Quadratic and Cubic Stocsastic Processes

Boboqulova Sarvinoz Bahodirovna
Bukhara State University Primary education theory
Lecturer of the department

ABSTRACT

The article examines the available scientific data on quadratic stochastic differential equations and cubic stochastic differential equations and stochastic processes .The results obtained can be used in new scientific studies of cubic random processes.

Key words: *Stochastic process, quadratic stochastic process, cubic stochastic construction, transition function, homogeneous cubic stochastic process, system of stochastic differential equations for cubic stochastic processes and its solution.*

I. Introduction

The theory of nonlinear random processes is one of the rapidly developing areas of recent years. Such random processes (quadratic, cubic) serve as a mathematical model for problems in physics, chemistry, and quantum mechanics. In this regard, the study of such processes and stochastic differential equations for them has both theoretical and practical importance.

The article uses the necessary information about quadratic and cubic random processes and obtains a result for one class of cubic random processes. When covering the article, the necessary scientific articles on quadratic random processes and cubic random processes were used, and the result was obtained for one class of cubic random processes.

II. Main Part

A.N.Kolmogorov considered differential equations for Markov random processes ($P_{ij}^{[s,t]}$) for their probabilities s i t) and showed that their solutions are Markov processes.

Definition: A process P is called a quadratic random process if it is arbitrary. t and s (t-s≥1) if the following condition is met:

$$1. p_{ij,k}^{[s,t]} = p_{ji,k}^{[s,t]} \text{ , любые } i,j,k \in E;$$

$$2. p_{ij,k}^{[s,t]} \geq 0, \ \sum_{k=1}^{n} p_{ij,k}^{[s,t]} = 1;$$

Analogy of the Kolmogorov-Chapman equation. The initial distribution in arbitrary E is $x^{(0)} = \left(x_1^{(0)}, \dots, x_n^{(0)}\right)$, and therefore for $s, \tau, t \in R_+ , t - \tau \geq 1, \tau - s \geq 1$.

$p_{ij,k}^{[s,t]} = \sum_{m,l=1}^{n} p_{ij,m}^{[s,\tau]} p_{ml,k}^{[\tau,t]} x_l^{(\tau)}$, if the condition is met

Therefore, a quadratic random process arises only if these three conditions are met. M.

Mukhammedov and U. Rozikov considered differential equations for quadratic random processes (for $P_{ij,k}^{[s,t]}$) and gave examples of , that their solutions are not quadratic random processes with arbitrary initial conditions, a random process.

Nonlinear stochastic processes , including quadratic and cubic stochastic processes, serve as models for many physical, chemical and biological processes. E=$\{1,2,\dots,n\}$ and $x^{(0)}$=($x_1^{(0)},x_2^{(0)},\dots,x_n^{(0)}$)- E will be the initial distribution. With the help of $P_{ijk,l}^{[s,t]}$ we determine the probability of the appearance of one element of the set E as a result of the interaction of elements i, j, k of the set E from time s to time t. In this case , if at time s $x^{(s)}$= ($x_1^{(s)},x_2^{(s)},\dots,x_n^{(s)}$), for all t $\geq$ s+1

$x^{(t)}$=($x_1^{(t)},x_2^{(t)},\dots,x_n^{(t)}$) is defined as follows

$x_l^t=\sum_{i,j,k} P_{ijk,l}^{[s,t]} x_i^{(s)} x_j^{(s)} x_k^{(s)}$.

Description: Subject to the following conditions.

1) $P_{ijk,l}^{[t,t+1]}=P_{ijk,l}^{[0,1]}$;

2) the value of $P_{ijk,l}^{[n,t]}$ does not change from an arbitrary exchange of i, j, k in E; for arbitrary t-s≥1 and τ - s ≥ 1

$$P_{ijk,l}^{[s,t]}=\sum_{m,\gamma,\delta} P_{ijk,m}^{[s,\tau]} P_{m\gamma\delta,l}^{[\tau,t]} x_\gamma^{(r)} x_\delta^{(r)} \quad (1)$$

equality fits (the Kolmogorov-Chapman equation), in this case the process defined by the function $P_{ijk,l}^{[s,t]}$ is called a cubic random process.

