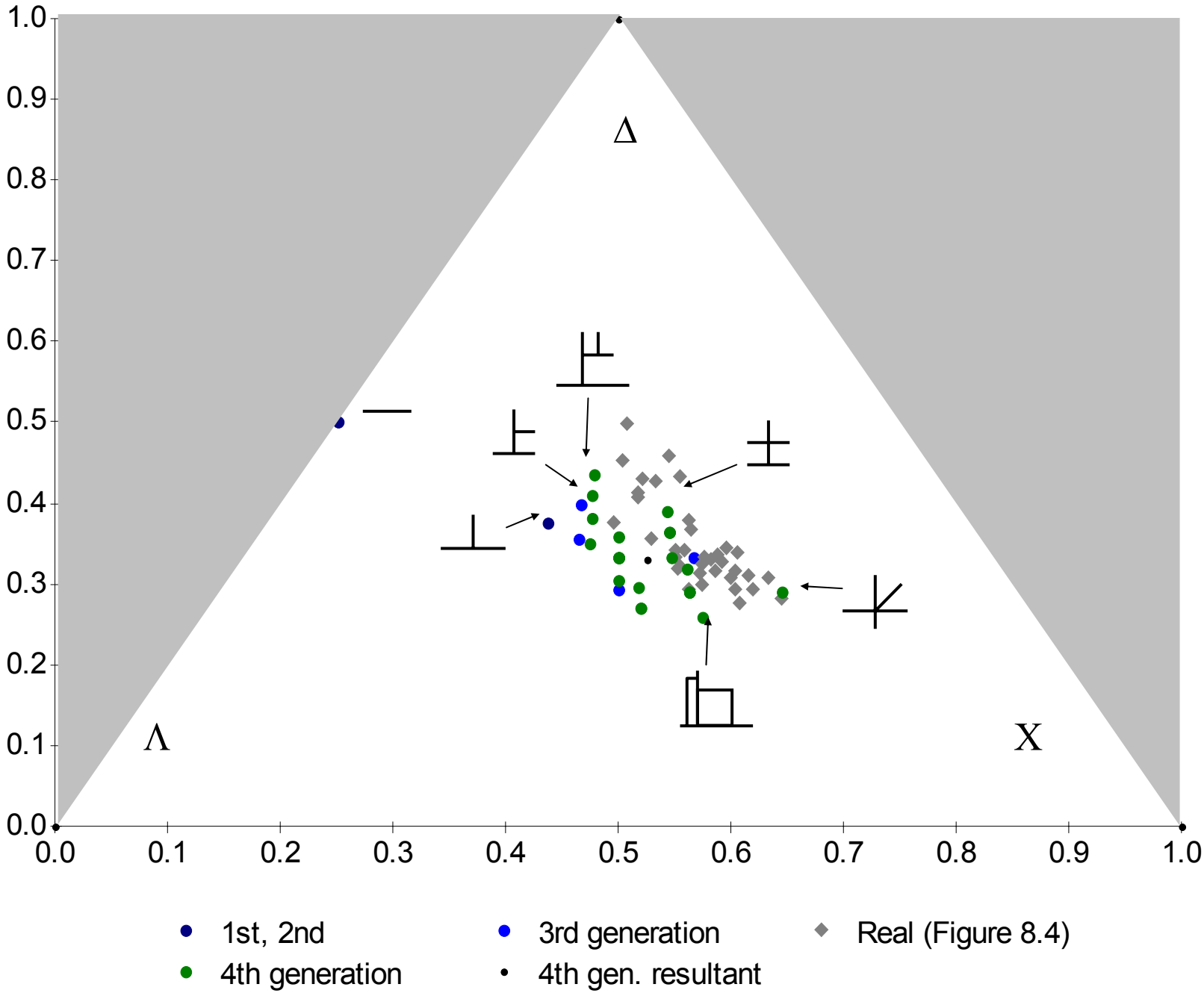

m


u_2

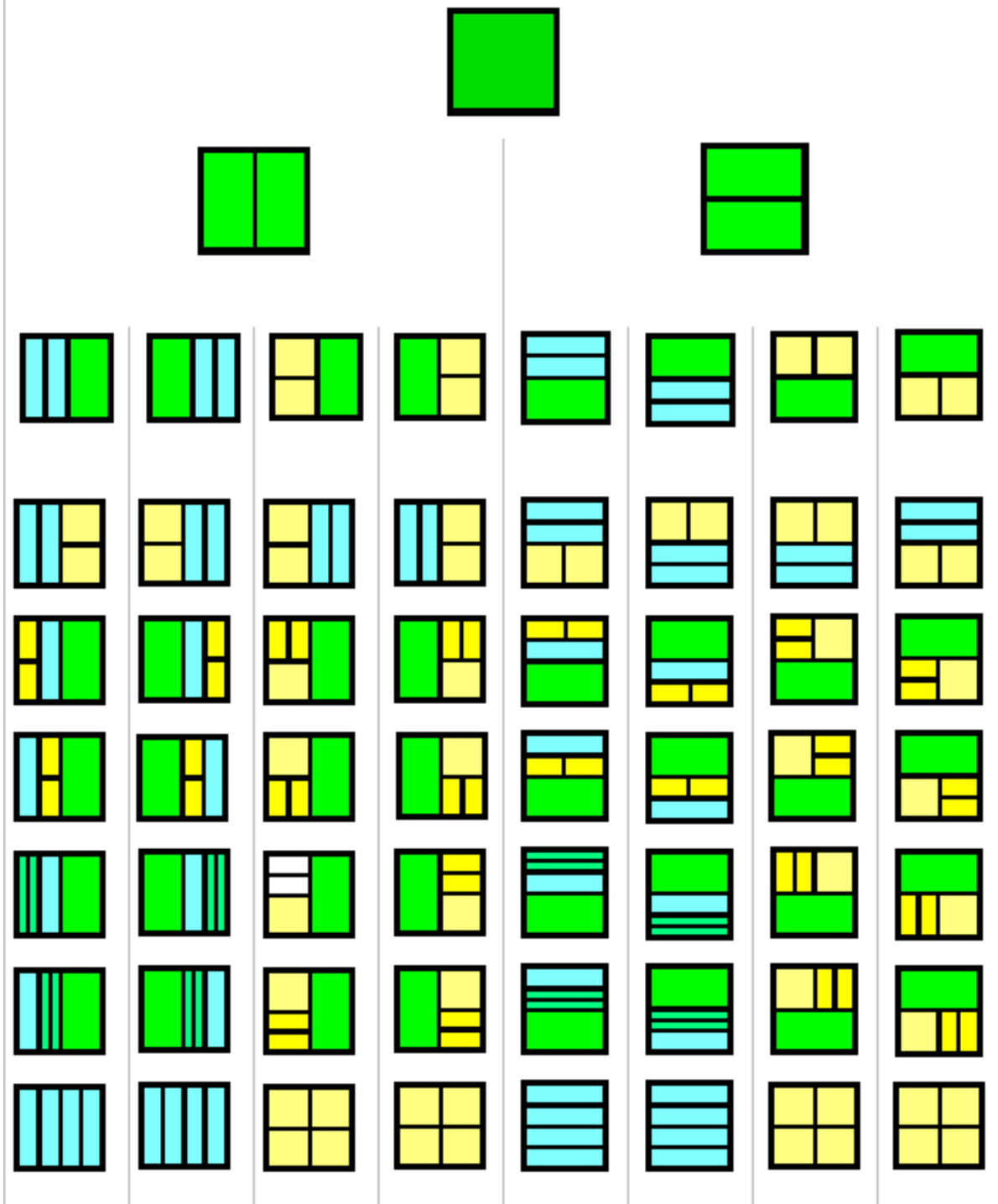
Stage of growth	Base plan	Structure and code
(a) Earliest 1st generation (1 route)		 I
(b) Intermediate 2nd generation (2 routes)		 II
(c) Early 12th Century 3rd generation (3 routes)		 IIIa
(d) Mid 12th Century 4th generation (4 routes)		 IVe$_2$
(e) Mid to late 12th Century 4th generation (4 routes extended)		 IVt


