Computer Utilization as A Balanced Opponent in Dam-Dam-an

Setiawan Wibowo Purnomo*, Susana Limanto*, Monica Widiasri*

Informatics Engineering Department, University of Surabaya, Surabaya 60293, East Java, Indonesia
Raya Kalirungkut 60293, Surabaya, East Java, Indonesia. Phone : 62-031-2981395.

**Corresponding author Email: s6124019@student.ubaya.ac.id, susana@staff.ubaya.ac.id, monica@staff.ubaya.ac.id*

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Dam-dam-an is a traditional game played by two players using a board with the size of 8x8 as a media. Each player gets 16 pieces that can be moved one step forward or leaped over opponent's piece. The goal of this game is to eliminate all of our pieces as soon as possible. It is exciting to have a challenging opponent, yet it is difficult to find a skillful one. A way to solve this problem is using intelligent computer. This paper presents the result of our research about the computer utilization as balanced opponent in dam-dam-an game using Alpha-Beta Pruning.Alpha-Beta Pruning is a best-step searching algorithm which works by considering and assessing every possibility while excluding the less useful steps. The implementation is developed using C# programming language based on Windows Runtime. Some features were added to make this game more exciting, particularly intelligence level selection (easy, medium, and hard), human or computer opponent selection, undo function, pausing menu, save-load the game, and setting the turning time. This game was validated by twenty respondents which were categorized based on their skill. Each respondent played against the computer thrice and the results were recorded. The results showed that the number of winning between the computer and each player are almost the same. It shows that the computer opponent may prove itself to be a challenging opponent for human player.

Keywords: Dam-dam-an, Artificial Intelligence, Game, Alpha-Beta Pruning.

1. Introduction

Psychologically, one of our needs is to have entertainments[1]. Eventhough it is not primary needs, it is always sought. A game has an ability to give us recreation, decreasing our stress, and regaining our focus[2].Besides that, playing a game can improve our cognitive, emotional, and social skills[3].An example of games is draughts, a two-player strategy board game involving diagonal moves of uniform game pieces and mandatory captures by jumping over opponent pieces. The name "draughts" is derived from the verb 'to draw' or 'to move'[4]. Because of its popularity over the world, each region creates their own variation, and gives them a name. For examples, Ghanaian draughts is called Damii, Brazilian draughts is called Derecha, and Indonesian draughts is called dam-dam-an.

Dam-dam-an has lots of variations too. Some regions have their own rules and board. As an example, dam-dam-an which is going to be discussed here is the one which came from a region in Kediri, East Java. It is a turn-taking based traditional game, played by two players using a board with the size of 8x8 as the media. The board has no unique layout and can be replaced with chess board. Each player gets 16 pieces that can be moved one step forward or leaped over opponent's pieces. If a piece is at the end of the board, it can't be moved, except leaping over opponent's piece. The goal of this game is to eliminate all of our pieces as soon as possible. The game ends when there is a player whose entire pieces are eliminated or when a player can't do any moves.

Since this game is played by two players, there is a possibility that a player can't find a balanced opponent when needed. A quick observation showed that lots of players had a problem in finding an opponent, or a balanced one. This problem can be solved by utilizing computer as a balanced player. Therefore, an action research was conducted to develop an application of dam-dam-an game. In this application, computer plays a role as a balanced opponent. A balanced computer opponent is one that behaves as humanly as possible, which means that the computer is not allowed to use its god-like ability to see further than we can, and sometimes screwed up when distracted, just like a human[5]. Besides that, a research states that the use of computer in dam-dam-an game can also improve player's mental rotation, spatial ability, and visual memory[6].

2. Methodology

This project is categorized as an action research, since it is built to evaluate that utilizing a computer to play dam-dam-an can help the players to find a balanced opponent[7]. It adopts system development life cycles the research methodology, consisting of four stages: analyzing, designing, implementing, and testing[8].

The first stage is analyzing the current conditions to understand the players' problems. It is done by doing an interview with twenty dam-dam-an players, ranged from twenty to forty years old, about their problems in finding an opponent in dam-dam-an. To make the analysis simpler, the respondents are selected using simple random sampling technique[9]. Afterwards, similar games are observed to find features that are implementable in dam-dam-an.

All the problems found in the analysis phase were used as considerations in the next stage, designing. There are three things that need to be designed: the data storage framework, workflow of computer player, and user interface. Data storage framework is designed to discover how the variables used in the game are stored. Workflow of computer player is designed to utilize the computer as a balanced opponent. User interface is designed to make the game easy to operate.

After the game had been designed, it was developed using C# on Windows Runtime platform. The purpose of using Windows Runtime platform is to make this game playable on Windows 8 Family and above with only one-time implementation.

Lastly, verification and validation were done to make sure that it runs as it supposed to be and no longer do something which can cause problems to the players[10]. The game and the computer player were verified with functional testing method to make sure that it has been correctly and completely developed[11]. Validation was done to assess whether the game solved the

problems in finding a balanced opponent or not[12].The game was validated by giving a chance to twenty players which was previously interviewed to play against the computer. Firstly, players were categorized based on their skill in playing dam-dam-an to create a balance match when playing against the computer. Then, players were required to play three times against the computer with the same difficulty as their category, and the result of the matches were recorded. Afterwards, they were interviewed once more about their assessment whether this game had already helped them finding a balanced opponent or not.

3. Results and Discussion

An interview with twenty players was required to obtain information about their problems in finding a dam-dam-an opponent. The respondents were chosen with simple random sampling method, ranged from twenty to forty years old and are able to play dam-dam-an. The result of the interviews with twenty people is more than half of them (65%) could not find an opponent. On the other hand, a quarter who found an opponent, tended not to have a balanced opponent. The rest of them did not have a problem in finding a balanced opponent. The result's data is presented in a graph which can be viewed on Figure 1.

Those are the main reason why a computer needs to be utilized as a balanced opponent in game dam-dam-an. A computer needs an intelligence to find the best move from the given state[13]. There are lots of methods which can be used to find the best move in dam-dam-an, one of them is Minimax[14]. Minimax is a best move searching algorithm which is suitable on a deterministic, turn-taking, two-player, zero-sum games of perfect information[15]. Deterministic means that the game is fully observable without any randomness. Zero-sum game means that the utility values at every state of the game are always equal and opposite, for instance when the game has ended, player one wins the game (+1), and on the other hand, player two loses the game (-1).

