第八届分枝过程及相关课题研讨会

The 8th Workshop on Branching Processes and Related Topics

会议手册

主办单位：北京大学数学科学学院

2022 年 8 月 18 号—8 月 19 号

目录

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General Information 会议指南

★ **会议时间**：2022 年 8 月 18 日–2022 年 8 月 19 日

★ **会议平台**：腾讯会议

　　⋆会议主题：第八届分枝过程及相关课题研讨会

　　⋆会议 ID: 632 1535 8095

　　⋆会议链接： https://meeting.tencent.com/dm/Inp0is2uiMFR

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Programs 会议日程

	08/18	08/19
主持人	**任艳霞**	**周晓文**
8:00-8:30	8:15 开幕式网上照相	向开南
8:30-9:00	石权	刘会利
9:00-9:30	张蕊	马儒刚
9:30-10:00	白天衣	孙鸿雁
10:00-10:10	休息	休息
主持人	**李增沪**	**施展**
10:10-10:40	陈昕昕	陈新兴
10:40-11:10	黄春茂	苏炎
11:10-11:40	杨帆	马恒
	休息	休息
主持人	**熊捷**	**洪文明**
14:00-14:30	孙振尧	朱庆三
14:30-15:00	朱雅萍	姚东
15:00-15:30	张树雄	顾陈琳
15:30-15:40	休息	休息
主持人	**张梅**	**李俊平**
15:40-16:10	王华明	李应求
16:10-16:40	张美娟	王娟
16:40-17:10	梁盛利	何辉

2022 年 8 月 18 日（周四）

时间	报告人	题目	主持人
8:15-8:30	开幕		任艳霞
8:30-9:00	石权	区间划分取值的分枝马氏过程	
9:00-9:30	张蕊	Lower deviation probabilities for supremum of the support of super-Brownian motion	
9:30-10:00	白天衣	On the special Markov property and boundary local times of critical branching random walks in high dimensions	
10:00-10:10		休息	
10:10-10:40	陈昕昕	Critical branching random walk conditioned to survive at a given set in two-dimensional lattice	李增沪
10:40-11:10	黄春茂	Harmonic moments and deviations for a supercritical branching process with immigration in a random environment	
11:10-11:40	杨帆	Branching Brownian motion in a periodic environment and pulsating travelling waves	
时间	报告人	题目	主持人
14:00-14:30	孙振尧	Subcritical superprocesses conditioned on non-extinction	熊捷
14:30-15:00	朱雅萍	Survival probability and a large deviation for a supercritical super-Brownian motion with absorption	
15:00-15:30	张树雄	On the empty balls of a critical super-Brownian motion	
15:30-15:40		休息	
15:40-16:10	王华明	随机游动轨道切割点的极限定理	张梅
16:10-16:40	张美娟	Asymptotic normality of M-estimator for a $(2,1)$ random walk in a parametric random environment	
16:40-17:10	梁盛利	Quenched invariance principles for random walks in time random environment conditioned to stay positive	

2022 年 8 月 19 日（周五）

时间	报告人	题目	主持人
8:00-8:30	向开南	拟等距同构和普适性角度下的离散概率：从具体例子出发	周晓文
8:30-9:00	刘会利	Exact modulus of continuities for Λ-Fleming-Viot processes with Brownian spatial motion	
9:00-9:30	马儒刚	Explosion of continuous-state branching processes with competition in Lévy environment	
9:30-10:00	孙鸿雁	Regeneration of branching processes with immigration in varying environments	
10:00-10:10		休息	
10:10-10:40	陈新兴	The sustainability probability for the critical Derrida–Retaux model	施展
10:40-11:10	苏炎	Stochastic games for multitype branching processes with discounted criteria	
11:10-11:40	马恒	Shotgun threshold for sparse Erdös-Rényi graphs	
时间	报告人	题目	主持人
14:00-14:30	朱庆三	Supercritical spatial SIR epidemics: spreading speed and herd immunity	洪文明
14:30-15:00	姚东	Epidemics on Evolving Graphs	
15:00-15:30	顾陈琳	Random recursive trees and contact tracing	
15:30-15:40		休息	
15:40-16:10	李应求	两性分枝过程	李俊平
16:10-16:40	王娟	Asymptotic behavior for Markov branching processes	
16:40-17:10	何辉	Brownian continuum random tree conditioned to be large	

