How does 6 months of active bike commuting or leisure-time exercise affect insulin sensitivity, cardiorespiratory fitness and intra-abdominal fat? A randomised controlled trial in individuals with overweight and obesity

Objectives: To evaluate effects of active bike commuting or leisure-time exercise of two intensities on peripheral insulin sensitivity (primary outcome), cardiorespiratory fitness and intra-abdominal adipose tissue mass (secondary outcomes).

Methods: 188 physically inactive, healthy women and men (20-45 years) with overweight or class 1 obesity were recruited. In the 6-month trial, 130 participants were randomised to either: no intervention (CON), active commuting (BIKE) or leisure-time exercise of moderate (MOD, 50% VO₂peak) or vigorous (VIG, 70% VO₂peak) intensity. 100 completed follow-up testing. Exercise prescription was 5 days/week with a weekly exercise energy expenditure of 1600 kcal for women and 2100 kcal for men. Testing was performed at baseline, 3 months and 6 months. Results: Peripheral insulin sensitivity (ml/min/pmol insulin/L) increased (improved) by 24% (95% CI 6% to 46%, p=0.01) in VIG compared with CON at 3 months. Peripheral insulin sensitivity increased (improved) by 20% in BIKE (95% CI 1% to 43%, p=0.04) and 26% in VIG (95% CI 7% to 47%, p<0.01) compared with CON at 6 months. Cardiorespiratory fitness increased in all exercise groups compared with CON at 6 months; but the increase was higher in those that undertook vigorous exercise than those who did moderate exercise. Intra-abdominal adipose tissue mass diminished across all exercise groups in comparison to CON at 6 months. Conclusions: Active bike commuting improved cardiometabolic health; as did leisure-time exercise. Leisure-time exercise of vigorous intensity conferred more rapid effects on peripheral insulin sensitivity as well as additional effects on cardiorespiratory fitness than did moderate intensity exercise. Trial registration: NCT01962259

General information
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Organisations: Centre for oil and gas – DTU, Image Analysis & Computer Graphics, Department of Applied Mathematics and Computer Science, University of Copenhagen
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Wind Turbine Surface Damage Detection by Deep Learning Aided Drone Inspection Analysis

Timely detection of surface damages on wind turbine blades is imperative for minimizing downtime and avoiding possible catastrophic structural failures. With recent advances in drone technology, a large number of high-resolution images of wind turbines are routinely acquired and subsequently analyzed by experts to identify imminent damages. Automated analysis of these inspection images with the help of machine learning algorithms can reduce the inspection cost. In this work, we develop a deep learning-based automated damage suggestion system for subsequent analysis of drone inspection images. Experimental results demonstrate that the proposed approach can achieve almost human-level precision in terms of suggested damage location and types on wind turbine blades. We further demonstrate that for relatively small training sets, advanced data augmentation during deep learning training can better generalize the trained model, providing a significant gain in precision.

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A 16-Week Aerobic Exercise Intervention Does Not Affect Hippocampal Volume and Cortical Thickness in Mild to Moderate Alzheimer's Disease

Introduction: Brain imaging studies in healthy elderly subjects suggest a positive effect of aerobic exercise on both brain structure and function, while the effects of aerobic exercise in Alzheimer's Disease (AD) has been scarcely investigated. Methods: In a single-blinded randomized MRI study, we assessed the effects of an aerobic exercise intervention on brain volume as measured by magnetic resonance imaging (MRI) and its correlation to cognitive functioning in patients with AD. The study was a sub-study of a larger randomized controlled trial (ADEX study). Forty-one patients were assigned to a control or exercise group. The exercise group performed 60-min of aerobic exercise three times per week for 16 weeks. All participants underwent whole-brain MRI at 3 Tesla and cognitive assessment at baseline and after 16 weeks. Attendance and intensity were monitored providing a total exercise load. Changes in regional brain
volumes and cortical thickness were analyzed using Freesurfer software. Results: There was no effect of the type of intervention on MRI-derived brain volumes. In the entire group with and without training, Exercise load showed a positive correlation with changes in volume in the hippocampus, as well as frontal cortical thickness. Volume changes in frontal cortical thickness correlated with changes in measures of mental speed and attention and exercise load in the exercise group. Conclusion: We did not find evidence to support an effect of 16 weeks of aerobic exercise on brain volume changes in patients with AD. Longer intervention periods may be needed to affect brain structure as measured with volumetric MRI.
healthy, normal-weight, late premenopausal (n=21), and early postmenopausal (n=20) women were included in a 3-month high-intensity exercise training intervention. Body composition was assessed by magnetic resonance imaging and dual-energy x-ray absorptiometry, whole body glucose disposal rate (GDR) by hyperinsulenic euglycemic clamp (40 mU/m/min), and femoral muscle glucose uptake by positron emission tomography/computed tomography, using the glucose analog fluorodeoxyglucose, expressed as estimated metabolic rate (eMR). Insulin signaling was investigated in muscle biopsies. Age difference between groups was 4.5 years, and no difference was observed in body composition. Training increased lean body mass (estimate [95% confidence interval] 0.5 [0.2-0.9] kg, P