Minimax is appropiate if seen on its purpose towards a two-player perfect-information game like dam-dam-an[16], but it requires lots of memory space and time when it does a deep search[17]. Therefore, an optimization is necessary to make minimax runs faster and uses smaller memory space. A way to optimize minimax is by implementing Alpha-Beta Pruning. Alpha-Beta Pruning is an optimization algorithm that prunes pointless nodes to be observed further[18]. The higher the branches are pruned, the greater the reductions in tree size. In a best case, Alpha-beta pruning can reduce the number of nodes which need to be examined from NN to $\sqrt{N}\sqrt{N}$[19], causing a great saving in memory usage and time needed. The reduced time and memory usage can be used to search up to twice deeper than the original minimax algorithm[20].

To enrich the game, some features need to be added. Based on the observation on the features of two games: Dama (downloaded from Google Play Store), and Checkers Free (downloaded from Google Play Store), here is the list features which are going to be implemented in dam-dam-an:

- A player can choose the difficulty of the computer opponent.
- A player can undo his moves.

- A player can set the time-per-turn.
- A player can save and load the game.
- A player can play against the computer, or another player on the same device.
- A player can pause the game.

Concerning the results of the analysis, data storage needs to be designed. The design shows that dam-dam-an needs a permanent storage and three temporary storages. The permanent storage is used for saving games. It is required to store all the information used in the current session into a single file. The three temporary storages: search tree, move history, and board state history; are used when the game is running. Search tree is used by the searching algorithm to find an optimal move. Move history is used to store the moves required from the current board state to the board state in children's node, allowing the algorithm to recall the moves used to go to the optimal move. Board state history is used to store all the board state from the beginning of the game until the current state, allowing the players undoing their moves.

Not only the data storages which need to be designed, but also user interface. The game contains of six pages: "Home", "VS Computer", "VS Human", "Configuration", "Help", and "Arena", the game itself. A computer's difficulty can be configured in "1 Player" page. "Time-per-turn" and "Allow undo" can be configured in "Configuration" page. The rest of the features can be found in the "Arena" page. To those who are new to dam-dam-an and/or this application, a "Help" page is provided and accessible from the "Home" page.

After the game has been designed, the game is ready to be developed. The permanent storage is saved into a file automatically by the game when a player saved the game. On the other hand, three temporary storages are implemented as a class and objects that is used in the game. The user interface is built based on the requirements stated in the design stage.

The last stage is verifying and validating the game. Verification with black-box method is done until it found no error and the game runs as expected. Then, the game is validated by twenty players who previously interviewed by playing against the computer three times, and have the results recorded. The result shows that the difficulty of the computer is quite balance with the players' skill. The match data from twenty players against the computer can be seen on Figure2. Even though some of the total winning of the computer and the player does not match, it only has small range of difference.

Finally, eighteen players who previously had a problem in finding a balanced opponent were interviewed for the last time to see if this game solved their problem. Fourteen out of Eighteen players said that it is enough to be used as a balanced opponent. On the other hand, four players were not satisfied with the results since they think that the computer player was easier or harder.

4. Conclusion

Based on the testing results, minimax with alpha-beta pruning optimization can be implemented in dam-dam-an, and has been successfully utilized as a balanced opponent based on the validation.

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Figure captions

Figure 1. Problems in finding an opponent in dam-dam-an
Figure 2. Total Winning Based on The Difficulties

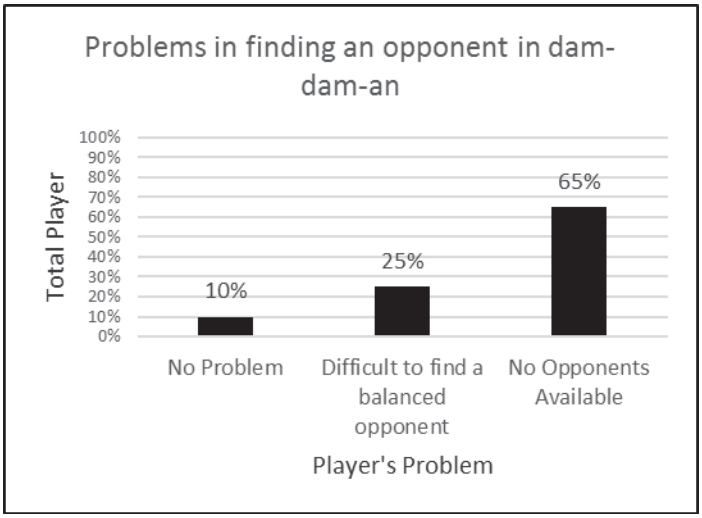

Figure 1. Purnomo et al

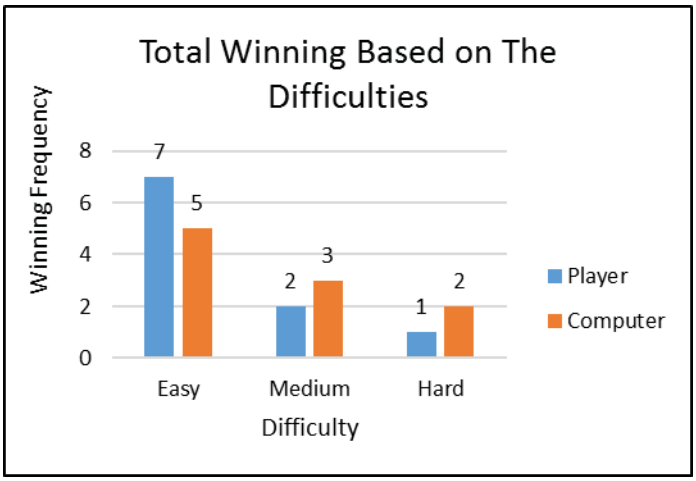

Figure 2. Purnomo et al

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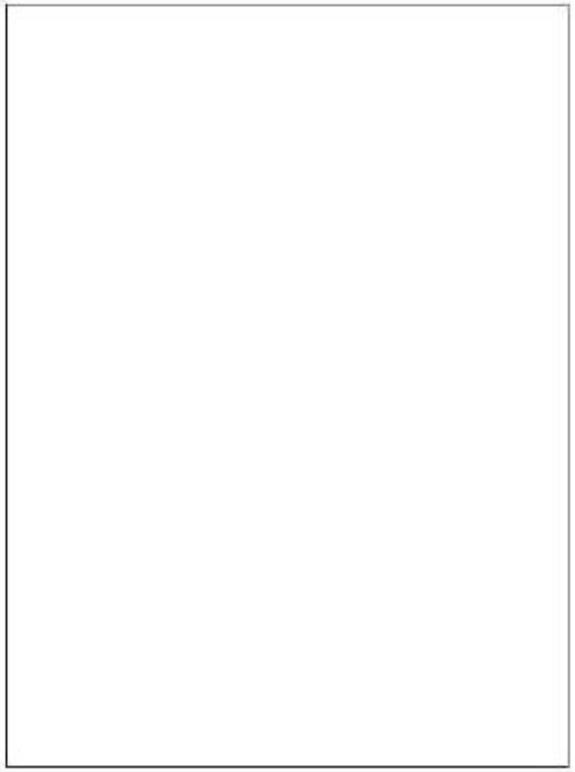