Abstracts 会议摘要

On the special Markov property and boundary local times of critical branching random walks in high dimensions

Tianyi Bai, 白天衣

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Abstract: Consider the critical branching random walk on the d-dimensional lattice, we are interested in counting the number of particles first arriving at a given sphere. We show that regardless of dimension, this quantity always converges to the exit local time of the integrated super-Brownian excursion. We also present our current attempt with the same local time method to the total number of particles on the sphere, generalizing a proposition of [Le Gall and Lin 2015] to high dimensions, and proposing a conjecture on the convergence to the subordination of the continuum random tree.

Critical branching random walk conditioned to survive at a given set in two-dimensional lattice

Xinxin Chen, 陈昕昕

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Abstract: We consider a discrete-time branching simple random walk in $\mathbb{Z}^2$ where each particle independently makes simple random walk and produces a random number of children so that the offspring law is of mean 1 and of finite variance. We study the asymptotic behaviours of the critical branching random walk (CBRW) conditioned to hit a given site at some large time n and obtain a Yaglom theorem. We also discuss the survival probabilities that the CBRW hits two sites at some large time n.

The sustainability probability for the critical Derrida–Retaux model

Xinxing Chen, 陈新兴

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Abstract: We are interested in the recursive model $(Y_n, n \geq 0)$ studied by Collet et al. (*Commun. Math Phys.* 1984) and by Derrida and Retaux (*J. Stat. Phys.* 2014). We prove that at criticality, the probability $\mathbb{P}(Y_n > 0)$ behaves like $n^{-2+o(1)}$ as n goes to infinity; this gives a weaker confirmation of predictions made in Collet et al. (1984), Derrida and Retaux (2014) and Chen et al. (2019). Our method relies on studying the number of pivotal vertices and open paths, combined with a delicate coupling argument. This talk is based on a joint work with Yueyun Hu and Zhan Shi.

Random recursive trees and contact tracing

Chenlin Gu, 顾陈琳

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Abstract: This talk is based on a joint work with Vincent Bansaye (Ecole Polytechnique) and Linglong Yuan (The University of Liverpool), and we study a model about the contact-tracing policy using random recursive trees. Besides the limit theorems, some new results and related work will be discussed in this talk.

Brownian continuum random tree conditioned to be large

Hui He, 何辉

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Abstract: We consider a Feller diffusion $(Z_s, s \geq 0)$ (with diffusion coefficient $\sqrt{2\beta}$ and drift $\theta \in \mathbb{R}$) that we condition on $\{Z_t = a_t\}$, where a_t is a deterministic function, and we study the limit in distribution of the conditioned process and of its genealogical tree. When a_t does not increase too rapidly, we recover the standard size-biased process (and the associated genealogical tree given by the Kesten's tree). When a_t behaves as $\alpha\beta^2 t^2$ when $\theta = 0$ or as $\alpha e^{2\beta|\theta|t}$ when $\theta \neq 0$, we obtain a new process whose distribution is described by a Girsanov transformation and equivalently by a SDE with a Poissonian immigration. Its associated genealogical tree is described by an infinite discrete skeleton (which does not satisfy the branching property) decorated with Brownian continuum random trees given by a Poisson point measure. As a by-product of this study, we introduce several sets of trees endowed with a Gromov-type distance which are of independent interest and which allow here to define in a formal and measurable way the decoration of a backbone with a family of continuum random trees. The talk is based on a joint work with R. Abraham and J.-F. Delmas.