**General information**

Publication status: Published
Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, University of Copenhagen
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**Publication information**

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ISSN (Print): 1072-3714

**Anthropometry, DXA and leptin reflect subcutaneous but not visceral abdominal adipose tissue by MRI in 197 healthy adolescents**

Background Abdominal fat distribution is associated with the development of cardio-metabolic disease independently of body mass index (BMI). We assessed anthropometry, serum adipokines, and DXA as markers of abdominal subcutaneous adipose tissue (SAT) and visceral adipose tissue (VAT) using magnetic resonance imaging (MRI). We performed a cross-sectional study that included 197 healthy adolescents (114 boys) aged 10–15 years nested within a longitudinal population-based cohort. Clinical examination, blood sampling, DXA, and abdominal MRI were performed. SAT% and VAT% were adjusted to total abdominal volume. Results Girls had a higher SAT% than did boys in early and late puberty (16 vs. 13%, P<0.01 and 20 vs. 15%, P=0.001, respectively), whereas VAT% was comparable (7% in both genders, independently of puberty). DXA android fat% (standard deviation score (SDS)), suprailiac skinfold thickness (SDS), leptin, BMI (SDS), waist-to-height ratio (WHtR), and waist circumference (SDS) correlated strongly with SAT% (descending order: r=0.90–0.55, all P<0.001) but weakly with VAT% (r=0.49–0.06). Suprailiac skinfold was the best anthropometric marker of SAT% (girls: R2=48.6%, boys: R2=65%, P<0.001) and VAT% in boys (R2=16.4%, P<0.001). WHtR was the best marker of VAT% in girls (R2=7.6%, P=0.007). Conclusions Healthy girls have a higher SAT% than do boys, whereas VAT% is comparable, independently of puberty. Anthropometry and circulating leptin are valid markers of SAT%, but not of VAT%.

**General information**

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Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, University of Copenhagen
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**Publication information**

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Automatic Segmentation of Abdominal Fat in MRI-Scans, Using Graph-Cuts and Image Derived Energies

For many clinical studies changes in the abdominal distribution of fat is an important measure. However, the segmentation of abdominal fat in MRI scans is both difficult and time consuming using manual methods. We present here an automatic and flexible software package, that performs both bias field correction and segmentation of the fat into superficial and deep subcutaneous fat as well as visceral fat with the spinal compartment removed. Assessment when comparing to the gold standard - CT-scans - shows a correlation and bias comparable to manual segmentation. The method is flexible by tuning the image-derived energies used for the segmentation, allowing the method to be applied to other body parts, such as the thighs.