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Volume 23, Number 12 (December 2017) pp.11635-12838

A SPECIAL SECTION
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Spasio-Temporal Variability of the Vegetation Cover Density in the Gunungsewu Karst Landscape Based on
Landsat 8 OLI Data
Eko Budiyanto
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[Abstract] [Full Text - PDF] [Purchase Article]

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Arinto Nugroho
Adv. Sci. Lett. 23, 11645–11648 (2017)
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Tsuroyya
Adv. Sci. Lett. 23, 11649–11653 (2017)
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Danang Tandyonomanu, Tsuroyya, and Awang Dharmawan
Adv. Sci. Lett. 23, 11654–11657 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

The Study of the Factors That Influence the Community to Survive Living in the Disaster Area
Ita Mardiani Zain, Sulistinah, and Drianda Immanuel Prasetya
Adv. Sci. Lett. 23, 11658–11661 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Development of Tourism in Kediri Regency Destination as the Local and National
Sri Murtini and L. Sudaryono
Adv. Sci. Lett. 23, 11662–11665 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Democratic Society in the Local Wisdom: Citizen Participatory Activity in the Environmental Movement
Maya Mustika Kartika Sari
Adv. Sci. Lett. 23, 11666–11669 (2017)
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Increasing the Productivity of Chips Manufacturers Through Utilization of Chip Raw Materials Chopper and Oil Drying Machine
Sukma Perdana Prasetya
Adv. Sci. Lett. 23, 11670–11673 (2017)
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Agus Machfud Fauzi
Adv. Sci. Lett. 23, 11674–11677 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

The Carrying Capacity Ratio (CCR) Analysis of Meteoric Water Resources at the Middle East Java Region
Bambang Hariyanto
Adv. Sci. Lett. 23, 11678–11682 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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Vinda Maya Setianingrum
Adv. Sci. Lett. 23, 11683–11686 (2017)
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Behavior of Bonek Supporters in the Perspective Subculture of Violence
Rr. Nanik Setyowati
Adv. Sci. Lett. 23, 11687–11691 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Strengthening Educational Function of Family Welfare Empowerment Movement: Educational Aids on Gender for Democracy
Oksiana Jatiningsih
Adv. Sci. Lett. 23, 11692–11696 (2017)
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Revitalization of Traditional Market Based on Deliberative Democracy Concept
Agus Prastyawan
Adv. Sci. Lett. 23, 11697–11701 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Building Students' Multicultural Values Through Citizenship Education to Create a Democratic Society
Totok Suyanto, Rr. Nanik Setyowati, and Made Pramono
Adv. Sci. Lett. 23, 11702–11705 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Role of Organization Culture Performance for Primary School Teachers
Suharningsih
Adv. Sci. Lett. 23, 11706–11709 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Effective Self-Management Affect the Performance of Teacher Primary School
Murtedjo
Adv. Sci. Lett. 23, 11710–11714 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Religion Spirit to the Development of Modern Science; Synergies Between Reason and Revelation
M. Turhan Yani
Adv. Sci. Lett. 23, 11715–11718 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Mediation Over Disputes Between Indigenous People and Industrial Plantation Forest Businessmen in Indonesia
Tamsil and Mahendra Wardhana
Adv. Sci. Lett. 23, 11719–11722 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Legal Protection of Traditional Knowledge, Recognition and Certainty of Property Protection of Traditional
Knowledge of Indigenous Peoples
Indri Fogar Susilowati and Budi Hermono
Adv. Sci. Lett. 23, 11723–11726 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Legal Protection for Victims of Bullying in the Learning Process in Terms of Epistemology
Nurul Hikmah and Pudji Astuti
Adv. Sci. Lett. 23, 11727–11730 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Rethinking on Criminalizing of Defamation (Evaluation of Criminal Policy)

Emmilia Rusdiana and Pudji Astuti
Adv. Sci. Lett. 23, 11731–11734 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Manuscript Controversy Issue Boekhandel Tan Khoen Swie Kediri (Historical Studies)
Wisnu, SeptinaAlrianingrum, and Artono
Adv. Sci. Lett. 23, 11735–11738 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Messianic Figures in the Late Period of Majapahit: An Anthropological Approach in Historical Archaeology Issues
Y. Hanan Pamungkas, Agus Trilaksana, and Sumarno
Adv. Sci. Lett. 23, 11739–11743 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Existence of Nation: Indonesian Football in Melbourne Olympics 1956
Rojil Nugroho Bayu Aji, Eko Satriya Hermawan, and Riyadi
Adv. Sci. Lett. 23, 11744–11747 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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Sugeng Harianto
Adv. Sci. Lett. 23, 11748–11752 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

An Intercultural Communication Dereliction and Prejudice: A Case Study in Sampang District, Madura, Indonesia
Awang Dharmawan
Adv. Sci. Lett. 23, 11753–11757 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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Agus Suprijono
Adv. Sci. Lett. 23, 11758–11761 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Construction and Strategies for Strengthening the Value of Integrity for Students to Build a Culture Dignity
and Competitively in Universitas Negeri Surabaya
Sarmini and Ketut Prasetyo
Adv. Sci. Lett. 23, 11762–11765 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

The Role of Family in Gender Equality Building
Listyaningsih
Adv. Sci. Lett. 23, 11766–11769 (2017)

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The Meaning of Coffee Shop for the Young People in Aceh
Sarmini, Ridwan, Ani Wakidah Basriani, and Ulin Nadiroh
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Sarmini and Warsono
Adv. Sci. Lett. 23, 11776–11780 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

The Roles of Parents in Building Family Harmony in Early Marriage Couple in Madura
Sarmini, Abdul Majid, Syarifah Hasanah, Ulin Nadiroh, and Hestin Sri Widiawati
Adv. Sci. Lett. 23, 11781–11786 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Developing Strategy for Rice Milling Unit Selection Process Using Analytical Hierarchy Process (AHP) Method:
A Case of Agroindustry in Indonesia
I. B. Suryaningrat and Angela Fianeka
Adv. Sci. Lett. 23, 11787–11792 (2017)
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Quality Characteristics of Natural Edamame Jam Without Preservative Ingredient as Supplementary of
Emergency Food
Nurhayati Nurhayati and Ahmad Rizky Alfian
Adv. Sci. Lett. 23, 11793–11796 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Savory Salt Production by Enzymatic Hydrolysis from Low Economic Value of Freshwater Fishes and
Saltwater Fishes
Yuli Witono, Iwan Taruna, Wiwik Siti Windrati, Lailatul Azkiyah, Tomoyuki Yoshino, and Ria Dewi Nurani
Adv. Sci. Lett. 23, 11797–11799 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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Herawati Budiastuti, Dewi Widyabudiningsih, Dianty Rosirda Dewi Kurnia, and Endang Sri Rahayu
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[Abstract] [Full Text - PDF] [Purchase Article]