Definition: if for all s, t satisfying the condition $P_{ijk,l}^{[s,t]}$ depends only on t-s, such a cubic random process is called homogeneous. The following lemma is suitable for such a cubic random process.

Lemma: Let $P_{ijk,l}^{[s,t]}$ be a homogeneous cubic random process. Then the equation $x_k^{(t)}=x_k^{(2)}$ holds for all i = 1,2, ..., n arbitrary t ≥2.

For this class (for $P_{ijk,l}^{[s,t]}$) a system of differential equations is constructed, an example is given that the solution of this system is not a cubic random process with arbitrary initial conditions, the solution is a cubic random process, the conditions are found.

Proof: $P_{ijk,l}^{[s,t]} = \sum_{m,\gamma,\delta} P_{ijk,m}^{[s,\tau]} P_{m\gamma\delta,l}^{[\tau,t]} x_\gamma^{(r)} x_\delta^{(r)}$ from the equality and homogeneity of the process for m≥2 and t ≥m:

$$x_l^{(m)}=\sum_{i,j,k} P_{ijk,l}^{[0,m]} x_i^{(0)} x_k^{(0)}=\sum_{i,j,k} P_{ijk,l}^{[t-m,t]} x_i^{(0)} x_k^{(0)}=\sum_{i,j,k} P_{ijk,l}^{[t-m,t]} x_i^{(0)} x_k^{(0)}=$$

$$=\sum_{i,j,k}(\sum_{p,q,\theta} P_{ijk,p}^{[t-m,t-1]} P_{pq\theta,l}^{[t-1,t]} x_q^{(t-1)} x_\theta^{(t-1)} x_k^{(0)} x_i^{(0)} x_j^{(0)}).$$

$$x_m^{(\tau)}=\sum_{i,j,k} P_{ijk,m}^{[0,\tau]} x_i^{(\tau)} x_j^{(\tau)} x_k^{(\tau)}$$

$$x_l^{(m)}=\sum_{p,q,\theta} P_{pq\theta,l}^{[0,1]} x_p^{(m-1)} x_q^{(t-1)} x_\theta^{(t-1)}. \quad (2)$$

From (2) t = m then

$x_l^{(m)}=\sum_{p,q,\theta} P_{pq\theta,l}^{[0,1]} x_p^{(m-1)} x_q^{(m-1)} x_q^{(m-1)} x_\theta^{(m-1)}$. (3)

Thus:

$\sum_{i,j,k} P_{ijk,l}^{[0,m]} x_i^{(0)} x_j^{(0)} x_k^{(0)}=\sum_{p,q,\theta} P_{pq\theta,l}^{[0,2]} x_q^{(t-2)} x_\theta^{(t-2)} x_p^{(m-2)}$

we get the equation.

In the last equation, let t=m

$$\sum_{p,q,\theta} P_{pq\theta,l}^{[0,2]} x_p^{(m-2)} x_q^{(t-2)} x_\theta^{(t-2)}=\sum_{p,q,\theta} P_{pq\theta,l}^{[s-2,s]} x_p^{(m-2)} x_q^{(t-2)} x_\theta^{(t-2)}=$$
$$=\sum_{p,q,\theta} \sum_{r,\gamma,\tau} P_{pq\theta,r}^{[s-2,s-1]} P_{r\gamma\tau,l}^{[s-1,s]} x_\gamma^{(s-1)} x_\tau^{(s-1)} x_q^{(m-2)} x_\theta^{(m-2)} x_p^{(m-2)}=$$
$$=\sum_{p,q,\theta} \sum_{r,\gamma,\tau} P_{pq\theta,r}^{[0,1]} P_{r\gamma\tau,l}^{[0,1]} x_\gamma^{(s-1)} x_\tau^{(s-1)} x_q^{(m-2)} x_\theta^{(m-2)} x_p^{(m-2)}.$$

Is this case consider (3)

