

# Contents

## Part I The simple Galton-Watson process: Classical approach

<b>1</b>	<b>Basic definitions and first results</b> . . . . .	3
1.1	The model . . . . .	3
1.2	The model behind: genealogical structure and random trees . . . . .	4
1.3	Generating functions and moments . . . . .	5
1.4	Back to the genesis: the extinction probability . . . . .	8
1.5	The linear fractional case . . . . .	15
1.6	A martingale and first limit theorems . . . . .	17
<b>2</b>	<b>Classical limit theorems</b> . . . . .	23
2.1	Supercritical case: The theorems by Heyde-Seneta and Kesten-Stigum . . . . .	23
2.2	Subcritical case: Two theorems by Kolmogorov and Yaglom and the expected extinction time . . . . .	33
2.3	Critical case: The Kolmogorov-Yaglom exponential limit theorem and the expected maximum . . . . .	40
2.4	The total progeny . . . . .	51
<b>3</b>	<b>Immigration</b> . . . . .	63
3.1	The model . . . . .	63
3.2	Generating functions . . . . .	64
3.3	Subcritical and critical case: a stability theorem and a gamma limit law . . . . .	66
3.4	Supercritical case: a counterpart of the Heyde-Seneta theorem . . . . .	71
3.5	The critical case revisited: criteria for null recurrence and transience . . . . .	75

## Part II The simple Galton-Watson process: Genealogical approach

<b>4</b>	<b>The Ulam-Harris model and Galton-Watson trees</b> . . . . .	83
4.1	Basic setup . . . . .	83

4.2	The Galton-Watson tree: formal definition and properties . . . . .	88
<b>5</b>	<b>Size-biased Galton-Watson trees with a spine</b> . . . . .	91
5.1	Size-biased distributions and random variables . . . . .	91
5.2	Size-biased Galton-Watson trees: construction and properties . . . . .	92
5.3	Size-biased Galton-Watson trees and GWPI . . . . .	99
5.3.1	Connection between GWPI and size-biased GWT's . . . . .	100
5.3.2	Asymptotic growth of supercritical GWPI . . . . .	101
5.3.3	Subcritical GWPI: Heathcote's result revisited . . . . .	104
5.4	Supercritical GWP's: Another proof of the Kesten-Stigum theorem .	108
5.5	The limiting behavior of subcritical GWP's . . . . .	112
	References . . . . .	119
<b>A</b>	<b>Prerequisites</b> . . . . .	121
A.1	Generating functions . . . . .	121
A.2	Total variation distance and coupling . . . . .	123
	<b>Index</b> . . . . .	127

# Acronyms

Use the template *acronym.tex* together with the Springer document class SVMono (monograph-type books) or SVMult (edited books) to style your list(s) of abbreviations or symbols in the Springer layout.

Lists of abbreviations, symbols and the like are easily formatted with the help of the Springer-enhanced `description` environment.

cdf	(cumulative) distribution function
chf	characteristic function
CLT	central limit theorem
dRi	directly Riemann integrable
FT	Fourier transform
GWM	Galton-Watson measure
GWP	Galton-Watson process
GWPI	Galton-Watson process with immigration
GWT	Galton-Watson tree
gf	generating function
iff	if, and only if
iid	independent and identically distributed
i.o.	infinitely often
LT	Laplace transform
mgf	moment generating function
MRCA	most recent common ancestor
MRW	Markov random walk
RP	renewal process
RW	random walk
SLLN	strong law of large numbers
SRP	standard renewal process = zero-delayed renewal process
SRW	standard random walk = zero-delayed random walk
ui	uniformly integrable
WLLN	weak law of large numbers