# 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:*** | **Computer aided diagnosis of lung diseases from CT imaging** |
| ***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. |
| Accurate and reproducible quantification of abnormalities in lung images is crucial to improve our understanding of the factors involved in development and progression of lung diseases, to assess the effect of treatment, and to recognize problems as early as possible and determine prognosis in individual patients. For this, automated image analysis is required, which is especially challenging in lung images because of the large deformations that occur during breathing.  Pulmonary image analysis at BIGR focuses on measuring structural lung damage in patients with cystic fibrosis (CF) - both in very early and in advanced stages - and on quantifying chronic obstructive pulmonary disease (smoker's lung, COPD) from CT images.  We suggest the following topics to work on within this PhD project, but you may also define related topics yourself.   1. Analysis of the airways   Untreated lung disease can lead to irreversible damage to the airways, which can be seen e.g. as a widening of the airway lumen or thickening of the wall. To detect this in an early stage, segmentation of the airways and of the neighboring vessels is needed. Some approaches exist, but these are not able to segment the smaller airways or airways with severe abnormalities and should therefore be improved (Fig 1). In addition, we need to develop strategies to compensate for the effect of differences in amount of inhaled air in the lungs on the derived airway measures.   1. Segmenting areas with trapped air   Air trapping, where parts of the air in the lung cannot be exhaled properly, is a sign of airway obstruction (Fig 2). We would like to measure the size and shapes of regions of trapped air, and investigate how they change over time.   1. Texture classification   Different lung abnormalities show a distinctive texture in the image (Fig3). Classifying the different textures can help detect and quantify lung disease. For this purpose, popular texture segmentation techniques from Computer Vision such as the `bag of words’ approach can be used.   1. Changes over time   To detect the onset or progression of lung disease, we should be able to measure local changes in airways, trapped air, and lung texture. Robust image registration methods need to be developed for this purpose. Methods need to be able to both cope with appearance changes caused by disease and compensate for large deformations caused by breathing.   1. CT versus MRI   Currently, CT is the most sensitive method to detect lung abnormalities. However, because of the radiation applied in CT imaging MRI is sometimes preferred, especially in dynamic imaging, in young children, or if a patient should be imaged frequently. At Erasmus MC we therefore investigate lung MRI as a safe alternative to lung CT. We followed a group of patients with both CT and MRI, which provides a perfect database to develop algorithms for analysis of lung MRI and to investigate the value of MRI compared to CT.  Techniques used in this project: Image segmentation, texture analysis, pattern recognition, image registration.   |  |  | | --- | --- | | airwaylung_3D | airtrapping | | Fig1. Airway segmentation. | Fig2. Trapped air is visible as darker regions in the lung tissue. | | mrace_illus_2010 | | | Fig 3. A CT scan of a patient with cystic fibrosis (left). Two years later, the disease has progressed and more abnormalities are visible (right). | | | |