Abstracts of the papers of Simeon Ribagin for participation in the concourse for academic position „Associated Professor"

I. Publications in Indicator B4

1. Dicho Stratiev, Svetoslav Nenov, Sotir Sotirov, Ivelina Shishkova, Georgi Palichev, Evdokia Sotirova, Vitaly Ivanov, Krassimir Atanassov, **Simeon Ribagin**, Nora Angelova, "Petroleum viscosity modeling using least squares and ANN methods", Journal of Petroleum Science and Engineering 212 (2022) 110306, https://doi.org/10.1016/j.petrol.2022.110306. (**Q1**; **IF = 4.346**)

274 crude oils pertaining to the groups of extra light (gas condensates), light, medium, heavy, and extra heavy crude oils were characterized by true boiling point distillation, specific gravity and kinematic viscosity at 21.11 and 37.78 ∘C. Eight published regression empirical methods were examined for their capability of accurately predicting the crude oil viscosity. Among them the model of Kotzakoulakis and George was found to provide the lowest average absolute relative error (AARE) of 24.0% with AARE of 21.5% for the crude oils containing <30 wt % vacuum residue (VR) and AARE of 37.2% for the crude oils having >30 wt% VR. The model of Aboul-Seoud and Moharam exhibited the lowest AARE (16.3%) for the crude oils with <30 wt% VR. A new nonlinear regression model was developed that predicted the viscosity of the 274 crude oils with AARE of 19.5%, with AARE of 14.9% for the crude oils containing <30 wt% VR, and AARE of 42.0% for the crude oils having >30 wt% VR. Another model based on the artificial neural network (ANN) technique was developed. The ANN model predicted the viscosity of the 274 crude oils with AARE of 44.3%, with AARE of 50.2% for the crude oils with <30 wt% VR, and AARE of 13.9% for the crude oils containing >30 wt% VR. The combination of predicting the viscosity of crude oils having <30 wt% VR by the new nonlinear regression model with the predicting of viscosity of crude oils with >30 wt% VR by the ANN model provides of AARE of 14.9% of viscosity prediction for the entire data base of 274 crude oils.

2. Angelova S., **Ribagin S**., Raikova R., Veneva V.. Power frequency spectrum analysis of surface EMG signals of upper limb muscles during elbow flexion – A comparison between healthy subjects and stroke survivors. J Electromyogr Kinesiol. 2018 Feb;38:7-16. doi: 10.1016/j.jelekin.2017.10.013. Epub 2017 Oct 31. PMID: 29107837. (**Q2**, **IF:1.51**)

After a stroke, motor units stop working properly and large, fast-twitch units are more frequently affected. Their impaired functions can be investigated during dynamic tasks using electromyographic (EMG) signal analysis. The aim of this paper is to investigate changes in the parameters of the power/frequency function during elbow flexion between affected, nonaffected, and healthy muscles. Fifteen healthy subjects and ten stroke survivors participated in the experiments. Electromyographic data from 6 muscles of the upper limbs during elbow flexion were filtered and normalized to the amplitudes of EMG signals during maximal isometric tasks. The moments when motion started and when the flexion angle reached its maximal value were found. Equal intervals of 0.3407 s were defined between these two moments and one additional interval before the start of the flexion (first one) was supplemented. For each of these intervals the power/frequency function of EMG signals was calculated. The mean2 (MNF) and median frequencies (MDF), the maximal power (MPw) and the area under the power function (APw) were calculated. MNF was always higher than MDF. A significant decrease in these frequencies was found in only three post-

stroke survivors. The frequencies in the first time interval were nearly always the highest among all intervals. The maximal power was nearly zero during first time interval and increased during the next ones. The largest values of MPw and Apw were found for the flexor muscles and they increased for the muscles of the affected arm compared to the non-affected one of stroke survivors.