Harmonic moments and deviations for a supercritical branching process with immigration in a random environment

Chunmao Huang, 黄春茂

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Abstract: We consider a supercritical branching process with immigration in a random environment. Let Z_n be the population size at time n and W_n be the natural sub-martingale formed by the normalization of Z_n. We are interested in the decay rates of the ratio W_{n+k}/W_n to 1 for fixed $k \in \{1, 2, \cdots, \infty\}$ by studying the convergence rates of the deviation events $\{|Z_n^{(1-\alpha)}(W_{n+k}/W_n - 1)| \geq \epsilon\}$. Here α is a constant belonging to $[1/2, 1]$, and it is $1/2, 1$, and in $(1/2, 1)$, corresponding to normal, large, and moderate deviations respectively. For these deviations, we establish relationships between the probabilities of the deviation events and the harmonic moments of Z_n, under both the quenched and annealed laws, and describe concretely the decay rates of those harmonic moments.

两性分枝过程

Yingqiu Li, 李应求

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Abstract: 本报告试图阐述两性分枝过程的一些研究情况，以管窥豹。我们将重点介绍随机环境中两性分枝过程的最新研究进展，特别我们是我们近年在该领域的一些尝试，抛砖引玉。

Quenched invariance principles for random walks in time random environment conditioned to stay positive

Shengli Liang, 梁盛利

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Abstract: We consider a random walk $\{S_n\}_{n\in\mathbb{N}}$ in random environment (in time) ξ. For almost each realization of ξ, we prove a quenched invariance principles for the random walk conditioned to stay positive (which specified by the Doob h-transform of the original one). To this end, a key step is to formulate a (quenched) harmonic function. Although the traditional approach Wiener-Hopf factorisation does not work in this case, we prove the existence of the (quenched) harmonic function under the annealed $2+\epsilon$ (for some $\epsilon > 0$) moment condition on the increments. This is a joint work with Hong Wenming.

Exact modulus of continuities for Λ-Fleming-Viot processes with Brownian spatial motion

Huili Liu, 刘会利

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Abstract: For a class of Λ-Fleming-Viot processes with Brownian spatial motion in $\mathbb{R}^d$ whose associated Λ-coalescents come down from infinity, we obtain sharp global and local modulus of continuities for the ancestry processes recovered from the lookdown constructions. As applications, we prove both global and local modulus of continuities for the Λ-Fleming-Viot support processes. In particular, if the Λ-coalescent is the Beta$(2 - \beta, \beta)$ coalescent for $\beta \in (1, 2]$ with $\beta = 2$ corresponding to Kingman's coalescent, then for $h(t) = \sqrt{t \log(1/t)}$, the global modulus of continuity holds for the support process with modulus function $\sqrt{2\beta/(\beta - 1)}h(t)$, and both the left and right local modulus of continuity hold for the support process with modulus function $\sqrt{2/(\beta - 1)}h(t)$. This is a joint work with Xiaowen Zhou.

Shotgun threshold for sparse Erdös-Rényi graphs

Heng Ma, 马恒

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Abstract: In the shotgun assembly problem for a graph, we are given the empirical profile for rooted neighborhoods of depth r (up to isomorphism) for some $r \geq 1$ and we wish to recover the underlying graph up to isomorphism. When the underlying graph is an Erdös-Rényi $\mathcal{G}\left(n, \frac{\lambda}{n}\right)$, we show that the shotgun assembly threshold $r_* \approx \frac{\log n}{\log(\lambda^2 \gamma_\lambda)^{-1}}$ where γ_λ is the probability for two independent Poisson-Galton-Watson trees with parameter λ to be rooted isomorphic with each other. Our result sharpens a constant factor in a previous work by Mossel and Ross (2019) and thus solve a question therein. This is a joint work with Jian Ding and Yiyang Jiang.

Explosion of continuous-state branching processes with competition in Lévy environment

Rugang Ma, 马儒刚

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Abstract:　Using the Lyapunov criteria arguments, we find sufficient conditions on explosion/nonexplosion for continuous-state branching processes with competition in Lévy random environment. In particular, we identify the necessary and sufficient conditions on explosion/nonexplosion when the competition function is a power function and the Lévy measure of the associated branching mechanism is stable. The results suggest that the random environment does not play an essential role on the explosion or nonexplosion of the process.