Heat Integration Between HVU and FCCU to Improve Energy Saving

Sintha Soraya Santi, Renanto, and Ali Altway
Adv. Sci. Lett. 23, 11804–11809 (2017)
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Characterization of IR Spectra and Molecular Weight of the Products on Modified Ring Opening Polymerization of Poly Lactid Acid
Yenny Meliana, Gatot Ibnusantosa, and Agus Haryono
Adv. Sci. Lett. 23, 11810–11814 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Characterization of Emulsion System on Mimba Oil as Organic Insecticide Using Surfactants Based on Vegetable Oil
Savitri and Yenny Meliana
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Synthesis and Characterization of Palm Oil and Polyethylene Glycol Based Polymeric Surfactants
Yan Irawan, Ika Juliana, and Indri Badria Adilina
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Economic Analysis and Development Strategies for Leading Products in Sampang District
Akhmad Fauzi, Kustini, Bowo Santoso, and Edy Mulyadi
Adv. Sci. Lett. 23, 11824–11827 (2017)
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Effect of Pressure on the Supercritical CO_2 Extraction of *Asiaticoside from Centella asiatica*
Dewi Sondari, Tun Tedja Irawadi, Dwi Setyaningsih, and Silvester Tursiloadi
Adv. Sci. Lett. 23, 11828–11833 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Alkoxy Groups of Sulfonated Natural Oil-Based Surfactant to Reduce Oil-Water Interfacial Tension for Chemical Flooding
Yani F. Alli, Usman, and Letty Brioletty
Adv. Sci. Lett. 23, 11834–11837 (2017)
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M. Muntoha, Ria A. A. Soemitro, and Farida Rachmawati
Adv. Sci. Lett. 23, 11838–11842 (2017)
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The Effect of Detention Time and Plant Density to the Effectivity of Constructed Wetland as Wastewater
Treatment Innovation in Small Industry of Cassava Chips
Erina Rahmadyanti, Andre Dwijanto Witjaksono, and Ulil Hartono
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[Abstract] [Full Text - PDF] [Purchase Article]

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with Organizational Commitment as Intervening Variable at PT. Cartenz Indonesia in Solo City-Indonesia
Wiji Utami, Lilik Farida, Nadia Azalia, and Muhammad Lutfi
Adv. Sci. Lett. 23, 11848–11852 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Developing a Harmony Ethnic Plurality in Pohuwato Society in Public Administration Perspective
Wantu Sastro and Tamu Yoan
Adv. Sci. Lett. 23, 11853–11856 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Optimizing Product Mix Using Linear Programming: A Case Study of 'Kopi Sembilan'
Andre Dwijanto Witjaksono, Erina Rahmadyanti, and Dwiarko Nugrohoseno
Adv. Sci. Lett. 23, 11857–11862 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Land Use Prospects and Challenges on Intermodal Terminal, Juanda International Airport
Amanda Ristriana Pattisinai, Anita Susanti, and Ari Widayanti
Adv. Sci. Lett. 23, 11863–11866 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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Arasy Alimudin, Soebandi, Achmad Zakki Falani, Eman Setiawan, and Bustomi Arifin
Adv. Sci. Lett. 23, 11867–11873 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

School Counseling Services Information System Optimization in Multi-Level School at Surabaya
Susana Limanto, Andre, Dhiani Tresna Absari, and Sholeh Hadi Setyawan
Adv. Sci. Lett. 23, 11874–11878 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Classification of Lung Disease Syndromes in Traditional Chinese Medicine Based on Learning Vector Quantization
I. G. P. Asto Buditjahjanto, Naim Rochmawati, and R. Hapsari Peni

Adv. Sci. Lett. 23, 11879–11883 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

The Ammoniation—A Way for Evolving the Rural Areas, Madura Island, Indonesia
Soedarto Teguh, Soemartono, Syaifuddin Zuhri, and Ertien Rining
Adv. Sci. Lett. 23, 11884–11888 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Computer Utilization as a Balanced Opponent in Dam-Dam-An
Setiawan Wibowo Purnomo, Susana Limanto, and Monica Widiasri
Adv. Sci. Lett. 23, 11889–11891 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Beef Weight Prediction System Based on Image Processing in Order to Increase Livestock Productivity
Lilik Anifah, Nurhayati, Haryanto, Rina Harimurti, Anita Qoiriah, and Ekohariadi
Adv. Sci. Lett. 23, 11892–11896 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Effect of PWM Signal on Hydrogen Production Using Hoffman Voltameter Methods
Wahyuni Martiningsih, Rocky Alfanz, M. A. Akbar, Joddy Arya Laksmono, and Yenny Meliana
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Determining Optimal Toolpath Strategy in the Manufacture of Insole Shoe Orthotic Made from Eva Foam
Rubber for Diabetes Patients
B. Bawono, P. W. Anggoro, A. A. Anthony, J. Jamari, and A. P. Bayuseno
Adv. Sci. Lett. 23, 11902–11909 (2017)
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Optimization of Manufacturing Process Parameters for the Product of ISO-Diabetes Patients with High Risk Classes
P. W. Anggoro, B. Bawono, J. Wibowo, J. Jamari, and A. P. Bayuseno
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Comparison of the Effect of Texturing Modes and Boundary Slip on Tribological Performance of Journal Bearing
Mohammad Tauviqirrahman, Bayu Kurniawan, Rifky Ismail, Susilowati, and Jamari
Adv. Sci. Lett. 23, 11918–11921 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Design of Shadow Trainer Equipment to Measure the Agility of Badminton Player
Agung Prijo Budijono and Pudjijuniarto
Adv. Sci. Lett. 23, 11922–11927 (2017)

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Syariah-Based Contract Farming as a Socio-Business Model: Experience of Local Phenomena
Hamidah Hendrarini and Sumartono
Adv. Sci. Lett. 23, 11928–11932 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

The Model "Orientasi IPA" to Improve the Critical Thinking Skills of Senior High School Students
Budi Jatmiko, Zainul Arifin Imam Supardi, and Rosyid
Adv. Sci. Lett. 23, 11933–11937 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