3. Dicho S. Stratiev, Sotir Sotirov, Ivelina Shishkova, Angel Nedelchev, Ilshat Sharafutdinov, Anife Veli, Magdalena Mitkova, Dobromir Yordanov, Evdokia Sotirova, Vassia Atanassova, Krassimir Atanassov Danail D. Stratiev, Nikolay Rudnev, **Simeon Ribagin**, "Investigation of relationships between bulk properties and fraction properties of crude oils by application of the Intercriteria Analysis" Petroleum Science and Technology, 2016, vol.34, No 13, 1113-1120. (**Q3, IF=0.655**)

Data from assays of 244 crude oils (condensates, extra light, light, intermediate, and heavy crudes) were processed by the InterCriteria Analysis with the aim to investigate the relationships between bulk properties and fraction properties of the crude oils and the degree of similarity between them. It was found that except the crude bulk properties sulfur, Conradson carbon, and metals content all other studied crude bulk properties exhibited lack of statistically meaningful relations or presence of weak statistically meaningful relations with the crude fraction properties. The use of the InterCriteria Analysis showed that crudes with very similar properties could be identified when a large crude database is available. In this way based on a previous experience in oil refining a selection of potentially beneficial new crudes for processing in a refinery could be made

4. D. S. Stratiev, I. K. Shishkova, R. K. Dinkov, I. P. Petrov, I.V. Kolev, D. Yordanov, S. Sotirov., E.Sotirova V. Atanassova, **S. Ribagin,** K. Atanassov, D. D. Stratiev, S. Nenov, Crude Slate, FCC slurry oil, Recycle, and Operating Conditions Effects on H-Oil product quality, Processes 2021, 9, 952. https:// doi.org/10.3390/pr9060952. (**Q3, IF=2.847**)

This paper evaluates the influence of crude oil (vacuum residue) properties, the processing of fluid catalytic cracking slurry oil, and recycle of hydrocracked vacuum residue diluted with fluid catalytic cracking heavy cycle oil, and the operating conditions of the H-Oil vacuum residue hydrocracking on the quality of the H-Oil liquid products. 36 cases of operation of a commercial H-Oil® ebullated bed hydrocracker were studied at different feed composition, and different operating conditions. Intercriteria analysis was employed to define the statistically meaningful relations between
135 parameters including operating conditions, feed and products characteristics. Correlations and regression equations which related the H-Oil® mixed feed quality and the operating conditions (reaction temperature, and reaction time (throughput)) to the liquid H-Oil® products quality were developed. The developed equations can be used to find the optimal performance of the whole refinery considering that the H-Oil liquid products are part of the feed for the units: fluid catalytic cracking, hydrotreating, road pavement bitumen, and blending.

5. Dicho Stratiev, Svetoslav Nenov, Dimitar Nedanovski, Ivelina Shishkova, Rosen Dinkov, Danail D. Stratiev, Denis D. Stratiev, Sotir Sotirov, Evdokia Sotirova, Vassia Atanassova**, Simeon Ribagin**, Krassimir Atanassov, Dobromir Yordanov, Nora A. Angelova, and Liliana Todorova-Yankova, "Empirical Modeling of Viscosities and Softening Points of Straight-Run Vacuum Residues from Different Origins and of Hydrocracked Unconverted Vacuum Residues Obtained in Different Conversions", Energies 2022, 15, 1755. https://doi.org/10.3390/en15051755. (**Q3, IF = 3.004**).

The use of hydrocracked and straight-run vacuum residues in the production of road pavement bitumen requires a good understanding of how the viscosity and softening point can be modeled and controlled. Scientific reports on modeling of these rheological properties for hydrocracked and straight-run vacuum residues are scarce. For that reason, 30 straight-run vacuum residues and 33 hydrocracked vacuum residues obtained in a conversion range of 55–93% were investigated, and the characterization data were employed for modeling purposes. An intercriteria analysis was applied to investigate the statistically meaningful relations between the studied vacuum residue properties. It revealed that the straight-run and hydrocracked vacuum residues were completely different, and therefore their viscosity and softening point should be separately modeled. Through the use of nonlinear regression by applying CAS Maple and NLPSolve with the modified Newton iterative method and the vacuum residue bulk properties the viscosity and softening point were modeled. It was found that the straight-run vacuum residue viscosity was best modeled from the molecular weight and specific gravity, whereas the softening point was found to be best modeled from the molecular weight and C7-asphaltene content. The hydrocracked vacuum residue viscosity and softening point were modeled from a single property: the Conradson carbon content. The vacuum residue viscosity models developed in this work were found to allow prediction of the asphaltene content from the molecular weight and specific gravity with an average absolute relative error of 20.9%, which was lower of that of the model of Samie and Mortaheb (Fuel. 2021, 305, 121609)—32.6%.