区间划分取值的分枝马氏过程

Quan Shi, 石权

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Abstract:　将实数轴上的一个区间分为一族互不相交的子区间，这称为一个区间划分 (interval partition)。本报告中将介绍一类具有分枝性质的区间划分取值的马氏过程。这类无穷维随机过程可视为某个分枝图 (branching graph) 上的马氏链的变尺度极限。我们还将介绍这一模型关于以下问题的一些应用：Ray–Knight 定理，群体遗传模型，随机树演化等。本报告是基于与 Noah Forman, Douglas Rizzolo, Matthias Winkel 的合作工作。

Stochastic games for multitype branching processes with discounted criteria

Yan Su, 苏炎

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Abstract: We consider two-decision-maker zero-sum and nonzero-sum discrete-time stochastic game problems for branching processes with k types of individuals and the discounted criterion. Under some mild conditions, we first show the existence of the randomized stationary static policy for the finite time horizon zero-sum game. Then, by the successive approximations, we extend this result to the infinite horizon zero-sum problem with non-negative but not necessarily substochastic transition matrices. Finally, based on the above discussion, we also establish the existence of Nash equilibrium static policy for the nonzero-sum stochastic game problems.

Regeneration of branching processes with immigration in varying environments

Hongyan Sun, 孙鸿雁

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Abstract: This is the joint work with Huaming Wang. In this paper, we consider two-type linear-fractional branching processes with immigration in varying environments. For $n \geq 0$, let Z_n counts the number of individuals of the n-th generation, which excludes the immigrant which enters into the system at time n. We call n a regeneration time if $Z_n = 0$. We give criteria for the finiteness or infiniteness of the number of regeneration times. Especially, some delicate analysis of the product of nonnegative matrices and the tails of continued fractions is required.

Subcritical superprocesses conditioned on non-extinction

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Abstract: We consider a class of subcritical superprocesses $(X_t)_{t \geq 0}$ with general spatial motions and general branching mechanisms. We study the asymptotic behaviors of $\mathbf{Q}_{t,r}$, the distribution of X_t conditioned on $\{X_{t+r} \neq \mathbf{0}\}$, where $\mathbf{0}$ is the null measure. We first show that, for any $r \geq 0$, $\mathbf{Q}_{t,r}$ converges weakly to a probability measure $\mathbf{Q}_{\infty,r}$ when $t \to \infty$. We then show that, for any $t \geq 0$, $\mathbf{Q}_{t,r}$ converges strongly to a probability measure $\mathbf{Q}_{t,\infty}$ when $r \to \infty$. We also show that an $L \log L$-type condition is equivalent to each of the following two statements: (1) $\mathbf{Q}_{\infty,r}$ converges strongly when $r \to \infty$; (2) $\mathbf{Q}_{t,\infty}$ converges weakly when $t \to \infty$. Finally, when the $L \log L$-type condition holds, we show that the strong limit of $\mathbf{Q}_{\infty,r}$ when $r \to \infty$, and the weak limit of $\mathbf{Q}_{t,\infty}$ when $t \to \infty$, are actually the same. Our main tool is the spine decomposition theorem for superprocesses. This is based on two joint works with Rongli Liu, Yanxia Ren, and Renming Song.

随机游动轨道切割点的极限定理

Huaming Wang, 王华明

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Abstract: 这个报告主要讨论变环境下 $(1,2)$ 与 $(2,1)$ 随机游动的极限行为。主要的工具是非齐次矩阵乘积及连分数的一些极限理论。通过深入讨论连分数的尾部性质，刻画了非齐次二阶非负矩阵乘积各元素的极限行为。基于此，分析了游动逃逸概率和击中概率一些精细的极限行为，并进一步给出了游动轨道切割点个数有限性的判定准则。变环境使游动轨道表现出一些奇特的性质。对一类暂留的渐近临界随机游动，我们证明，游动轨道在 $[0,n]$ 内切割点个数的阶为 $\frac{\log n}{(\log \log n)^{\beta}}$，与此形成鲜明对比的是，暂留简单随机游动轨道在 $[0,n]$ 内切割点的数量与 n 同阶。

