# Erasmus University Rotterdam CSC PhD 2013

## Project Description

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| ***School/Department:*** | Biomedical Imaging Group Rotterdam (BIGR) ([www.bigr.nl](http://www.bigr.nl))  Erasmus University Medical Center, Rotterdam, The Netherlands |
| ***Project Title:*** | **MR brain image analysis** |
| ***Requirements of candidate:*** | You should have a Master's degree in physics, electrical engineering, mathematics, biomedical engineering, computer science, or a related field. Experience with biomedical image analysis and/or machine learning is an advantage. You should be familiar with programming. You should be able to work in a multi-disciplinary team. Strong theoretical skills and affinity with experimental work are required.  *Compulsory EUR requirement for English test:*  *IELTS score 7.0 or higher (min. 6.0 for all sub scores)*  *or*  *TOEFL score 100 or higher (min. 20 for all sub scores)* |
| ***Supervisor information:*** | Ass Prof. dr. Marleen de Bruijne  Email: [marleen.debruijne@erasmusmc.nl](mailto:marleen.debruijne@erasmusmc.nl)  Marleen de Bruijne is an associate professor in medical image analysis both at the Erasmus MC, Rotterdam, The Netherlands and at the Department of Computer Science, University of Copenhagen, Denmark. She leads the "Model-based Medical Image Analysis" research group in which she develops novel techniques for quantitative analysis of medical images, with a focus on large scale image-based studies. Her research interests include shape analysis, model based segmentation, and pattern recognition approaches in a variety of applications.  Dr. de Bruijne (co)authored over 100 peer-reviewed full papers in international conference proceedings and journals and 17 patent applications (2 granted), and co-edited 4 books. She currently supervises 7 PhD students and 2 postdocs and has (co)supervised 6 PhD students who graduated in the last 5 years. She is a member of the Program Committee of over 25 international conferences including the two primary conferences in the field - SPIE Medical Imaging and MICCAI. She is also an editorial board member of Medical Image Analysis.  An extended CV and publication list are available from <http://image.diku.dk/marleen/>  Recent publications:  P. Lo, B. van Ginneken, J.M. Reinhardt, Tarunashree Y., P.A. de Jong, B. Irving, C. Fetita, M. Ortner, R. Pinho, J. Sijbers, M. Feuerstein, A. Fabijanska, C. Bauer, , R. Beichel, C. S. Mendoza, R. Wiemker, J. Lee, A. P. Reeves, S. Born, O. Weinheimer, E. M. van Rikxoort, J. Tschirren, K. Mori, B. Odry, D.P. Naidich, I. Hartmann, E.A. Hoffman, M. Prokop, J.H. Pedersen, and M. de Bruijne. Extraction of airways from CT (EXACT’09). IEEE Transactions on Medical Imaging, 31(11):2093-2107, 2012. [ [link](http://dx.doi.org/10.1109/TMI.2012.2209674) | [pdf](http://image.diku.dk/marleen/papers/Lo_TMI12.pdf) | [Abstract](http://image.diku.dk/marleen/deBruijne_Publications_abstracts.php#Lo12) ]    Fan Liu, Fedde van der Lijn, Claudia Schurmann, Gu Zhu, M. Mallar Chakravarty, Pirro G. Hysi, Andreas Wollstein, Oscar Lao, Marleen de Bruijne, M. Arfan Ikram, Aad van der Lugt, Fernando Rivadeneira, Andre. Uitterlinden, Albert Hofman, Wiro J. Niessen, Georg Homuth, Greig de Zubicaray, Katie L. McMahon, Paul M. Thompson, Amro Daboul, Ralf Puls, Katrin Hegenscheid, Liisa Bevan, Zdenka Pausova, Sarah E. Medland, Grant W. Montgomery, Margaret J. Wright, Carol Wicking, Stefan Boehringer, Timothy D. Spector, Tomas Paus, Nicholas G. Martin, Reiner Biffar, and Manfred Kayser. A genome-wide association study identifies five loci influencing facial morphology in europeans. PLoS Genetics, 8(9):e1002932, 2012. [ [link](http://dx.doi.org/10.1371%2Fjournal.pgen.1002932) | [Abstract](http://image.diku.dk/marleen/deBruijne_Publications_abstracts.php#Liu12) ]    N. Baka, M. de Bruijne, T. van Walsum, B.L. Kaptein, J.E. Giphart, M. Schaap, W.J. Niessen, and B.P.F. Lelieveldt. Statistical shape model based femur kinematics from bi-plane fluoroscopy. IEEE Transactions on Medical Imaging, 31(8), 2012. [ [link](http://dx.doi.org/10.1109/TMI.2012.2195783) | [Abstract](http://image.diku.dk/marleen/deBruijne_Publications_abstracts.php#Baka12) ]    X. Wang, T. Heimann, P. Lo, M. Sumkauskaite, M. Puderbach, M. de Bruijne, H.