6. Vassilev, P., **Ribagin, S**.. A note on intuitionistic fuzzy modal-like operators generated by power mean. Advances in Intelligent Systems and Computing, 643, Springer, Cham, 2018, ISBN:978-3-319-66826-0, DOI:https://doi.org/10.1007/978-3-319-66827-7_43, (**SJR (Scopus):0.174**)

In this paper we propose new type of intuitionistic fuzzy modal like operators generated by the application of the power mean. We study some of their properties and establish some relations between them.

II. Publications in Indicator Г7

1. Andreev, N., Sotirova, E., Ribagin, S.. Intercriteria analysis of data from the centers for transfusion haematology in Bulgaria. Comptes rendus de l'Académie bulgare des Sciences, 72, 7, 2019, ISSN:ISSN 1310–1331, 982-990. JCR-IF (Web of Science) (**IF=0.251, Q4**)

The InterCriteria Analysis (ICrA) approach is applied to data connected with the centres for Transfusion Haematology in Bulgaria. The results are commented from different points of view: centre activities, relations between sex and age of the donors, transfusion haematology processes in the years. Conclusions for the future of the Bulgarian centres for Transfusion Haematology are given.

2. Dicho Stratiev, Ivelina Shishkova, Rosen Dinkov, Vassia Atanassova, Simeon Ribagin, Danail D. Stratiev, Krassimir Atanassov, Evaluation of crude slate and processing of recycle effects on H-Oil performance, Int. J. Oil, Gas and Coal Technology, Vol. 30, No. 2, 2022, 130-156. (**Q4, IF=0.82**).

The LUKOIL Neftohim Burgas (LNB) H-Oil hydrocracker performance at different operating conditions, and different crude oils, and processing of recycle of partially blended fuel oil (PBFO) was assessed. The lower throughput, a result from the Covid 19 pandemic, allowed the LNB H-Oil hydrocracker to operate at a capacity lower than 50% of the design and to process recycle of PBFO achieving a vacuum residue conversion of 93%. The impact of crude oil slate, and processing of recycle of PBFO on conversion and on the unconverted hydrocracked vacuum residue quality was discussed. Intercriteria analysis was employed to evaluate the statistically meaningful relations of the operating conditions to the H-Oil conversion and yields. Regression equations were developed and discussed.

3. Dicho. Stratiev, Ivelina Shishkova, Ivan Petrov, Rosen Dinkov, Vassia Atanassova, Simeon Ribagin, Danail Stratiev, Krassimir Atanassov, "About H-Oil performance improvement and cetane number of finished refinery diesel", Oil Gas European Magazine, 2021, 47, (3), 13-16 (**Q4, IF=0.242**).

It was observed in the LUKOIL Neftohim Burgas refinery that the employed 2-ethyl hexil nitrate cetane improver treating rate increased by a factor of two for the last 17 months. An analysis performed using intercriteria analysis revelaed that the main culprit for cetane improver treating rate augmentation is the deterioration of the cetane index of the finished automotive diesel fuel as a result of the increased H-Oil severity of operation. The estimation of the cetane number (index) of the refinery diesel fuel employing the linear blending rule established that the high severity mode of operation of H-Oil leads to production of refinery diesel having about 1 point lower cetane index (number). The slope of enhancement of diesel fuel with magnification of cetane improver treating rate indicated that 1 point lower diesel cetane number (index) will need about 370ppm higher cetane improver treating rate.