Δ
Deeply layered and
branching structures
Meshes and spokes
Long chain structures
Λ
X

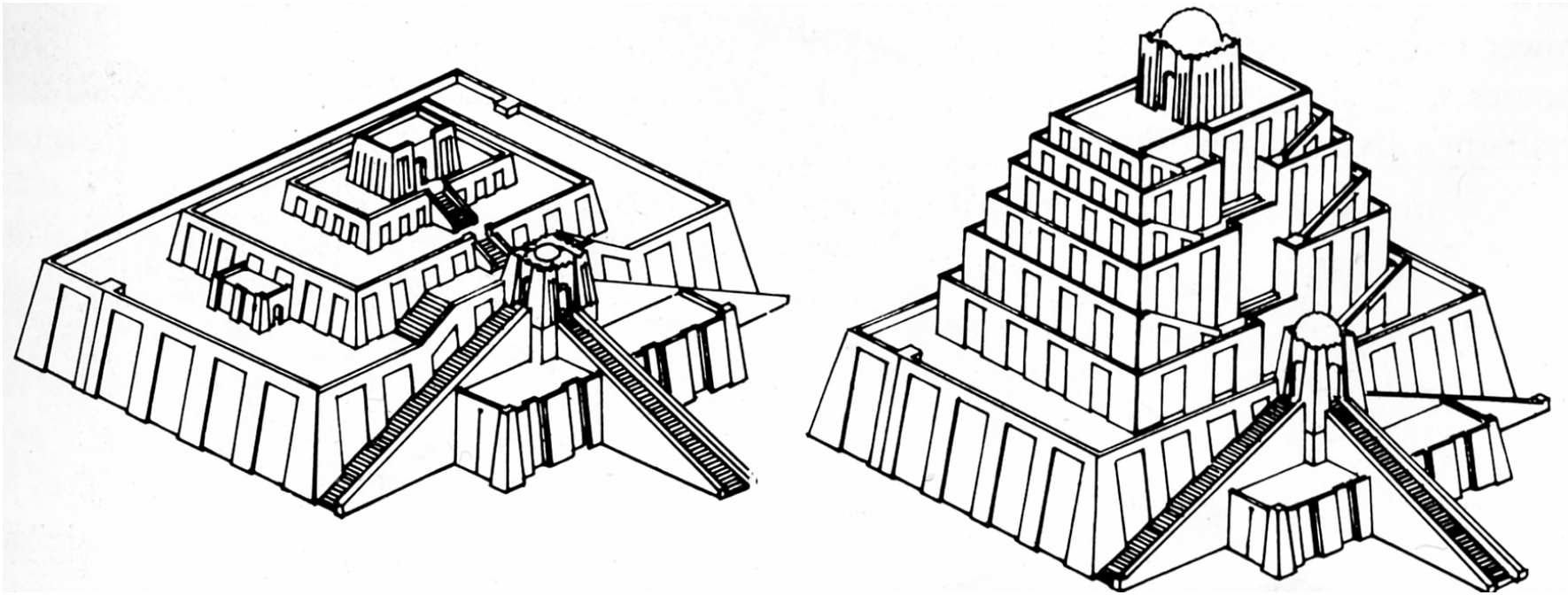

Δ
Tree-like street patterns
Inter-mediate
Grid-like street patterns
Area where actual street patterns are typically found
Λ
X


1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Δ
Λ
X
1st, 2nd
3rd generation
Real (Figure 8.4)
4th generation
4th gen. resultant