-P. Meinzer, and I. Wegner. Statistical tracking of tree-like tubular structures with efficient branching detection in 3D medical image data. Physics in Medicine and Biology, 57(16):5325-42, 2012. [ [link](http://dx.doi.org/10.1088/0031-9155/57/16/5325) | [Abstract](http://image.diku.dk/marleen/deBruijne_Publications_abstracts.php#Wang12) ]    M. Ganz, M de Bruijne, E. Dam, P. Pettersen, M. Karsdal, C. Christiansen, and M Nielsen. Distribution, size, and shape of abdominal aortic calcified deposits and their relationship to mortality in postmenopausal women. International Journal of Biomedical Imaging, 2012. [ [link](http://dx.doi.org/10.1155/2012/459286) | [Abstract](http://image.diku.dk/marleen/deBruijne_Publications_abstracts.php#Ganz12) ]    C.T. Metz, N. Baka, H. Kirisli, , M. Schaap, S. Klein, L.A. Neefjes, N.R. Mollet, B. Lelieveldt, M. de Bruijne, W.J. Niessen, and T. van Walsum. Regression-based cardiac motion prediction from single-phase cta. IEEE Transactions on Medical Imaging, 31(6), 2012. [ [link](http://dx.doi.org/10.1109/TMI.2012.2190938) | [Abstract](http://image.diku.dk/marleen/deBruijne_Publications_abstracts.php#Metz10a) ]    V. Gorbunova, J. Sporring, P. Lo, M. Loeve, H. Tiddens, M Nielsen, A. Dirksen, and M de Bruijne. Mass preserving image registration for lung CT. Medical Image Analysis, 16(4):786 - 795, 2012. [ [link](http://dx.doi.org/10.1016/j.media.2011.11.001) | [pdf](http://image.diku.dk/marleen/papers/Gorbunova_MEDIA12.pdf) | [Abstract](http://image.diku.dk/marleen/deBruijne_Publications_abstracts.php#Gorbunova11) ]    M. Loeve, M. de Bruijne, I.C.J. Hartmann, M. van Straten, W.C.J. Hop, and H.A.W.M. Tiddens. Three-section expiratory CT: Insufficient for trapped air assessment in patients with cystic fibrosis? Radiology, 262(3):969-976, 2012. [ [link](http://dx.doi.org/10.1148/radiol.11110966) | [Abstract](http://image.diku.dk/marleen/deBruijne_Publications_abstracts.php#Loeve11c) ]    M. Loeve, W.C.J. Hop, M. de Bruijne, P.Th.W. van Hal, P. Robinson, M.L. Aitken, J.D. Dodd, H.A.W.M. Tiddens, and on behalf of the Computed Tomography Cystic Fibrosis Survival study group. Chest computed tomography scores are predictive of survival in CF patients awaiting lung transplantation. American Journal of Respiratory and Critical Care Medicine, 2012. [ [link](http://ajrccm.atsjournals.org/content/early/2012/03/07/rccm.201111-2065OC.abstract) | [Abstract](http://image.diku.dk/marleen/deBruijne_Publications_abstracts.php#Loeve12a) ]    K. Murphy, J.P.W. Pluim, E.M. van Rikxoort, P.A. de Jong, B. de Hoop, H.A. Gietema, O. Mets, M. de Bruijne, P. Lo, M. Prokop, and B. van Ginneken. Toward automatic regional analysis of pulmonary function using inspiration and expiration thoracic CT. Medical Physics, 39(3):1650-1662, 2012. [ [link](http://link.aip.org/link/?MPH/39/1650/1) | [Abstract](http://image.diku.dk/marleen/deBruijne_Publications_abstracts.php#Murphy12) ]    S.B. Shaker, A. Dirksen, P. Lo, L.T. Skovgaard, M. de Bruijne, and J.H. Pedersen. Factors influencing decline in lung density in a Danish lung cancer screening cohort. European Respiratory Journal, 2012. [ [link](http://erj.ersjournals.com/content/early/2012/03/08/09031936.00207911.abstract) | [Abstract](http://image.diku.dk/marleen/deBruijne_Publications_abstracts.php#Shaker12a) ]    F. van der Lijn, M. de Bruijne, S. Klein, T. den Heijer, Y.Y. Hoogendam, A. van der Lugt, M.M.B. Breteler, and W.J. Niessen. Automated brain structure segmentation based on atlas registration and appearance models. IEEE Transactions on Medical Imaging, 31(2):276 - 286, 2012. [ [link](http://dx.doi.org/10.1109/TMI.2011.2168420) | [pdf](http://image.diku.dk/marleen/papers/vanderLijn_TMI12.pdf) | [Abstract](http://image.diku.dk/marleen/deBruijne_Publications_abstracts.php#Lijn11) ]    F. van der Lijn, B.F.J. Verhaaren, M.A. Ikram, S. Klein, M. de Bruijne, H.A. Vrooman, M.W. Vernooij, A. Hammers, D. Rueckert, A. van der Lugt, M.M.B. Breteler, and W.J. Niessen. Automated measurement of local white matter lesion volume. NeuroImage, 59(4):3901-3908, 2012. [ [link](http://dx.doi.org/10.1016/j.neuroimage.2011.11.021) | [Abstract](http://image.diku.dk/marleen/deBruijne_Publications_abstracts.php#Lijn11a) ] |