4. Zaharieva, B., Doukovska, L., **Ribagin, S**., Radeva, I." Intercriteria analysis of data obtained from patients with Behterev's disease. International Journal Bioautomation, 1, 24, 2020, DOI:doi: 10.7546/ijba.2020.24.1.000507, 5-14. (**SJR (Scopus):0.242**)

This paper continues series of research on application of the novel approach of InterCriteria Analysis (ICrA) to medical data. It describes a new method of analyzing the treatment results of patients with Behterev's disease in order to aid the decision making process for treatment course - InterCriteria Analysis. The ICrA analysis is applied on the results of medicine, physiotherapeutic treatment and kinesitherapeutical program characteristics. The main goal is an improvement of general quality of patients' life through practices of specific methodology of kinesitherapy and ergotherapy. The object of empirical study is health status of patients suffering Rheumatoid spondylitis in relation to their current life conditions. Here are analyzed the data from observation about 25 patients (14 women and 11 men, aged 25 to 67). The results confirm previously performed research, showing that the muscles in the human body are closely connected and the improving of one movement will lead

to improving another. The obtained results also prove applicability of ICrA to the researched problem, give grounds for extending its application and potential of further in-depth study

5. Dicho Stratiev, Ivelina Shishkova, Mihail Ivanov, Ivan Petrov, Vassia Atanassova, **Simeon Ribagin**, Krassimir Atanassov, Vesislava Toteva, Danail Stratiev, "Commercial and laboratory experience with catalytic cracking of straight run hydrotreated vacuum gas oil and H-Oil gas oils", Journal of Chemical Technology and Metallurgy, 2022, 57, 2, 215-223 (**SJR = 0.220**; Scopus).

This study presents for the first time an investigation of fluid catalytic cracking of 100 % H-vacuum gas oil at a commercial FCC unit. 100 % straight run hydrotreated vacuum gas oil (HTSRVGO) and 100 % H- vacuum gas oil have been cracked in the commercial LUKOIL Neftohim Burgas fluid catalytic cracking and in a laboratory confined ebbulated bed ACE catalytic cracking unit. The relations between the operating conditions of the commercial FCC unit and conversion level in both cases 100 % HTSRVGO and its blends with H-Oil VGO were investigated using intercriteria analysis. Multiple regressions were developed to quantify the effect of the operating conditions as well as quantity and quality of H-Oil VGO on conversion level in the commercial FCC unit. ACE laboratory tests with feed containing about 20 % H-Oil VGO at different catalyst-to-oil ratios and reaction temperature were performed and the results are discussed.

6. Shishkova I.K., Stratiev D.S., Tavlieva M.P., Dinkov R.K., Yordanov D., Sotirov S., Sotirova E., Atanassova V, **Ribagin S**., Atanassov K., Stratiev D.D., Todorova-Yankova L.. Evaluation of the different compatibility indices to model and predict oil colloidal stability and its relation to crude oil desalting. Resources, 10, 8, 2021, ISSN:2079-9276, DOI:10.3390/resources10080075, SJR (Scopus):0.749

Thirty crude oils, belonging to light, medium, heavy, and extra heavy, light sulfur, an high sulfur have been characterized and compatibility indices defined. Nine crude oil compatibility indices have been employed to evaluate the compatibility of crude blends from the thirty individual crude oils. Intercriteria analysis revealed the relations between the different compatibility indices, and the different petroleum properties. Tetra-plot was employed to model crude blend compatibility. The ratio of solubility blending number to insolubility number was found to best describe the desalting efficiency, and therefore could be considered as the compatible index that best models the crude oil blend compatibility. Density of crude oil and the n-heptane dilution test seem to be sufficient to model, and predict the compatibility of crude blends.