The Effectiveness of Different Diluent Media as the Storage Medium for Human Sperm: To Maintain Its Quality
Isnawati, Tjandrakirana, and Nur Ducha
Adv. Sci. Lett. 23, 11938–11942 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Implementation of Science Character Values with Green Chemistry Insight Integrated on Basic Chemistry
Course by Using Project Based Learning
Mitarlis, Bertha Yonata, and Rusly Hidayah
Adv. Sci. Lett. 23, 11943–11947 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Qualitative Study of Antibacterial Activity of Chitosan-ZnO/Al_2O_3 Nanocomposites
Dina Kartika Maharani, Rusly Hidayah, and Lailatul Khasanah
Adv. Sci. Lett. 23, 11948–11951 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Product and Process Performance Improvement of Candidate Physics Teachers by Implementation of an
Integrated Learning Strategy
Dwikoranto, Madlazim, Eko Hariyono, and Dyah Permata Sari
Adv. Sci. Lett. 23, 11952–11955 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

The Effect of Combine Between Dietary Protein Level Variation and Laserpuncture Induction on Catfish
(*Clarias* sp) Oocyte Development
Dyah Hariani, Erlix R. Purnama, and Pungky Slamet Wisnu Kusuma
Adv. Sci. Lett. 23, 11956–11961 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

The Formulation of Biopesticide Combination (SpltMNPV Virus, Beauveria bassiana and

Neem Seed
(*Azadirachta indica* A. Juss.) as Biocontrol Agents Against Soybean Pest
Evie Ratnasari, Mahanani Tri Asri, and Winarsih
Adv. Sci. Lett. 23, 11962–11966 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Learning Model of the Basic Physics to Improve Concept Understanding and Critical Thinking Skills
Hainur Rasid Achmadi, Budi Jatmiko, and Wasis
Adv. Sci. Lett. 23, 11967–11971 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Effectiveness of Ruminant Feed Formula from the Fermented Water Hyacinth (*Eichhornia crassipes*) to
Produce the High Level Protein of Goat Meat
Herlina Fitrihidajati and Isnawati Evie Ratnasari
Adv. Sci. Lett. 23, 11972–11975 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Building the Design of Blended Learning in Web Lite-Based and Industrial Visits Inorganic Chemical Course
Kusumawati Dwiningsih, Sukarmin, and Muchlis
Adv. Sci. Lett. 23, 11976–11981 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

The Role of Yacon Fructooligosaccharides on the Bile Acids Binding and Bile Salt Hydrolase Activities
Leny Yuanita, Prima Retno Wikandari, and Wahyu Budi Sabtiawan
Adv. Sci. Lett. 23, 11982–11985 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Earthquake Broadband-Noises Experiments: Spectrogram and Spectral Analysis for Hydrocarbon
Reservoir Detection
Madlazim and Tjipto Prastowo
Adv. Sci. Lett. 23, 11986–11990 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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Manuharawati
Adv. Sci. Lett. 23, 11991–11994 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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Scientific Approach

Masriyah
Adv. Sci. Lett. 23, 11995–12001 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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Munasir, A. J. Hairin Pribadi, Z. A. Imam Supardi, Moch. Zainuri, Triwikantoro, and Darminto
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[Abstract] [Full Text - PDF] [Purchase Article]

Effect Egg Yolk in CEP Extender for Sperm Capacitation of Bull During Storage at Temperature 4–5 ?C
Nur Ducha, Trinil Susilawati, Aulanni'am, and Sri Wahyuningsih
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[Abstract] [Full Text - PDF] [Purchase Article]

A Comparative Study of PCA, FFT and Wavelet as Feature Extraction for Gamelan Tones Recognition
Atik Wintarti, Elly Matul Imah, and Joko Winarko
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[Abstract] [Full Text - PDF] [Purchase Article]

Analysis of Cypermethrin Using an Electrode Solid Copper Amalgams Developed as a Working Electrode
in Differential Pulse Voltammetry Compared with Gas Chromatography Methods
Pirim Setiarso and I. Gusti Made Sanjaya
Adv. Sci. Lett. 23, 12016–12019 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Yeast Hydrolysate Enzymatic (YHE) as Degradation Result Using Pineapple's Bromelain as Preparation
Material of Microbiology Culture Media
Rudiana Agustini and Mirwa Adiprahara
Adv. Sci. Lett. 23, 12020–12024 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Characterization of Mesoporous NaZSM-5 and K_3PO_4/NaZSM-5 from Adsorption and Desorption Isotherms
Samik, Ratna Ediati, and Didik Prasetyoko
Adv. Sci. Lett. 23, 12025–12028 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Promoting Pre-Service Chemistry Teachers' Environmental Value Orientation and Creative Thinking Skill
Through the Implementation of Green Chemistry Laboratory Learning
Sri Poedjiastoeti, Suyono, Bertha Yonata, and Arini Siti Wahyuningsih
Adv. Sci. Lett. 23, 12029–12032 (2017)

[Abstract] [Full Text - PDF] [Purchase Article]

Nest Development of Two Type Edible Nest in Gresik. East Java
Sunu Kuntjoro and Ayu Vitasari
Adv. Sci. Lett. 23, 12033–12036 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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July 17, 2006 and Changes in Coulomb Stress and Seismicity Rate
Supardiyono, Andri Dian Nugraha, Madlazim, and Bagus Jaya Santosa
Adv. Sci. Lett. 23, 12037–12042 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Experimental Design Skills Improvement in Earth and Space Sciences Learning by Implementing Four
Question Strategy
Supriyono and Madlazim
Adv. Sci. Lett. 23, 12043–12046 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Formulating Variation of Strategy for Reducing Burden of Chemistry Students' Misconceptions Based on
Conceptual Change Strategy and Individual Characteristic
Suyono, Masriyah, and Muchlis
Adv. Sci. Lett. 23, 12047–12053 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Content of Heavy Metals (Pb, Cd, and Se) on Agricultural Land Contaminated Hot Mud Porong and the
Impact on Safety of Agricultural Product
Tarzan Purnomo and Soegiyanto
Adv. Sci. Lett. 23, 12054–12057 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Reasoning Processes of Prospective Teachers in Proving Theorem Regarding Differences in Mathematical Ability
Susanah, I. Ketut Budayasa, Tatag Yuli Eko Siswono, and Mega Teguh Budiarto
Adv. Sci. Lett. 23, 12058–12063 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Rapid Determination of Earthquake Magnitude Using Measurements of the Dominant Period of P-Waves
Observed at Local Stations in North Sulawesi
Tjipto Prastowo, DyahAyu Puspitasari, La Ode Ngkoimani, and La Ode Safiuddin
Adv. Sci. Lett. 23, 12064–12067 (2017)