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Keywords: Computer Science, Image Processing and Computer Vision, Pattern Recognition, Artificial Intelligence (incl. Robotics), Computer Graphics, Data Mining and Knowledge Discovery
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MR spectroscopy of hepatic fat and adiponectin and leptin levels during testosterone therapy in type 2 diabetes: a randomized, double-blinded, placebo-controlled trial

Men with type 2 diabetes mellitus (T2D) often have lowered testosterone levels and an increased risk of cardiovascular disease (CVD). Ectopic fat increases the risk of CVD, whereas subcutaneous gluteofemoral fat protects against CVD and has a beneficial adipokine-secreting profile. Testosterone replacement therapy (TRT) may reduce the content of ectopic fat and improve the adipokine profile in men with T2D. A randomized, double-blinded, placebo-controlled study in 39 men aged 50-70 years with T2D and bioavailable testosterone levels

General information
Publication status: Published
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Porosity variability in chalk and the scale of variations

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Organisations: Centre for oil and gas – DTU, Image Analysis & Computer Graphics, Department of Applied Mathematics and Computer Science, Geological Survey of Denmark and Greenland
Contributors: Frykman, P., Christensen, A. N.
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Peer-reviewed: Yes
Event: Abstract from Danish Hydrocarbon Research and Technology Centre Technology Conference 2017, Lyngby, Denmark.

Data Analysis of Medical Images: CT, MRI, Phase Contrast X-ray and PET
Data analysis of medical images is an important and growing area, as systems for imaging becomes still more available and complex.

The goal of the thesis is to demonstrate solutions to data analysis problems in a cross disciplinary context. Further, to develop methods for analysis of new imaging modalities and to combine cross disciplinary knowledge from various fields to find new solutions to existing problems.

More specifically the thesis shows segmentation of images, classification and statistics used on a variety of quite different problems. Active Appearance models, Chan-Vese and graph-cut has been used, as well as a variety of statistical tools centred on the General Linear Model.

The point of departure for the thesis is the NanoGuide project, in which gel based x-ray markers for use in radiotherapy has been developed. Two different types of gels has been analysed using segmentation of micro-CT images followed by a statistical analysis of homogeneity, contrast, degradation, and other qualities. By combining knowledge from the different professions in the project, a new application for one of the developed gels - in-vivo dosimetry in radiotherapy - has been studied.

Analysis of differences between groups and of correlations between brain regions and cognitive tests in alzheimers patients is another contribution. Segmentation of fat in abdominal MRI-scans has also been studied and a robust algorithm based on graph-cut is presented.

A relatively new modality phase-contrast x-ray and dark-field has shown promise for diagnosis of a variety of diseases in the lungs. A classification algorithm for differentiation of healthy, emphysematous and fibrotic lung tissue on pixel level is presented.

General information
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Injectable silver nanosensors: in vivo dosimetry for external beam radiotherapy using positron emission tomography

Development of safe and efficient radiotherapy routines requires quantification of the delivered absorbed dose to the cancer tissue in individual patients. In vivo dosimetry can provide accurate information about the absorbed dose delivered during treatment. In the current study, a novel silver-nanosensor formulation based on poly(vinylpyrrolidinone)-coated silver nanoparticles formulated in a gelation matrix composed of sucrose acetate isobutyrate has been developed for use as an in vivo dosimeter for external beam radiotherapy. In situ photonuclear reactions trigger the formation of radioactive (106)Ag, which enables post treatment verification of the delivered dose using positron emission tomography imaging. The silver-nanosensor was investigated in a tissue equivalent thorax phantom using clinical settings and workflow for both standard fractionated radiotherapy (2 Gy) and stereotactic radiotherapy (10- and 22 Gy) in a high-energy beam setting (18 MV). The developed silver-nanosensor provided high radiopacity on the planning CT-scans sufficient for patient positioning in image-guided radiotherapy and provided dosimetric information about the absorbed dose with a 10% and 8% standard deviation for the stereotactic regimens, 10 and 22 Gy, respectively.

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Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Department of Micro- and Nanotechnology, Colloids and Biological Interfaces, University of Copenhagen, Copenhagen University Hospital, Technical University of Denmark
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Web of Science (2016): Impact factor 7.367
Web of Science (2016): Indexed yes
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Source: FindIt
Source-ID: 2303886910
Research output: Contribution to journal › Journal article – Annual report year: 2016 › Research › peer-review

