Journal of Quality Measurement and Analysis
Jurnal Pengukuran Kualiti dan Analisis

JQMA 8(2) 2012, 21-36

A CASE STUDY ON QUALITY OF SLEEP AND HEALTH USING BAYESIAN NETWORKS

(Suatu Kajian Kes tentang Kualiti Tidur dan Kesihatan Menggunakan Rangkaian Bayesan)

HONG CHOON ONG, CHIEW SENG LEE & CHYE CHING SIA

ABSTRACT

The objectives of this study are to investigate the associations of the socio-demographic characteristics, living habits, social and interpersonal factors and behaviour-related risk factors with both the quality of sleep and state of health. The tool used is Bayesian networks (BNs), a special case of probabilistic graphical models. The data utilised in this study is collected by employing the sample survey technique through the online network. A total of 1316 sets of data are collected with 20 variables of interest being studied. Our situation is whereby the BNs structure is unknown with full observability. A structural learning is conducted on the data to learn the correct network structure. There are several phases involved including implementation of the learning algorithms, integration of prior knowledge through the whitelist argument and arc setting to form directed acyclic graphs. The network scores computation is implemented to estimate the fitting of the resulting network of each structural learning algorithm in order to choose the best-fitted network. The arc strength or edge intensity is computed to estimate the marginal confidence on the presence of an arc. We found that the quality of sleep is dependent on certain factors in socio-demographic characteristics. The state of health is dependent on some factors in socio-demographic characteristics and living habits. We can also deduce that the quality of sleep has an impact on the state of health.

Keywords: quality of sleep; Bayesian networks; directed acyclic graphs; learning algorithms; network scores

ABSTRAK

Penyelidikan ini bertujuan untuk mengkaji hubungan antara ciri sosiodemografi, gaya hidup, faktor-faktor sosial dan interpersonal, faktor-faktor risiko berkaitan tingkah laku dengan kualiti tidur serta keadaan kesihatan. Kaedah yang digunakan dalam kajian ini adalah rangkaian Bayesan, iaitu salah satu kes khas dalam model grafik kebarangkalian. Data yang digunakan dalam kajian ini dikumpulkan dengan menggunakan teknik tinjauan sampel melalui rangkaian dalam talian. Sejumlah 1316 set data telah terkumpul dengan sebanyak 20 pemboleh ubah yang dikaji dalam projek ini. Situasi penyelidikan ini adalah struktur rangkaian Bayesan tidak diketahui dengan ketercerapan yang lengkap. Pembelajaran struktur rangkaian dijalankan ke atas data untuk mengenal pasti struktur rangkaian yang tepat. Terdapat beberapa fasa yang terlibat, termasuklah pelaksanaan al-Khwarizmi pembelajaran, integrasi pengetahuan yang sedia ada melalui hujah senarai putih dan penetapan lengkok untuk membentuk graf berarah tanpa kitaran. Pengiraan skor rangkaian dilaksanakan untuk menganggar kesesuaian rangkaian yang terhasil bagi setiap algoritma pembelajaran struktur untuk memilih rangkaian yang paling sesuai. Kekuatan atau intensiti lengkok dikira untuk menganggar keyakinan marginal atas kehadiran sesuatu lengkok. Didapati bahawa kualiti tidur adalah bersandaran pada faktor tertentu dalam ciri sosiodemografi. Keadaan kesihatan adalah bersandaran kepada beberapa faktor dalam ciri sosiodemografi dan gaya hidup. Turut disimpulkan bahawa kualiti tidur mempunyai impak ke atas keadaan kesihatan.

Kata kunci: kualiti tidur; rangkaian Bayesan; graf berarah tanpa kitaran; al-Khwarizmi pembelajaran; skor rangkaian

References

Barclay N. L., Eley T. C., Rijsdijk F. V. & Gregory A. M. 2011. Dependent negative life events and sleep quality: an examination of gene-environment interplay. *Sleep Medicine* **12**: 403-409.