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Cognitive Process Analysis of PISA, TIMSS, and UN Science Items Based on Revised Bloom Taxonomy
Wasis, Sukarmin, and Muji Sri Prastiwi
Adv. Sci. Lett. 23, 12068–12072 (2017)
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Widowati Budijastuti, Sucipto Hariyanto, and Agoes Soegianto
Adv. Sci. Lett. 23, 12073–12078 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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Ni Nyoman Aryaningsih, Made. Marsa Arsana, and Ketut Irianto
Adv. Sci. Lett. 23, 12079–12083 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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I. Ketut Budarma and Ni Made Rai Erawati
Adv. Sci. Lett. 23, 12084–12088 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Knowledge Management System as Transfer Media in Balinese Handicraft SMEs
I. Wayan Budi Sentana and Ni Luh Ayu Kartika Yuniastari
Adv. Sci. Lett. 23, 12089–12093 (2017)
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Approach Temperature of Heating Process in Double Tube Heat Exchanger with Al_2O_3-Water Nanofluid
Daud Simon Anakottapary, Ahmad Wibolo, Putu Wijaya Sunu, and I. Made Rajendra
Adv. Sci. Lett. 23, 12094–12097 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Developing Green Tourism Model: A Case Study of "Cultic" at Belimbing Village, Bali-Indonesia
I. Dewa M. C. Santosa, I. Putu Astawa, IN. G. Suta Waisnawa, I. Putu M. Astawa, I. Wayan Temaja, and Lilik Sudiajeng
Adv. Sci. Lett. 23, 12098–12102 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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Ni Made Ernawati and Ni Made Sudarmini

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Ni Made Ernawati, Ni Gst Nym Suci Murni, and Wayan Jendra
Adv. Sci. Lett. 23, 12109–12115 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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I. Ketut Widana and I. Ketut Sudiartha
Adv. Sci. Lett. 23, 12116–12120 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Development of Practice Set of Fares and Ticketing 3 Subject Based on Simulation with Abacus/Sabre Emulator
I. Made Budiasa and I. Ketut Suparta
Adv. Sci. Lett. 23, 12121–12126 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Effect of Pragmatic-Based Learning Model on Students' Pragmatic Competence
I. Made Rai Jaya Widanta, Made Budiarsa, I. Wayan Simpen, and I. Made Netra
Adv. Sci. Lett. 23, 12127–12131 (2017)
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Learning Achievement in the Faculty of Medicine
N. Juni Triastuti
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Modification of the Psychiatric Emergency Patient Acuity Tool Within a Triage System in an Emergency Unit
Arum Pratiwi, Arief Wahyudi Jadmiko, and Arif Widodo
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Level of Family Knowledge on Diabetes Mellitus Diet in Yogyakarta
Fahni Haris and Aulia Ayu Nugraheni
Adv. Sci. Lett. 23, 12563–12567 (2017)
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Correlation Between Incentives and Nurses' Job Satisfaction in Indonesia: A Cross Sectional

Study in Surabaya
Husada Utama Hospital
Sukadiono, Ratna Agustin, Abdul Aziz Alimul Hidayat, and Annisah Ulfa Hanif
Adv. Sci. Lett. 23, 12568–12570 (2017)
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The Correlation Between Infant Temperament and Sleep Quality of Postpartum Mother in Primary Health
Care Prambanan and Jogonalan Klaten Indonesia
Yuni Astuti, Imami Nur Rachmawati, and Hayuni Rahma
Adv. Sci. Lett. 23, 12571–12574 (2017)
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The Innovation of Artrihpi Irrigation Wound Cleansing for Decreasing Bacterial Load in the Treatment Diabetic
Foot Ulcers: Randomized Controlled Trial
Resti Yulianti Sutrisno, Dewi Gayatri, and Agung Waluyo
Adv. Sci. Lett. 23, 12575–12579 (2017)
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The Correlation Between Demographic Data of Kaders' to Health Locus of Control Score and the Opinion About
Mental Health Services in Indonesia
Shanti Wardaningsih and Takayuki Kageyama
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Surahma Asti Mulasari and Fatwa Tentama
Adv. Sci. Lett. 23, 12584–12588 (2017)
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Validation of the Breast Cancer Awareness Scale Indonesian (BCAS-I) in Yogyakarta, Indonesia
Solikhah Solikhah, Monthida Sangruangake, Supannee Promthet, and Cameron P. Hurst
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Professional Behavior Learning by Trigger Film, Self-Reflection and Expert Panel in Medical Education
Wiwik Kusumawati, Titi S. Prihatiningsih, Gandes R. Rahayu, and Soenarto Sastrowijoto
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Cognitive Therapy Model to Control the Blood Sugar Level for Diabetic Patients in a Community

A. Muhlisin, Arum Pratiwi, and Winarsih Nurambarwati
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Validity and Reliability of Caring Instrument for Emergency Department; Gadar Caring Scale (GCS-46)
Jebul Suroso
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Empowerment Model of Breastfeeding Mothers in Exclusive Breast Milk Program in Yogyakarta Indonesia
Mufdlilah, Endang Sutisna, A. A. Subijanto, and Muhammad Akhyar
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The Effectiveness of Walking Exercise and Yoga Training Effect Comparison to Increase Expiration Peak
Toward Sleep Quality for COPD (Respiratory) Patients in Respiratory Hospital West Sumatera
Zuriati, Melti Suriya, Yuanita Ananda, and Novrianti Achyiar
Adv. Sci. Lett. 23, 12613–12615 (2017)
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College Students' Motivation and Willingness to Pay for Smoking Cessation Services
Arlina Dewi and Dianita Sugiyo
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The Effect of the Foot Care Education Program on Knowledge and Self-Efficacy Among Family of Diabetes
Mellitus Patients in PKU Muhammadiyah Gamping Yogyakarta Indonesia
Yanuar Primanda, Puput Bayu Putra, Sitti Rahma Soleman, and Wiwi Melianita Arba
Adv. Sci. Lett. 23, 12619–12622 (2017)
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Perceptions of Indonesian Practical Nurses Towards Nursing Competence: A Qualitative Study
Fitri Arofiati and Khanitta Nuntaboot
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Positive Spiritual Value of Elderly Diabetics in "Rumah Peduli Diabetes Mellitus"
Dinasti Pudang Binoriang, Etty Rekawati, and Wiwin Wiarsih
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Family Support Toward Adherence of Pregnant Woman to Consume Fe Tablets in Puskesmas Gamping 2, Yogyakarta
Nur Azizah Indriastuti and Rizqi Nur Alifah
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Exploratory Factor Analysis of the Diabetes Self-Efficacy Scale Among Type 2 Diabetes Mellitus in Thailand
Monthida Sangruangake, Solikhah Solikhah, Chananya Jirapornkul, and Cameron Hurst
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Parental Behavior Based on Parent Knowledge to Give Information About Reproduction Health to Teenagers
Dewi Puspita and Lisyah Bonita Paputungan
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The Increased Knowledge of Handwashing on Elementary School Students Due to Education About Handwashing with Donkey Bridge
Kusbaryanto and Rasikhah
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Fatwa Tentama, Nurfitria Swastiningsih, and Subardjo
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Differences in Response of Staphylococcus aureus Protein to Serum IgG and Secretion of Uterine Cervical s-IgA from Fertile and Infertile Couples Women with Non-Specific Vaginitis
Muhammad Anas, Aulanni'am Aulanni'am, I. Wayan Arsana Wiyasa, Teguh Wahju Sardjono, and Sumarno
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Winny Setyonugroho
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Comparison of Root Mean Square of Successive Differences (RMSSD) Among Adolescent