7. **Ribagin, S**., Zaharieva, B., Radeva, I., Pencheva, T.. Generalized Net Model of Proximal Humeral Fractures Diagnosing. Int. J. Bioautomation, 22, 1, 2018, ISSN:1314-2321 (on-line), 1314-1902 (print), 11-20. (**SJR (Scopus):0.267**)

Proximal humeral fractures are common injuries and they occur primarily in older patients. They represent 5.7% of diagnosed fractures and are the third most common fracture pattern seen in elderly. Fractures of the proximal humerus usually occur after a high or low energy fall. Due to the variety of factors, which influence the classification, and the diagnosis of these fractures, early detection is the key factor for an appropriate treatment. Accordingly, in this study we present a successful example of Generalized Nets application in traumatology and propose a novel approach to timely detection and diagnosing of proximal humeral fractures.

8. Raikova R., Angelova S., **Ribagin S**.. Changes in EMG Activities of Upper Arm Muscles and in Shoulder Joint Angles in Post-stroke Patients. INTERNATIONAL JOURNAL BIOAUTOMATION, 20, 3, 2016, ISSN:1314-2321 (онлайн) 1314-1902 (печатно издание), 389-408. (**SJR (Scopus):0.228**)

The aim of the paper is to compare the electromyographic signals (EMGs) and the joint angles of the affected upper limb muscles of stroke survivors to those of their non-affected limb as well as to those of the dominant and the non-dominant limbs of healthy volunteers. Twentyfive volunteers, ten post-stroke survivors and fifteen healthy subjects as control group, participated in the experiments. EMGs of muscles of the upper limbs and two angles in the shoulder joint were registered and processed during three static and two dynamic tasks. The results showed a big variability of all investigated parameters (mean and median frequencies, ranges of motions, maximal normalized EMGs) both for the patients and for the healthy subjects, for right and for left han. This makes difficult a deduction of definitive conclusions about the changes in motor control of the upper limbs due to stroke. Moreover, natural differences in motor control exist for dominant and non-dominant limb. On the whole, the power-frequency analysis and the relevant statistical analysis indicated that the muscles of the affected limb had lower median frequencies than those of the healthy limb. Examination of full elbow flexions in the sagittal plane showed that the range of the motion in the shoulder joint of both limbs of the patients increased when compared to the healthy subjects and that this increase was larger for the affected limb. The post-stroke survivors used more of their muscle power although no increased co-contraction was observed.

9. Dicho Stratiev, Ivelina Shishkova, Rosen Dinkov, Ivan Petrov, Iliyan Kolev, Dobromir Yordanov, Sotir Sotirov, Evdokia Sotirova, Simeon Ribagin, Krassimir Atanassov, Danail Stratiev, Svetoslav Nenov, Liliana Todorova-Yankova, Kamen Zlatanov, "Empirical Models to Characterize the Structural and Physiochemical Properties of Vacuum Gas Oils with Different Saturate Contents", Resources 2021, 10, 71. (**SJR=. 0.749; Scopus Q2**).

Inter-criteria analysis was employed in VGO samples having a saturate content between 0.8 and 93.1 wt.% to define the statistically significant relations between physicochemical properties, empirical structural models and vacuum gas oil compositional information. The use of a logistic function and employment of a non-linear least squares method along with the aromatic ring index allowed for our newly developed correlation to accurately predict the saturate content of VGOs. The empirical models developed in this study can be used not only for obtaining the valuable structural information necessary to predict the behavior of VGOs in the conversion processes but can also be utilized to detect incorrectly performed SARA analyses. This work confirms the possibility of predicting the contents of VGO compounds from physicochemical properties and empirical models.