A new self-made digital slide scanner and microscope for imaging and quantification of fluorescent microspheres
Objective: A low-cost microscope slide scanner was constructed for the purpose of digital imaging of newborn piglet brain tissue and to quantify fluorescent microspheres in tissue. Methods: Using a standard digital single-lens reflex (DSLR) camera, fluorescent imaging of newborn piglet brain tissue was performed. A computer algorithm available for download was created to detect fluorescent microspheres in the brain tissue slides and to calculate regional cerebral blood flow (rCBF). The precision of the algorithm was tested by comparing with manual counting of the fluorescent microspheres. Finally, bright-field imaging was tested by adding light diffuser film. Results: Cost of the slide scanner was a fraction of the cost of a commercial slide scanner. The slide scanner was able to image a large number of tissue slides in a semiautomatic manner and provided a large field of view (FOV) of 101 mm2 combined with a resolution of 2.9 μm. The
mean difference (SD) between manual and automatic counts was in absolute numbers 0.32 (1.5) microspheres ranging from -5 to 5 microspheres per slide. The relative total difference between automatic and manual counts was -3.1%.

Conclusions: A slide scanner was constructed and an automatic algorithm to detect fluorescent microspheres in tissue was developed and validated and showed an acceptable difference to “gold standard” manual counting. The slide scanner can be regarded as a low-cost alternative for researchers when digital slide imaging and quantification of fluorescent microspheres are needed.

**General information**

Publication status: Published
Organisations: Department of Photonics Engineering, Diode Lasers and LED Systems, Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, University of Copenhagen, Copenhagen University Hospital
Contributors: Henning, W., Bjerglund Andersen, J., Højgaard, L., Greisen, G., Law, I., Thorseth, A., Christensen, A. N.
Pages: 33-39
Publication date: 2015
Peer-reviewed: Yes

**Publication information**

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Volume: 5
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ISSN (Print): 1925-4008

**Injectable Colloidal Gold for Use in Intrafractional 2D Image-Guided Radiation Therapy**

In the western world, approximately 50% of all cancer patients receive radiotherapy alone or in combination with surgery or chemotherapy. Image-guided radiotherapy (IGRT) has in recent years been introduced to enhance precision of the delivery of radiation dose to tumor tissue. Fiducial markers are often inserted inside the tumor to improve IGRT precision and enable monitoring of the tumor position during radiation therapy. In the present article, a liquid fiducial tissue marker is presented, which can be injected into tumor tissue using thin and flexible needles. The liquid fiducial has high radio-opacity, which allows for marker-based image guidance in 2D and 3D X-ray imaging during radiation therapy. This is achieved by surface-engineering gold nanoparticles to be highly compatible with a carbohydrate-based gelation matrix. The new fiducial marker is investigated in mice where it is highly biocompatible and stable after implantation. To investigate the clinical potential, a study is conducted in a canine cancer patient with spontaneously developed solid tumor in which the marker is successfully injected and used to align and image-guide radiation treatment of the canine patient. It is concluded that the new fiducial marker has highly interesting properties that warrant investigations in cancer patients.

**General information**

Publication status: Published
Organisations: Department of Micro- and Nanotechnology, Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Colloids and Biological Interfaces, Department of Chemistry, Organic Chemistry, University of Copenhagen, Copenhagen University Hospital
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**Publication information**

Journal: Advanced Healthcare Materials
Volume: 4
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ISSN (Print): 2192-2640
Calibrated image-derived input functions for the determination of the metabolic uptake rate of glucose with \([18F]\)-FDG PET

We investigated the use of a simple calibration method to remove bias in previously proposed approaches to image-derived input functions (IDIFs) when used to calculate the metabolic uptake rate of glucose \(K_m\) from dynamic \([18F]\)-FDG PET scans of the thigh. Our objective was to obtain nonbiased, low-variance \(K_m\) values without blood sampling.

Commentary to 'Application of calibrated image-derived input function to a clinical protocol'.