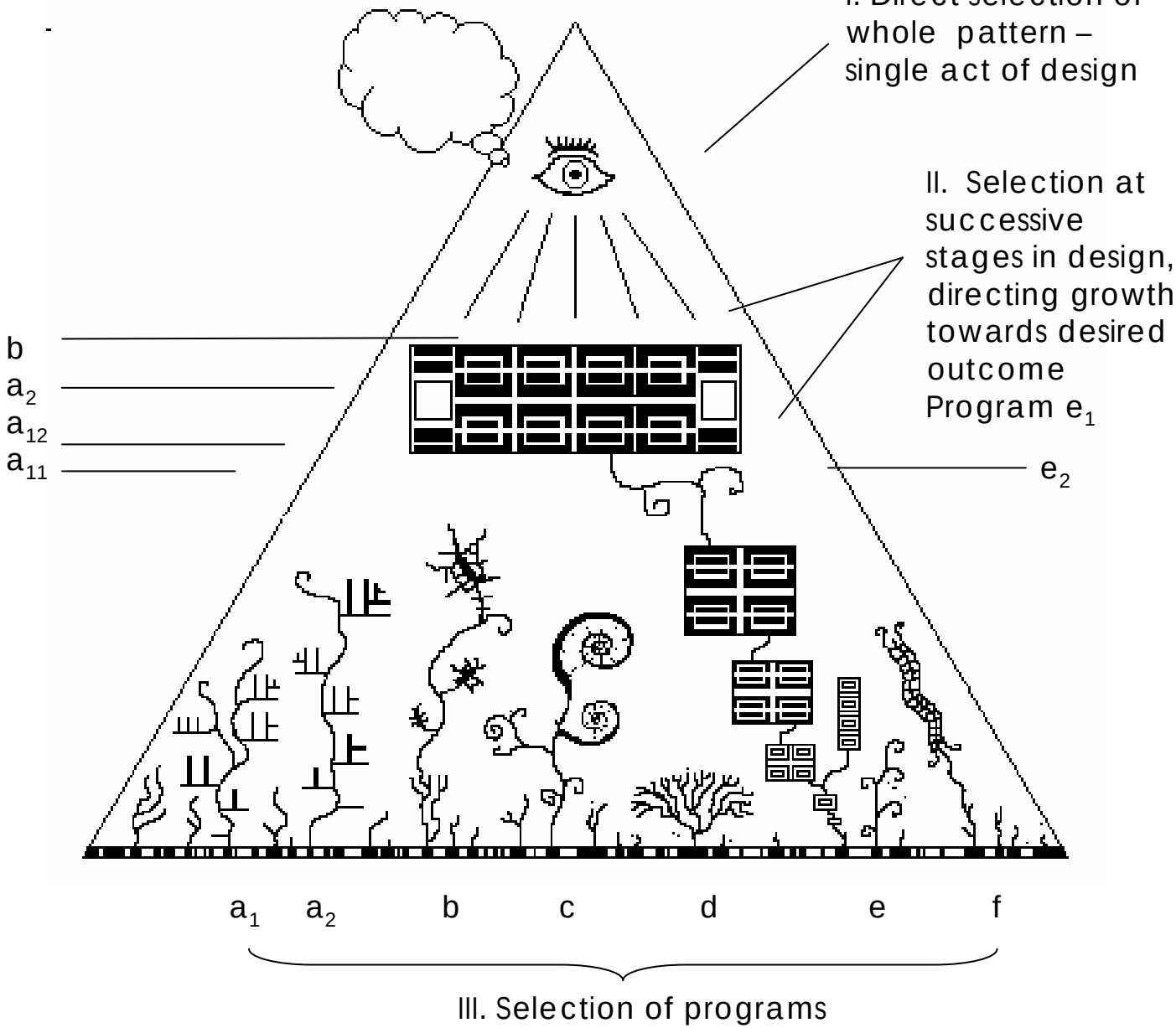
2D



3D nesting, etc.