Smokers and
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Nurvita Risdiana
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Spatial Memory in Adulthood Rat with Prenatal Hypoxia-Ischaemia
Ratna Indriawati, Soedjono Aswin, Ginus Partadiredja, and Rina Susilowati
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Construction of Smart Exercise Guide Information System for Supporting Rehabilitation Training Program
Chang Won Jeong, Lypengleang Seang, and Su Chong Joo
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Chae-Reen Kim, JinSoo Park, and Doo-Soon Park
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Experimental Results of Zooming Speed and Zooming Pattern for IPTV UI/UX
Samuel Sangkon Lee
Adv. Sci. Lett. 23, 12683–12688 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Designing Private LPWAN Gateway
Kwang-il Hwang
Adv. Sci. Lett. 23, 12689–12692 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

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Guang-Ho Cha
Adv. Sci. Lett. 23, 12693–12696 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Secret Web Browser Structural Designs for Web Service Capsulation
Changhyun Oh, Mansik Kim, Moon-Seog Jun, and Jungho Kang
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A Study on the Design of the System for Security Risk Assessment of the Works for Prevention of Money
Laundering at Financial Institutes
PillJung Kim, EunJoo Kim, and JaePyo Park
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A Study on the Derivation of Performance Measurement Items of Public Application Through Survey
PillJung Kim, EunJoo Kim, and JaePyo Park
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Human Action Recognition Using Reproducing Kernel Hilbert Space for Product Manifold of Symmetric
Positive Definite Matrices and K-NN Method
Wanhyun Cho, Sangkyoon Kim, and Soonyoung Park
Adv. Sci. Lett. 23, 12712–12716 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

A Regression Analysis for the Prediction of the Food Supply in Livestock
Saraswathi Sivamani, Changsun Shin, Jangwoo Park, Kyungryong Cho, and Yongyun Cho
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[Abstract] [Full Text - PDF] [Purchase Article]

DRM Market System for Media Service Platform Supporting Multi-DRM in Cloud Environment
Dueckyoun Cho, Seogchan Hwang, and Gunho Jeong
Adv. Sci. Lett. 23, 12721–12724 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Suggestion SSL-VPN for Traffic Signal Control System
Hansaem Wi, Chan-Kuk Jang, Jae-Hoon Lee, and Okyeon Yi
Adv. Sci. Lett. 23, 12725–12728 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Proposal of Piecewise Key Management Design Considering Capability of Underwater Communication Nodes
Hyunki Kim, Jaehoon Lee, and Okyeon Yi
Adv. Sci. Lett. 23, 12729–12733 (2017)
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Light Source Difference Image for Retrieving 3D Models
Sungjun Han, Yongbae Kim, and Jongweon Kim
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[Abstract] [Full Text - PDF] [Purchase Article]

Proposal for Pricing Adequacy Evaluation of Public Information System Projects in Lowest-Price Bidding
Seunghee Kim
Adv. Sci. Lett. 23, 12738–12742 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Design of a Low Complexity PHY for Close Proximity Point-to-Point Communication at 60 GHz Band
Jae Seung Lee, Young-Hoon Kim, Hoo Sung Lee, and Moon-Sik Lee
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[Abstract] [Full Text - PDF] [Purchase Article]

The Collaboration System of a Drone and Ground Vehicles Using QR Code Detection
Myeong-Suk Pak, Jong-Hwan Beck, and Sang-Hoon Kim
Adv. Sci. Lett. 23, 12748–12751 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

ECDH-Based 3PAKE Protocol for Secure Smart Home Service
Dae-Hwi Lee and Im-Yeong Lee
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[Abstract] [Full Text - PDF] [Purchase Article]

WSKE: A Web-Scale Spatial Knowledge Extractor
S. Lee and I. Kim
Adv. Sci. Lett. 23, 12757–12761 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Measurement of Sleep Data Using Kinect V2 and Thermovision Camera
Kwi-Bin Seo, Sung-Yeup Kim, and Min Hong
Adv. Sci. Lett. 23, 12762–12768 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Customized Recommendation System Based on Rule Matrix in SaaS Aggregation Service Platform
Yun Cui, Myoungjin Kim, Jongjin Jung, Khongmin Kwon, Baul Kim, Ilkyeun Ra, and Hanku Lee
Adv. Sci. Lett. 23, 12769–12774 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Predicting Flu-Rate Using Big Data Analytics Based on Social Data and Weather Conditions
Shikha Verma, Younghee Park, and Mihui Kim
Adv. Sci. Lett. 23, 12775–12779 (2017)

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Design and Implementation of NAND Simulator for Bit Error Rate Model
Kijin Kim and Seung-Ho Lim
Adv. Sci. Lett. 23, 12780–12784 (2017)
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Detection of Malfunction of Gas Sensor Using Principal Component Analysis
Ki-Su Yoon, Seoung-Hyeon Lee, Jae-Pil Lee, and Jae-Kwang Lee
Adv. Sci. Lett. 23, 12785–12787 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Effective Identification of Essential Proteins Based on Genetic Algorithm
Wei Liu, Qiangmei Wu, Jin Wang, and Ling Chen
Adv. Sci. Lett. 23, 12788–12792 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

An Efficient Partially Blind Signature from Pairing for IoT Environment
Kyung-Soo Lim and Daewon Lee
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[Abstract] [Full Text - PDF] [Purchase Article]

A Robust Deep Learning Based Fault Diagnosis of Rotary Machine Bearings
Muhammad Sohaib and Jong-Myong Kim
Adv. Sci. Lett. 23, 12797–12801 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

A Study on User Modeling Based on Consumer Behavior Pattern by Consumption Region
Jinah Kim and Nammee Moon
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Towards the Development of Tele-Rehabilitation System Based on Virtual Reality Environment and Cloud Service
Y. R. Cha, J. Y. Kim, W. H. Gu, S. A. Lee, and B. K. Jung
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A Study on the Performance and Influence of Patent Development Strategy in ICT Convergence Technology
Using the Big Data
Kyeong-Rae Cho and Su-Been Cho
Adv. Sci. Lett. 23, 12812–12817 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Study on Personal Information Leak Detection Based on Machine Learning