| ***Department information:*** | The Biomedical Imaging Group Rotterdam is part of the departments of Medical Informatics and Radiology of the Erasmus MC - University Medical Center Rotterdam, The Netherlands. The group develops and validates novel image analysis techniques for biomedical applications and is internationally at the forefront of biomedical imaging.  We offer a dynamic, challenging, and cooperative research environment. The group currently consists of 28 PhD students, 6 postdocs, and 7 staff members, all working in biomedical image analysis. We have excellent access to large scale imaging studies (clinical, epidemiological, biological) and we collaborate closely with clinical experts from different departments within the Erasmus MC. |
| MR images of the brain reveal evidence of neurological disorders already before clinical symptoms appear. For instance, some brain structures are slightly smaller in people who will develop dementia later on. Such image based markers are of enormous importance for early diagnosis and may lead to improved treatment in an early stage.  Erasmus MC performs a large scale image based study of the aging brain to investigate the complex neurodegenerative patterns involved in the development of dementia as well as in normal aging. Within this study, multi-sequence MR brain data of approximately 5500 participants is collected at intervals of three years. In addition, a large set of multimodal brain scans of young children is currently collected to study factors determining brain development.  In this PhD project you will develop model based segmentation techniques to automatically analyze brain structures and lesions in these databases, and you will use machine learning techniques to derive image markers, related to the shape, size, and appearance of brain structures, that can help in recognizing different disorders such as Alzheimer's disease.  We suggest the following topics to work on within this PhD project, but you are welcome to define related topics yourself in your proposal.   1. Automatic detection of microbleeds   Microbleeds are small bleedings in the brain which are associated with a higher risk on brain disorders and which are visible as dark spots on some MR sequences (Fig 1). A dataset of several hundreds of MR scans with manually annotated microbleeds is available to develop, train, and evaluate a computer aided detection system. The successful microbleed detection system will be applied in epidemiological studies as well as in the dementia clinic.   1. Segmentation of brain structures   Several studies measuring e.g. the volume of different brain structures have relied on manual segmentations (Fig 2), but large scale studies require automated analysis. We have previously developed a technique for automatic segmentation of one of the brain structures, the hippocampus (Fig 3). This technique should be extended to cope with multiple different structures.   1. Shape analysis of brain structures   We have already developed and evaluated methods for hippocampus shape analysis (Fig 4), which were shown to detect dementia in an earlier stage than does hippocampal volume. Techniques to simultaneously analyze a number of structures need to be developed.   1. Changes over time   We will use image registration to accurately measure changes as a result of disease progression, aging, or growth, based on scans taken from the same person at different points in time.   1. Analysis across scanners   Most current analysis methods are dependent on the scanner protocol and therefore give unreliable results if data acquired with different scanner models or protocols is compared. We will develop new techniques that are invariant to differences in scanner protocol.  Techniques used in this project: Image segmentation, pattern recognition, machine learning, image registration.   |  |  | | --- | --- | | MB | brain_hammers_atlas_frame_0044 | | Fig1. Microbleeds. Shown are two MR images from the same patient, with on the left potential microbleeds detected by image enhancement (red) and true positives (yellow box). | Fig2. Manual segmentation of a large number of brain structures. | | hippo | density-map_meike | | Fig3. Hippocampus segmentation. | Fig 4. Hippocampus shape analysis | | |