$\sum_{p,q,\theta} P_{pq\theta,l}^{[0,2]} x_p^{(m-2)} x_q^{(t-2)} x_\theta^{(m-2)}=\sum_{r,\gamma,\tau} P_{r\gamma\tau,l}^{[0,1]} x_r^{(s-1)} x_\gamma^{(m-1)} x_\tau^{(m-1)}$,$s \geq 2$,

$x_l^{(m)}=\sum_{r,\gamma,\tau} P_{r,\gamma,\tau}^{[0,1]} x_r^{(s-1)} x_\gamma^{(m-1)} x_\tau^{(m-1)}$, $s \geq 2$. (4)

The definition of a cubic random process in (2) for m = 2, t = n:

$x_l^{(2)}=\sum_{i,j,k} P_{i,j,k}^{[0,1]} x_i^{(1)} x_j^{(n-1)} x_k^{(n-1)}$. (5)

Setting s = 2 in (4), we present the proof of the lemma taking into account (5)

$x_l^{(m)}=\sum_{p,q,\theta} P_{pq\theta,l}^{[0,1]} x_p^{(m-1)} x_q^{(m-1)} x_\theta^{(m-1)}$ (3)

III. Conclusion

Thus, in this article, a lemma is proved relating to the cases of a homogeneous cubic random process, for this process a system of stochastic differential equations is constructed, the solution of which is not a cubic random process for all initial conditions, the cubic stochastic technological separation conditions are found.

References:

1. Allen E.”Modeling with Ito Stochastic Differential Equation”, Springer, (2007).
2. Abdushukurov A.A, Zufarov T, “Ehtimollar nazariyasi va matematik statistika” T Universitet 2015
3. Akramova Surayo Renatovna. Interpretation of lexical and semantic features of uzbek-tajik words in jamal kamal's poem “Uzbek language. ACADEMICIA: An International Multidisciplinary Research Journal Year: 2020, Volume: 10, Issue: page:1434-1440. https://saarj.com/wp-content/uploads/ACADEMICIA-OCTOBER-2020-FULL-JOURNAL.pdf

4. Akramova G. R. Modern approaches to the development of critical thinking of students. European Journal of Research and Reflection in Educational Sciences Vol. 7 No. 11, 2019 ISSN 2056-5852. http://www.idpublications.org/wp-content/uploads/2019/09/Full-Paper-MODERN-APPROACHES-TO-THE-DEVELOPMENT-OF-CRITICAL-THINKING-OF-STUDENTS.pdf
5. Akramova G.R., Akramova S.R. Developing critical thinking on elementary class pupils is the most important factor for preparing social relationship. JOURNAL OF CRITICAL REVIEWS. ISSN- 2394-5125 VOL 7, ISSUE 17, 2020. URL: http://www.jcreview.com/?mno=20061
6. Akramova G.R., Bakhshulloeva Sh.A. Motivation as a factor in the success of educational activities of primary school students. https://internationalconference.ru/images/PDF/2020/60/motivatsiya-kak-faktor-.pdf
7. Akramova Gulbahor Renatovna, Akramova Surayo Renatovna. Pedagogical and psychological conditions of preparing students for social relations on the basis of the development of critical thinking. PSYCHOLOGY AND EDUCATION. Vol. 58 No. 2 (2021): Volume 58 No. 2 (2021). P. 4889-4902 http://psychologyandeducation.net/pae/index.php/pae/article/view/2886
8. Akramova Gulbakhor Renatovna. Psychological and pedagogical foundations for the development of critical thinking of students. Academicia: An International Multidisciplinary Research Journal Year: 2020, Volume: Vol. 10, Issue 4. P.581-584. https://www.indianjournals.com/ijor.aspx?target=ijor:aca&volume=10&issue=4&article=081
9. Bashorat Jamilova. Description of the spirit of teenagers in uzbek children's prose . MIDDLE EUROPEAN SCIENTIFIC BULLETIN ISSN 2694-9970 https://cejsr.academicjournal.io/index.php/journal/article/view/134
10. Boboqulova.S.B “Kubik stoxastik jarayonlar” O`zb. ilmiy-amaliy tadq.konf. Toshkent 2020
11. C.W. Gardiner. Handbook of Stochastic Methods: for Physics, Chemistry and the Natural Sciences (англ.). –Springer, 2004. –P.415.
12. Djurayeva Salomat Nabiyevna, Dustova Dildora Sabirjanovna. Pedagogical bases and technologies for professional development of personality. Vol. 7 No. 10, 2019. http://www.idpublications.org/wp-content/uploads/2019/09/Full-Paper-PEDAGOGICAL-BASES-AND-TECHNOLOGIES-FOR-PROFESSIONAL-DEVELOPMENT-OF-PERSONALITY.pdf
13. Fayzullayev M. B., Sadullayeva M. G., Fayzulloyev O. M. НАЦИОНАЛЬНО-КУЛЬТУРНЫЕ ЦЕННОСТИ ВОСТОКА В БАСНЯХ МУХАММАДА ШАРИФА ГУЛЬХАНИ //Theoretical & Applied Science. – 2020. – №. 2. – С. 528-532.
14. Gafurovna Lukmonova Salomat. The essence of the content of the concept of digital educational resources and its role in primary education. ACADEMICIA: An International Multidisciplinary Research Journal. 2020, Volume: 10, Issue: 5. P.1451-1456. https://www.indianjournals.com/ijor.aspx?target=ijor:aca&volume=10&issue=5&article=211
15. Gaybullaevna Dilova Nargiza Innovative approach to education is a factor for developing new knowledge, competence and personal qualities. Asian Journal of Multidimensional Research (AJMR) Year : 2021, Volume : 10, Issue : 1 First page : (148) Last page : (153). https://www.indianjournals.com/ijor.aspx?target=ijor:ajmr&volume=10&issue=1&article=021
16. Jamilova B.S. Basics of Uzbek Children's Reading. TEST Engineering & Management// http://www.testmagzine.biz/index.php/testmagzine