Asymptotic behavior for Markov branching processes

Juan Wang, 王娟

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Abstract: We consider a Markov branching process (MBP) $\{Z(t); t > 0\}$, then there exists a well-known sequence $\{C(t); t > 0\}$ such that $W(t) := Z(t)/C(t)$ a.s. converges to a non-degenerate random variable W as $t \to \infty$. We attempt to study the asymptotic behavior of $\mathbb{P}(Z(t) = k_t)$ and $\mathbb{P}(0 \le Z(t) \le k_t)$ with $k_t = o(C(t))$ as $t \to \infty$ for MBPs, which helps to study large deviations of $Z(t+s)/Z(t)$. Moreover, we further research the self-normalized large deviations for $Z(t)$. Our result is the self-normalized version for the continuous-time case of the conclusion reached by Athreya. On the other hand, the self-normalized large deviation is also discussed for the branching-immigration systems. We apply the self-normalized large deviations results for i.i.d. random variables in Shao (1997) during the argumentation.

拟等距同构和普适性角度下的离散概率：从具体例子出发

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Abstract: V. Sidoravicius, L. M. Wang (王龙敏), K. N. Xiang (2022+, *Comm. Pure Appl. Math.* to appear) 证明了非初等双曲群上分枝随机游走的体积增长和边界的 Hausdorff 维数的临界指数为 1/2 的普适性 (在 S. Lalley ICM2006 邀请报告中的一个相关猜想上取得了突破)。K. N. Xiang, L. Zou (邹浪) (2022. Surviving ends in Bernoulli percolation on graphs roughly isometric to a tree. *Stat. Probab. Lett.* **184**, 109378, 6pp.) 证明了渗流中的存活末梢数具有一定的拟等距同构不变性。从这些等出发，阐述离散概率模型的普适性和刚性。

注意重整化群理论的一个核心预言是：在多项式增长群（有限维图）上的统计物理模型的临界行为只依赖于维数而不依赖于格点的特殊选取和群的大尺度几何。对无穷维图（如，非顺从图），诸多统计物理模型的临界行为是否只依赖于某大尺度几何（例如双曲性）？这些属于统计物理模型的普适性问题。在拟等距同构观点下，众多概率论专家认为群和图上的一些基本随机过程的某些性质是拟等距同构不变的；这些属于离散概率模型的刚性。

Branching Brownian motion in a periodic environment and pulsating travelling waves

Fan Yang, 杨帆

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Abstract: We study the limits of the additive and derivative martingales of one-dimensional branching Brownian motion in a periodic environment. Then we use the limits to give a probabilistic representation of the pulsating travelling wave of the corresponding F-KPP equation in a periodic environment. Our main tools are the spine decomposition and martingale change of measures. This talk is based on a joint work with Prof. Yanxia Ren and Renming Song.

Epidemics on Evolving Graphs

Dong Yao, 姚东

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Abstract: In the standard model on a graph, infected individuals infect their susceptible neighbors at rate λ. The evoSI model is a modification of the standard SI model where infected-susceptible pairs are broken at rate ρ and the susceptible individual rewires to a uniformly randomly chosen individual. EvoSIR model is similarly defined with infected individuals recovering at rate 1. We consider evoSI and evoSIR models on graphs given by the configuration model and Erdös-Rényi random graph. We show that there is a quantity whose sign governs the continuity of the phase transition of final epidemic size. We also consider the survival probability of critical evoSI model, which has a polynomial decay rate. Based on joint work with Wenze Chen, Rick Durrett, and Yuewen Hou.