Ziggurat of Ur


I. Direct selection of whole pattern – single act of design
II. Selection at successive stages in design, directing growth towards desired outcome
Program e_1
b
a_2
a_{12}
a_{11}
e_2
a_1 a_2 b c d e f
III. Selection of programs

Conclusions and Implications

1. Demonstration of a possible mechanism for the probabilistic generation of characteristic urban structure

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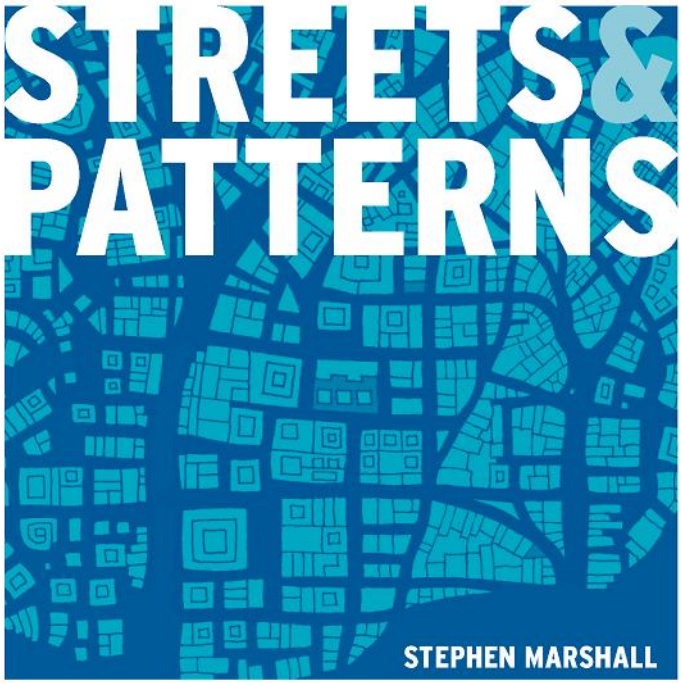
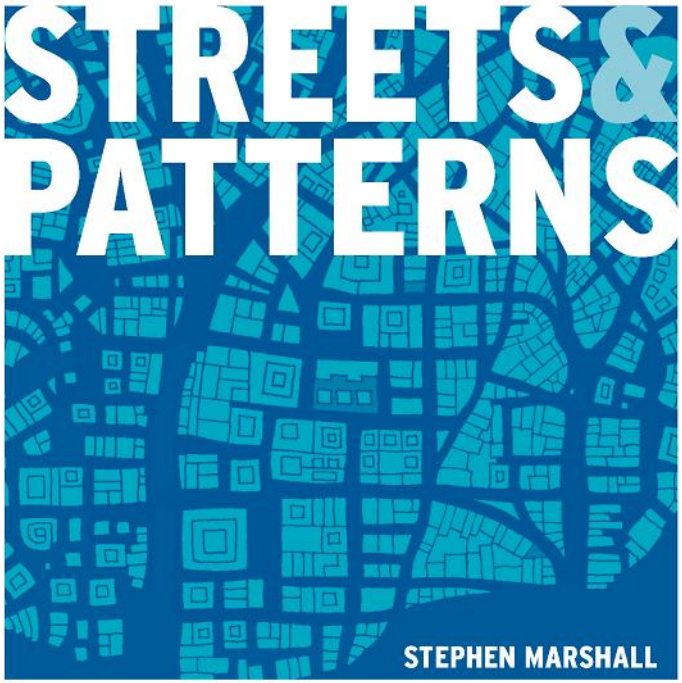
1. Demonstration of a possible mechanism for the probabilistic generation of characteristic urban structure
2. Neo-traditional patterns could be recreated using ‘programs’ rather than pattern templates
3. A program-based *design* approach can use simple rules yet generate *complex* patterns
4. This approach could be an alternative to conventional ‘town planning’ or ‘master planning’
5. Possibility of practical application through synthesis of ‘urban coding’ + ‘road hierarchy’



STEPHEN MARSHALL

s.marshall@ucl.ac.uk

www.sponpress.com



STEPHEN MARSHALL

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