17. Jamilova Bashorat Sattorovna, Nuriddinova Shaxnoza. O‘zbek bolalar adabiyotida badiiy tafakkur yangilanishining tadriji. 2020- yil, 12-son, 20-27-b. https://tilvaadabiyot.uz/f/12-son_2020_jil_mukova-mun.pdf

18. Levakov A.A, Stochastic differential equations [in Russian], Belarusian Gos. Univ, Minsk (2009).
19. Mamurov B.J., Rozikov U.A. On cubic stochastic operators and processes. Journal of Physics: Conference Series 697(2016) 01.2017.p.1-14.

20. Mamurov.B.J, Boboqulova.S.B,“Об одном свойстве кубических стохастических процессов” материалы респуб. науч. прикл. Конф. Навои. 2019.с. 183.
21. Mohichehra Yoqubovna Ro'ziyeva. Color Symbolism In Uzbek Folklore. 2020 Theoretical & Applied Science 85(05):277-284. https://www.researchgate.net/publication/342161517_COLOR_SYMBOLISM_IN_UZBEK_FOLKLORE
22. Nargiza Dilova Activity Areas of Primary School Teachers. Nr. 3 (2016): Eastern European Scientific Journal 03-2016 http://journale.auris-verlag.de/index.php/EESJ/article/view/681
23. Ro'ziyeva Mohichehra Yoqubovna. COLOR SYMBOLISM IN UZBEK FOLKLORE. JCR. 2020; 7(18): 860-868. doi:10.31838/jcr.07.18.119. http://www.jcreview.com/?mno=95124
24. Ruzieva Mokhichekhra Yoqubovna Expression of Attitude to Colors in Turkic National Ritual Songs. Vol 6, No 1 (2017) http://anglisticum.org.mk/index.php/IJLLIS/article/view/1411
25. Ruzieva, M.Y. (2020). Expression of Attitude to Colours in Turkic National Ritual Songs. Sociosphere Journal, Issue 4, pp. 50-55
26. Safarov Firuz Sulaymonovich, Istamova Shohida Maqsudovna. TYPES OF LEXICAL MEANINGS. JCR. 2020; 7(6): 481-484. doi:10.31838/jcr.07.06.87. http://www.jcreview.com/?mno=101993
27. Sattorovna Jamilova Bashorat, Sadriddinovna Nuriddinova Shaxnoza The spiritual description of adults in uzbek children's prose-the place of literary psychologism. Academicia: an international multidisciplinary research journal. Year: 2021, Volume:11, Issue:1 https://cejsr.academicjournal.io/index.php/journal/article/view/134/136
28. Xalilova Ruxsora Raupovna. The Formation Of Professional Speech Of Students In The Learning Process At The University. European Journal of Research and Reflection in Educational Sciences Vol 7. 2019 http://www.idpublications.org/wp-content/uploads/2019/09/Full-Paper-THE-FORMATION-OF-PROFESSIONAL-SPEECH-OF-STUDENTS-IN-THE-LEARNING-PROCESS-AT-THE-UNIVERSITY.pdf
29. Акрамова Г.Р. Development of students’ critical thinking in the process of continuous education. https://cyberleninka.ru/article/n/development-of-students-critical-thinking-in-the-process-of-continuous-education
30. Акрамова Г.Р. Эффективные методы развития критического мышления у учащихся [Effective methods for developing critical thinking in students] // international scientific review of the problems of pedagogy and psychology (Boston, USA - 19 April, 2018). с. https://scientific-conference.com/h/sborniki/pedagogicheskie-nauki2/1078-effective1.html