10. Dicho Stratiev, Svetoslav Nenov, Dimitar Nedanovski, Ivelina Shishkova, Rosen Dinkov, Danail Stratiev, Denis Stratiev, Sotir Sotirov, Evdokia Sotirova, Vassia Atanassova, Krassimir Atanassov. Dobromir Yordanov, Nora A. Angelova, Simeon Ribagin, Liliana Todorova-Yankova, "Different Nonlinear Regression Techniques and Sensitivity Analysis as Tools to Optimize Oil Viscosity Modeling. Resources 2021, 10, 99. (**SJR=. 0.749; Scopus Q2**)

Four nonlinear regression techniques were explored to model gas oil viscosity on the base

of Walther's empirical equation. With the initial database of 41 primary and secondary vacuum gas oils, four models were developed with a comparable accuracy of viscosity calculation. The Akaike information criterion and Bayesian information criterion selected the least square relative errors (LSRE) model as the best one. The sensitivity analysis with respect to the given data also revealed that the LSRE model is the most stable one with the lowest values of standard deviations of derivatives. Verification of the gas oil viscosity prediction ability was carried out with another set of 43 gas oils showing remarkably better accuracy with the LSRE model. The LSRE was also found to predict better viscosity for the 43 test gas oils relative to the Aboul Seoud and Moharam model and the Kotzakoulakis and George.

11. **Ribagin, S**., P. Chountas, T. Pencheva, Generalized Net Model of Muscle Pain Diagnosing, Flexible Query Answering Systems, 12th International Conference, FQAS 2017, London, UK, June 21–22, 269-275, 2017.(**Scopus SJR: 0.32**,)

Pain is the most common symptom of the many musculoskeletal pathologies. Musculoskeletal pain affects the muscles, ligaments, tendons, nerves and bones and might be caused by diverse factors. Musculoskeletal pain ranges from mild to severe. It can be local or diffuse, and acute or chronic. Due to the wide range of conditions that may cause such a symptom, diagnosing process is challenging and a systematic approach is necessary. In this investigation we present a successful example of generalized nets application in medical diagnosing and propose a novel approach leading to the appropriate diagnostic considerations. The method proposed in this investigation accurately identifies the various steps during the muscle pain diagnosing process and significantly improves the health care level. Obtained so far results could be used to assist in the decision making in the diagnostic processes.

12. **Ribagin, S**, Sotirova, E., Pencheva, T.. Generalized Net Model of Adhesive Capsulitis Diagnosing. Lecture Notes in Computer Science, Springer, Cham, 2018, ISSN:0302-9743, DOI:https://doi.org/10.1007/978-3-319-73441-5_44, 408-415. **(SJR (Scopus):0.283)**

Adhesive capsulitis is a musculoskeletal condition of the shoulder characterized by pain and gradual loss of the global shoulder motion. Proper diagnosis of adhesive capsulitis is extremely important for designing a coordinated exercise program and reliable monitoring progress during treatment. In this investigation we present a successful example of Generalized Nets (GN) application in orthopedics and propose a novel approach to timely detection of adhesive capsulitis. The developed GN-model provides a framework that can be used by primary care practitioners to guide diagnostic processes for patients suspected to have adhesive capsulitis and might assist in optimizing patient outcomes and more effective treatment. The method proposed in this investigation accurately identifies the various steps during the diagnosing processes and significantly improve the health care level. Obtained so far results could be used to assist in the decision making in the diagnostic processes.

13. **Ribagin, S.,** Atanassov, K., Roeva, O., Pencheva, T.. Generalized Net Model of Adolescent Idiopathic Scoliosis Diagnosing. Uncertainty and Imprecision in Decision Making and Decision Support: Cross-fertilization, New Models and Applications, Vol. 559 of the Advances in Intelligent Systems and Computing, Springer, 2018, ISBN:978-3-319-65544-4 (print), 978-3-319-65545-1 (online), DOI:10.1007/978-3-319-65545-1_31, 333-348. (SJR (Scopus):0.174)

Of the many postural disorders commonly found in the population, scoliosis is the most complex and the most difficult to diagnose and treat. Adolescent idiopathic scoliosis affects 2% to 4% of adolescent population. Although most of those patients will not develop clinical symptoms, scoliosis can progress

to rib deformity and respiratory compromise, and can cause significant cosmetic problems and emotional distress for some patients. Accordingly, early detection is the key factor to prevent the curve magnitude progress, as well as to ensure an appropriate and successful treatment. Proper diagnosis is extremely important for designing a coordinated exercise programs and reliable monitoring progress during treatment. The purpose of the present study is to present a successful example of Generalized Nets application in orthopedics and to propose a novel approach to timely detection of adolescent idiopathic scoliosis and its categorization.