Sangdo Lee, Hanchul Woo, and Yongtae Shin
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[Abstract] [Full Text - PDF] [Purchase Article]

System Providing Air Pollution Information Using LED Sculpture
Hyunwoo Lee, Jihoon Yoo, Dongil Shin, and Dongkyoo Shin
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[Abstract] [Full Text - PDF] [Purchase Article]

Self-Organizable Flying Agent Control Architecture for Unmanned Aerial Vehicles
Kiwon Yeom
Adv. Sci. Lett. 23, 12826–12830 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Anti-Inflammatory Effects for Mobile Electronic Patient Charts Using Numerical Modeling of IoT
Deok Gyu Lee and In-Chul Lee
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Design and Implementation of an Application with File Encryption for Cloud Storage
Minseok Sohn and Yoojae Won
Adv. Sci. Lett. 23, 12835–12838 (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Table of Contents to Volume 23, Numbers 1–12, 2017
Adv. Sci. Lett. 23, xxxxx–xxxxx (2017)
[Abstract] [Full Text - PDF] [Purchase Article]

Author Index to Volume 23, Numbers 1–12, 2017
Adv. Sci. Lett. 23, xxxxx–xxxxx (2017)
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The success criteria of formal education of a student are not only determined by academic ability, but also by attitude, interest, and value that is possessed by the student. Therefore, the School Counseling Services (SCS) becomes more important part of the school, to help students to accept and understand themselves and their environments. The SCS can also drive the students to self-direct and self-adapt to the demands of their environments. By providing a good service, SCS can help students to study and reach better achievement in education, social, and their career related to their interest and their talent. The goal of this research is to develop a software to optimize process of SCS used in multi-level school at Surabaya. Software is developed based on analysis and grand design from previous research. Evaluation of Information System SCS conducted by distributing survey to all three types of users, which are: Classroom Teacher, Counseling Services Teacher, and parents. The evaluation results proves that at least 75% of users agreed that the SCS able to improve teacher performances, improve capability of collaboration, each user understand its each individual roles, and maintain communication between different users. Furthermore, SCS IS could be expanded for more better and optimum service solution. Notification and messaging system between student-parents-teacher could be added to improve integrity of system, and to minimize redundancy. Academic System and other system such as School Medical Facilities should be interconnected to improve better services. Deployment planned to be carried out by executing the old and new systems simultaneously during academic year 2015–2016 in the scope of Kindergarten, Grade 1 and 4 Elementary School. Evaluation will be conducted after one year for further development.

Keywords: Counseling Services; School Information System

Document Type: Research Article

Affiliations: Informatics Engineering Department, University of Surabaya, Raya Kalirungkut, Surabaya 60293, East Java, Indonesia

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Computer Utilization as a Balanced Opponent in Dam-Dam-An

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Dam-dam-an is a traditional game played by two players using a board with the size of 8×8 as a media. Each player gets 16 pieces that can be moved one step forward or leaped over opponent's piece. The goal of this game is to eliminate all of our pieces as soon as possible. It is exciting to have a challenging opponent, yet it is difficult to find a skillful one. A way to solve this problem is using intelligent computer. This paper presents the result of our research about the computer utilization as balanced opponent in dam-dam-an game using Alpha-Beta Pruning. Alpha-Beta Pruning is a best-step searching algorithm which works by considering and assessing every possibility while excluding the less useful steps. The implementation is developed using C# programming language based on Windows Runtime. Some features were added to make this game more exciting, particularly intelligence level selection (easy, medium, and hard), human or computer opponent selection, undo function, pausing menu, save-load the game, and setting the turning time. This game was validated by twenty respondents which were categorized based on their skill. Each respondent played against the computer thrice and the results were recorded. The results showed that the number of winning between the computer and each player are almost the same. It shows that the computer opponent may prove itself to be a challenging opponent for human player.

Keywords: Alpha-Beta Pruning; Artificial Intelligence; Dam-Dam-An; Game

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24
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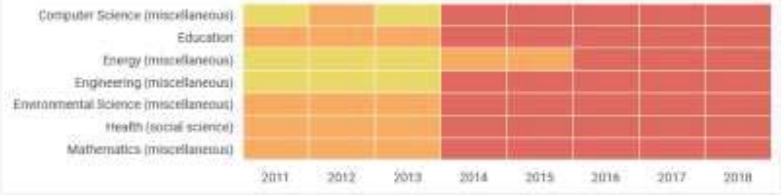

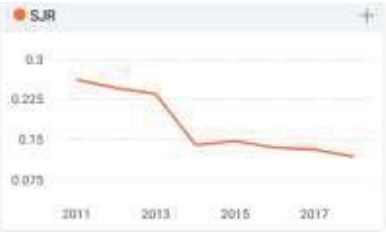
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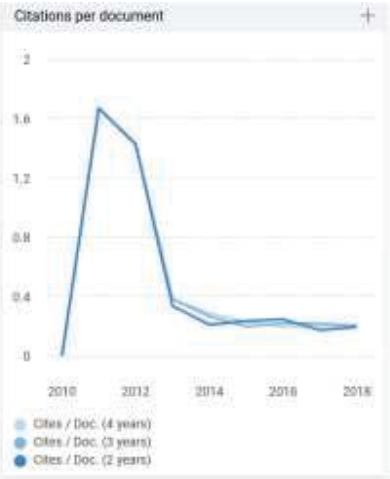
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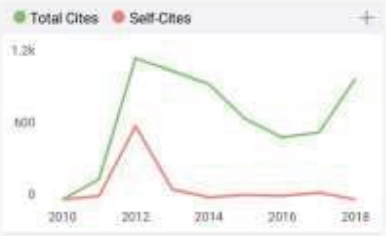
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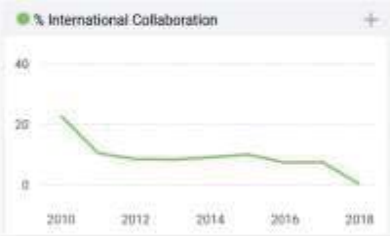
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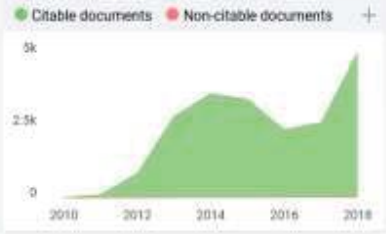
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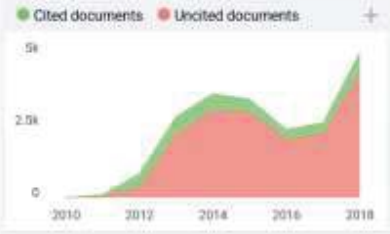
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