31. Акрамова Гулбаҳор. Ўқувчиларнинг танқидий тафаккурини ривожлантириш асосида ижтимоий муносабатларга тайёрлаш технологияси. Том 1 № 1 (2020): Таълим ва инновацион тадқиқотлар. Б. 51-61. http://interscience.uz/index.php/home/article/view/20
32. Акрамова С. Р. Роль интерактивных технологий в развитии информационной компетенции учащихся // European research № 2(60). 2020. С. 85-88.
33. Акрамова Сураё Ренатовна. Роль интерактивных технологий в развитии информационной компетенции учащихся. european reseach: innovation in science, education and technology London, United Kingdom, 10–11 февраля 2020 года. https://www.elibrary.ru/item.asp?id=42427112
34. Баҳодир Маъмуров. Акмеологик Ёндашув Асосида Бўлажак Ўқитувчиларда Таълим Жараёнини Лойиҳалаш Кўникмаларини Ривожлантириш. Том 1 № 1 (2020): Таълим ва инновацион тадқиқотлар. http://interscience.uz/index.php/home/article/view/15
35. Башорат Жамилова, Мохигул Каххорова. Болалар детектив насридаўсмирлар руҳияти тасвири. Том 1 № 1 (2020): Таълим ва инновацион тадқиқотлар. http://interscience.uz/index.php/home/article/view/37

36. Бобокулова.С.Б Бобоева.М.Н. “Использование игровых элементов при введении первичных понятий математики” Москва 2020.
37. Давронова Дилдора Саидовна. Оилада ёшлар ғоявий-сиёсий маданиятини шакллантириш тизимига инновацион ёндашув муҳим ижтимоий масала сифатида. https://cyberleninka.ru/article/n/oilada-yoshlar-oyaviy-siyosiy-madaniyatini-shakllantirish-tizimiga-innovatsion-yondashuv-mu-im-izhtimoiy-masala-sifatida
38. Давронова Дилдора Саидовна. Педагогические возможности воспитания идейно-политическое культуры современной молодежи в семье. Евразийский союз ученых. https://elibrary.ru/item.asp?id=27440471
39. Джураева Саломат Набиевна . Дидактические принципы в образовании. https://cyberleninka.ru/article/n/didakticheskie-printsipy-v-obrazovanii
40. Джураева Саломат Набиевна. Способы воспитания личных качеств у студентов педагогической специальности. https://cyberleninka.ru/article/n/sposoby-vospitaniya-lichnyh-kachestv-u-studentov-pedagogicheskoy-spetsialnosti
41. Джураева Саломат Набиевна. Педагогическое сотрудничество как базовое условие развития личности учащихся. International scientific review of the problems of philisophy, psychology and pedagogy Boston, USA, 10–11 декабря 2019 года. https://elibrary.ru/item.asp?id=41486846
42. Дилова Н.Г. Важность совместного обучения в повышении эффективности начального образования // International Scientific Review № 2(44) / International Scientific Review of the Problems and Prospects of Modern Science and Education: XLII International Scientific and Practical Conference (Boston. USA - 26 February, 2018). https://scientific-conference.com/h/sborniki/pedagogicheskie-nauki2/987-importance1.html
43. Жамилова, Башорат. Трактовка и формы выражения экологического воспитания в произведениях для детей. Сборник научных статей по итогам работы Международного научного форума Том. 2. https://www.elibrary.ru/item.asp?id=37532655&selid=37532696