14. **Ribagin, S**.. Generalized Net Model of Osteoarthritis Diagnosing. Advanced Studies in Contemporary Mathematics, 27, 4, Jangjeon Mathematical Society, 2017, ISSN:1229-3067, 589-598. (**SJR (Scopus):0.269**)

Musculoskeletal disorders are the leading cause of disability among the world population. They encompass a spectrum of conditions, from those of acute onset and short duration to lifelong disorders, including osteoarthritis (OA), rheumatoid arthritis (RA), gout, osteoporosis etc. Of these conditions OA is the most common disorder and it is the major complaint prompting a patient to seek physician referral. Joint pain and reduced mobility are the first and cardinal symptoms of OA. When assessing patient with joint pain and reduced mobility it is important to build a structured, systematic and reliable diagnostics and decision making algorithm to confirm the OA is the primal diagnosis. To streamline the diagnostic process and to avoid misdiagnosis, mathematical modeling methods can be applied. In this paper we propose a mathematical model, which represents the diagnostic plan for patients with OA symptoms

15. **Ribagin, S**. (2022). Possible Application of Generalized Nets in Telemedicine Screening of Corona Virus Disease 2019 (COVID-19). In: Sotirov, S.S., Pencheva, T., Kacprzyk, J., Atanassov, K.T., Sotirova, E., Staneva, G. (eds) Contemporary Methods in Bioinformatics and Biomedicine and Their Applications. BioInfoMed 2020. Lecture Notes in Networks and Systems, vol 374. Springer, Cham. https://doi.org/10.1007/978-3-030-96638-6_15

The purpose of the present paper is to present possible application of generalized nets with the development of a reduced GN-model as a telemedicine screening tool for COVID-19. The model describes a possible algorithm for remote symptom screening and the different transitions of the model are representing respectively the different criteria of the evaluation process.

16. Andreev, N., **Ribagin, S**., Atanassov, K. (2022). A Generalized Net Model of the Process of Obtaining and Diagnosing Convalescent Plasma from Patients with COVID-19. In: Sotirov, S.S., Pencheva, T., Kacprzyk, J., Atanassov, K.T., Sotirova, E., Staneva, G. (eds) Contemporary Methods in Bioinformatics and Biomedicine and Their Applications. BioInfoMed 2020. Lecture Notes in Networks and Systems, vol 374. Springer, Cham. https://doi.org/10.1007/978-3-030-96638-6_14

In the present study we propose a GN-model of the process of obtaining and diagnosing convalescent plasma from patients with COVID-19. The presented GN-model describes in details the different steps during the evaluation of the convalescent plasma, which will find expression in process optimization.

17. **Ribagin, S**., Grozeva, A., Popova, G. (2022). Generalized Net Model of Telerehabilitation Program for Patients with Socially Significant Diseases. In: Sotirov, S.S., Pencheva, T., Kacprzyk, J., Atanassov, K.T., Sotirova, E., Staneva, G. (eds) Contemporary Methods in Bioinformatics and Biomedicine and Their Applications. BioInfoMed 2020. Lecture Notes in Networks and Systems, vol 374. Springer, Cham. https://doi.org/10.1007/978-3-030-96638-6_10

The development of telecommunication technologies and artificial intelligence has led to a significant change in the healthcare trends. A strong example of innovative healthcare provision is the so-called telerehabilitation (TR), which is part of the rapidly evolving field of telemedicine. In the present paper we propose a reduced GN-model representing a real time patient/therapist interaction via video-conferencing platform. The model allows different treatment behavior depending on the disease. The model describes a telerehabilitation protocol and algorithm for choosing the best rehabilitation treatment based on the patient dysfunctions and the possible outcomes.