Behavioral Risk Factor Surveillance System (BRFSS) Questionnaire. 2011. http://www.cdc.gov/brfss/questionnaires/pdf-ques/2011brfss.pdf (10 December 2011).

Ben-Gal I. 2007. Bayesian networks. *Encyclopedia of Statistics in Quality and Reliability,* New Jersey: John Wiley & Sons.

Cinicioglu E., Onsel S. & Ülengin F. 2012. Competitiveness analysis of automotive industry in Turkey using Bayesian networks. *Expert System with Applications* **39**: 10923-10932.

Dalstra J. A. A., Kunst A. E. & Mackenbach J. P. 2006. A comparative appraisal of the relationship of education, income and housing tenure with less than good health among the elderly in Europe. *Social Science and Medicine* **62**: 2046-2060.

Dewald J. F., Meijer A. M., Oort F. J., Kerkhof G. A. & Bögels S. M. 2010. The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescent: a meta – analytic review. *Sleep Medicine Reviews* **14**: 179-189.

Ge Y., Li C. & Yin Q. 2010. Study on factors of floating women's income in Jiangsu province based on Bayesian networks. *Adv. in Neural Network Research & Application* **67**: 819-827.

Health-Related Quality of Life Survey. 2011. https://docs.google.com/spreadsheet/embeddedform?formkey=dFhGRHU5NUhYeU9UMGQ0MHNCOWxfT0E6MQ (11 May 2012).

Health System Performance Assessment. 2003. http://www.who.int/healthinfo/survey/whs_hspa_book.pdf (10 December 2011).

Henderson R. M. 2005. The bigger the healthier: are the limits of BMI risk changing overtime? *Economics and Human Biology* **3**: 339-366.

Krystal A. D. & Edinger J. D. 2008. Measuring sleep quality. *Sleep Medicine* **9 Suppl. 1**: S10-S17.

Larose D. T. 2006. *Data Mining Methods and Models*. New Jersey: John Wiley & Sons Inc.

Lee T. 2006. *Sleep: A Comprehensive Handbook*. New Jersey: John Wiley & Sons Inc.

Oliveira M. A., Possamai O., Valentina L. V. O. D. & Flesch C. A. 2012. Applying Bayesian networks to performance forecast of innovation projects: a case study of transformational leadership influence in organizations oriented by projects. *Expert System with Applications* **39**: 5061-5070.

Pourret O. 2008. Introduction to Bayesian networks. In Pourret O., Naim P. & Marcot B. (eds.). *Bayesian Networks: A Practical Guide to Applications:* 1-13. West Sussex: John Wiley & Sons Ltd.

Scutari M. 2010. Learning Bayesian networks with the bnlearn R package. *Journal of Statistical Software* **35** (3).

Scutari M. 2011a. bnlearn-an R package for Bayesian network learning and inference. http://www.bnlearn.com/ (10 December 2011).

Scutari M. 2011b. Measures of variability for graphical models. PhD Thesis. University of Padova.

Strine T. W. & Chapman D. P. 2005. Associations of frequent sleep insufficiency with health-related quality of life and health behaviors. *Sleep Medicine* **6**: 23-27.

Troxel W. M., Robles T. F., Hall M. & Buysse D. J. 2007. Marital quality and the marital bed: examining the covariation between relationship quality and sleep. *Sleep Medicine Reviews* **11**: 389-404.

Weiss G. L. & Lonnquist L. E. 2003. *The Sociology of Health, Healing, and Illness*. 4th Ed. New Jersey: Pearson Education Inc.

Witten I. H. & Frank E. 2005. *Data Mining: Practical Machine Learning Tools and Techniques*. 2nd Ed. San Francisco: Morgan Kaufmann Publishers.

World Health Organization. 2003. WHO definition of health. http://www.who.int/about/definition/en/print.html (30 April 2012).

School of Mathematical Sciences
Universiti Sains Malaysia
11800 USM Penang
MALAYSIA
E-mail: hcong@cs.usm.my, lcs105904@student.usm.my, c.ching_89@hotmail.com*

* *Corresponding author*