44. Жамилова, Башорат. Сюжет и его творческая трактовка // Современная филология : материалы II Междунар. науч. конф. (г. Уфа, январь 2013 г.). — Т. 0. — Уфа : Лето, 2013. — С. 1-2. https://moluch.ru/conf/phil/archive/78/3286/
45. Истамова Шохида Махсудовна. Поэтико-композиционные функции сна в художественном произведении [Text] : автореф. дис. ... д-ра филос. наук (PhD) по филологии : 10.00.02 / Истамова Шохида Махсудовна ; Бухар. гос. ун-т. - Самарканд, 2017. - 44 с. - Текст узб., рос., англ. http://www.samdu.uz/images/avtoreferat/2017-12-22-06-07-35-cghbHV4T8o.pdf
46. Лукмонова С.Г. Цифровые образовательные ресурсы в педагогической деятельности [Digital educational resources in teaching] // XXI International scientific review of the problems of philosophy, psychology and pedagogy. https://scientific-conference.com/h/sborniki/yuridicheskie-nauki2/2249-media-security-trend.html
47. М. Б. Файзуллаев, Н. Шарапова, А. О Мухаммадова. Валентность Каузативных Глаголов Психического Состояния. Том 1 № 1 (2020): Таълим ва инновацион тадқиқотлар. http://interscience.uz/index.php/home/article/view/36

48. Мамуров.Б.Ж Бабакулова.С.Б “Теорема сходимости для последовательности симметрично зависимых случайных величин” Academy № 4(55).2020. Российский импакт-фактор: 0,19. Научно-метод журн.
49. Мамуров.Б.Ж Бобокулова.Б.С “О решение эволюционных уравнений для кубических стохастических процессов” Сборник материалов межд.конф. КРОМШ-2019.
50. Маҳмудов Мэлс. Дидактик Лойиҳалаш – Замонавий Таълимда Самарадорлик Кафолати. Том 1 № 1 (2020): Таълим ва инновацион тадқиқотлар. http://interscience.uz/index.php/home/article/view/14

    Оксендаль Б. –‘’Стохатические дифференциальные уравнения-введение в теорию и приложения’’, 2003.
51. Рўзиева М. Ё. Туркий халқлар фольклорида ранг ифодаловчи сўзлар ва уларнинг семиотик таҳлили. Том 1 № 1 (2020): Таълим ва инновацион тадқиқотлар. http://interscience.uz/index.php/home/article/view/34
52. Рўзиева Моҳичеҳра Ёқубовна Ўзбек халқ қўшиқларида ранг символикаси. Дис. Автореферати. 2017. http://library.ziyonet.uz/uzc/book/85761
53. Халилова Р. Р. Повышение культуры речи будущего учителя, как педагогическая проблема. № 1. - 2015. - S. 23-30. https://cyberleninka.ru/article/n/povyshenie-kultury-rechi-buduschego-uchitelya-kak-pedagogicheskaya-problema Авторы

54. Халилова Р.Р “The formation of professional speech of students in the learning process at the university” European Journal of Research and Refection in Educational Sciences 2019
55. Халилова Р.Р. Прагматические принципы интернет- коммуникаций / Р.Р. Халилова // Инновационные подходы в современной науке: сб. ст. по материалам LXXXIX Международной научно-практической конференции «Инновационные подходы в современной науке». – № 5(89). – М., Изд. «Интернаука», 2021. https://www.internauka.org/authors/halilova-ruhsora-raupovna