18. Lubich, M., Shannon, A., Slavov, C., Pencheva, T., **Ribagin, S.,** Atanassov, K. (2022). A Generalized Net Model of the Pattern of Behavior in Patients with eGFR < 20 mL/min (CKD Stage IV-V). In: Sotirov, S.S., Pencheva, T., Kacprzyk, J., Atanassov, K.T., Sotirova, E., Staneva, G. (eds) Contemporary Methods in Bioinformatics and Biomedicine and Their Applications. BioInfoMed 2020. Lecture Notes in Networks and Systems, vol 374. Springer, Cham. https://doi.org/10.1007/978-3-030-96638-6_12

In the present study a mathematical model of behavior in patients with eGFR < 20 mL/min. (Chronic kidney disease (CKD) stage IV-V) based on generalized nets (GNs) is proposed. The developed reduced GN-model allows for optimization of clinical behavior in patients with CKD stage IV-V.

19. Atanassov, K., **S. Ribagin**, L. Doukovska, V. Atanassova, Implication →190, NIFS, Vol.23, No.4, 79-83, 2017.

A new – with current number 190 – intuitionistic fuzzy implication is introducedand some of its basic properties are studied.

20. Vassilev, P., **S. Ribagin**, L. Todorova, L., On an aggregation of expert value assignments using index matrices, NIFS, Vol.23, No.4, 75-78, 2017.

We elaborate on an idea firstly proposed by V. Traneva. We extend the approach byconsidering new possibilities for aggregation based on what we name "total relevance". This allows for better knowledge discovery and selection of the most influential input.

21. **Ribagin S**., Shannon, A., Atanassov, K.. Intuitionistic Fuzzy Evaluations of the Elbow Joint Range of Motion. Novel Developments in Uncertainty Representation and Processing, series Advances in Intelligent Systems and Computing, 401, Springer, 2016, 225-230

Following (Ribagin et al. 2015, In: 19th International Workshop on IFSs, [8]), in this paper it is proposed a technique to evaluate the functional capacity of the elbow joint during a complex movement using intuitionistic fuzzy and interval valued intuitionistic fuzzy sets. The membership and non-membership values are

not always possible up to our satisfaction, but in deterministic (hesitation) part has more important role here, the fact that in decision making, particularly in case of orthopedic physical assessment, there is a fair chance of the existence of a non-zero hesitation part at each moment of evaluation. Based on our previous study here we will introduce intuitionistic fuzzy estimations of flexion-extension and pronation-supination movements of the elbow joint

22. **Ribagin, S**., Vassilev, P., Zoteva, D.. Generalized Net Model of an Active Elbow Orthosis Prototype. Advances in Intelligent Systems and Computing, 1081, Springer, 2021, ISSN:2194-5357, DOI:https://doi.org/10.1007/978-3-030-47024-1_18, 167-173. SJR (Scopus):0.22

This paper presents a novel approach for describing the functioning of an active elbow orthosis with the use of generalized nets modeling. The so proposed model will permit the development of user-oriented control of sEMG- powered elbow orthosis. We propose an abstract model based on the "on-off" myoelectric control, appropriate for maximum two degrees of freedom in the elbow joint.

III.   Publications in Indicator Г8

1∗ **Ribagin, S**., Lyubenova, V.. Metaheuristic Algorithms: Theory and Applications. Studies in Computational Intelligence, 934, Springer Nature, 2021, ISSN:1860-949X, 385-419. (SJR (Scopus):0.185

Metaheuristic is a collective concept of a series of intelligent strategies to enhance the efficiency of heuristic procedures. Metaheuristic algorithms are becoming an important part of modern optimization. A wide range of metaheuristic algorithms have emerged over the last two decades, and are becoming increasingly popular. This article presents a brief overview of the scientific research on new metaheuristic algorithms, as well as their modifications and hybridizations and its various fields of application. The results presented are limited to those proposed by scientists from the Bulgarian Academy of Sciences for the last 20 years.