Asymptotic normality of M-estimator for a $(2,1)$ random walk in a parametric random environment

Meijuan Zhang, 张美娟

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Abstract: We consider a $(2,1)$ random walk in an i.i.d. random environment, whose environment involves certain parameter. Based on a single observation of the path till the time it reaches a distant site, we have constructed an M-estimator for the environment parameter and obtained its weak consistency, where the M-estimator is similar to maximum likelihood estimator. We here further prove the asymptotic normality of the M-estimator. Although there is no analytical expression for the value of the M-estimator, the intrinsic branching structure within $(2,1)$ RWRE can help us establish the central limit theorem for gradient vector of the criterion function, and then obtain the asymptotic normality of the M-estimator.

Lower deviation probabilities for supremum of the support of super-Brownian motion

Rui Zhang, 张蕊

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Abstract: In this paper, we investigate the limiting behaviour of the supremum of the support, denoted by M_t, of a supercritical super-Brownian motion. It has been proved that, under some conditions, $M_t - m(t)$ converges weakly, where $m(t) = c_0 t - c_1 \log t$, and we also gave the large deviation of M_t. In this paper, we continue to study the asymptotic behaviour of the lower deviation probabilities $\mathbb{P}(M_t \leq \delta c_0 t | \mathcal{S})$, for $\delta < 1$.

On the empty balls of a critical super-Brownian motion

Shuxiong Zhang, 张树雄

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Abstract: Let $\{X_t\}_{t\geq 0}$ be a d-dimensional critical super-Brownian motion started from a Poisson random measure whose intensity is the Lebesgue measure. Denote by $R_t := \sup\{u > 0 : X_t(\{x \in \mathbb{R}^d : |x| < u\}) = 0\}$ the radius of the largest empty ball centered at the origin of X_t. In this work, we prove that for $r > 0$,

$$\lim_{t\to\infty} \mathbb{P}\left(\frac{R_t}{t^{(1/d)\wedge(3-d)^+}} \geq r\right) = e^{-A_d(r)},$$

where $A_d(r)$ satisfies $\lim_{r\to\infty} \frac{A_d(r)}{r^{|d-2|+d\mathbf{1}_{\{d=2\}}}} = C$ for some $C \in (0,\infty)$ depending only on d. This is a joint work with Prof. Jie Xiong.

Supercritical spatial SIR epidemics: spreading speed and herd immunity

Qingsan Zhu, 朱庆三

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Abstract: We consider supercritical spatial SIR epidemics on $\mathbb{Z}^2 * \{1,\ldots,N\}$, where each site in $\mathbb{Z}^2$ represents a village and N stands for the village size. We establish several important asymptotic results as N goes to infinity. In particular, we derive the probability that the epidemic will last forever if the epidemic is started by one infected individual. Moreover, conditional on that the epidemic lasts forever, we show that the epidemic spreads out linearly in all directions and derive an explicit formula for the spreading speed. Furthermore, we prove that the ultimate proportion of infection converges to a number that is constant over space and find its explicit value. This talk is based on joint work with Xinghua Zheng.

Survival probability and a large deviation for a supercritical super-Brownian motion with absorption

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Abstract: We consider a one-dimensional superprocess with a supercritical branching mechanism ψ, where particles move as a Brownian motion with drift $-\rho$ and are killed when they reach the origin. It is known that the process survives with a positive probability if and only if $\rho < \sqrt{2\alpha}$ where $\alpha = -\psi'(0)$. When $\rho > \sqrt{2\alpha}$, we obtain a large-time asymptotic formula for the survival probability. When $\rho < \sqrt{2\alpha}$, Kyprianou et al. (2012) proved that $\lim_{t\to\infty} \frac{R_t}{t} = \sqrt{2\alpha} - \rho$ almost surely on the survival set, where R_t is the right-most position of the support at time t. Motivated by this work, we investigate its large deviation, in other words, the convergence rate of $\mathbb{P}_{\delta_x}(R_t > \gamma t + \theta)$ as $t \to \infty$, where $\gamma > \sqrt{2\alpha} - \rho$, $\theta \geq 0$. As a by-product, the related Yaglom-type conditional limit theorem is obtained. Analogue results for branching Brownian motion can be found in Harris et al. (2006).