General information
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Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Copenhagen University Hospital, University of Copenhagen
Contributors: Christensen, A. N.
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PET and PET/CT Physics

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Contributors: Christensen, A. N.
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Pub1642web_16821314.pdf
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Source-ID: 112094307
Research output: Chapter in Book/Report/Conference proceeding

Validation of a new technique to estimate regional cerebral blood flow in piglets using fluorescent microspheres

**General information**
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Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Copenhagen University Hospital
Contributors: Henning, W., Andersen, J., Christensen, A. N., Greisen, G., Liselotte, H., Law, I.
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Web of Science (2014): Impact factor 6.16
Web of Science (2014): Indexed yes
Original language: English

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Source: PublicationPreSubmission
Differential effects of aerobic exercise on insulin-stimulated glucose uptake in skeletal muscle and adipose tissue examined with PET/CT

General information
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Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, University of Copenhagen, Copenhagen University Hospital
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Peer-reviewed: Yes

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Web of Science (2013): Indexed yes
Original language: English

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Musculoskeletal I: PET & Experimental Imaging, Abstract No. 255
Source: PublicationPreSubmission
Source-ID: 101790542
Research output: Contribution to journal › Conference abstract in journal – Annual report year: 2014 › Research › peer-review

Non-invasive Estimation of Metabolic Uptake Rate of Glucose using F18-FDG PET and Linear Transformation of Outputs
For quantitative analysis and kinetic modeling of dynamic PET-data an input function is needed. Normally this is obtained by arterial blood sampling, potentially an unpleasant experience for the patient and laborious for the staff. Aim: To validate methods for determination of the metabolic uptake rate (Km) of glucose from dynamic FDG-PET scans using Image Derived Input Functions (IDIF) without blood sampling. Method: We performed 24 dynamic FDG-PET scans of the thigh of 14 healthy young male volunteers during a hyperinsulinemic isoglycemic clamp. Ten of the subjects were scanned twice 11 weeks apart and all with concurrent Arterial Blood Sampling (ABS). We proceeded to evaluate different earlier proposed methods as well as several new ones based on Archetypal Analysis for generating IDIFs. Comparison of the methods was based on the sets of Km-values generated for each scan from Patlak plots based on one common tissue curve against all the IDIFs. When compared to ABS Km values, an underestimation was found for all methods. Using ordinary least squares estimation on the ABS Km values vs. the IDIF Km a calibration factor and term was identified for each method and used for transformation. The Mean Squared Error (MSE) was determined for the different methods before transformation, and estimated by N-fold cross validation and .632+ bootstrapping after transformation. Further, since ordinary least squares is an unbiased estimator we could use the estimated MSE to determine the standard deviation of the different unbiased methods after transformation using the relation MSE(θ) = variance(θ)+bias(θ)^2.
Results: All methods performed poorly before transformation, except one described by Backes et al.. After transformation all methods yields unbiased Km based on the IDIF alone but have different standard deviations with the best method- Parker and Feng- at 0.0030 i. e. around 10 %. Conclusion: Based on this study, we can estimate the metabolic uptake rate of glucose with good accuracy and precision in similar future studies without blood sampling. Given the high variance of the femoral artery diameter in the material, the method should also be applicable to women and people of other ages, but used with caution in the elderly due to variance in intramuscular adipose distribution. If only Km and no other kinetic parameters are needed, the described method with transformation of the results based on ordinary least squares, gives unbiased low variance results without arterial blood sampling and it has the potential for use in other regions of the body.

General information
Publication status: Published
Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics, Copenhagen University Hospital, University of Copenhagen
Projects:

**Deep learning methods for otoscopy and wideband tympanometry for the diagnosis of otitis media with effusion and acute otitis media**
Sundgaard, J. V., PhD Student, Department of Mathematics
Paulsen, R. R., Main Supervisor
Christensen, A. N., Supervisor
Harte, J., Supervisor
01/05/2019 → 30/04/2022
Project: PhD

**Tomographic Imaging of Flow in Porous Media**
Rasmussen, P. W., PhD Student, Department of Mathematics
Dahl, A. B., Main Supervisor
Christensen, A. N., Supervisor
01/12/2018 → 30/11/2021
Project: PhD

**Machine Learning for Ultrasonic Fault Detection**
Jeppesen, N., PhD Student, Department of Mathematics
Dahl, A. B., Main Supervisor
Christensen, A. N., Supervisor
Vesth, L., Supervisor
Eksternt finansieret virksomhed
15/08/2017 → 14/08/2020
Award relations: Machine Learning for Ultrasonic Fault Detection
Project: PhD

**4D Seisimics for Fracture Characterization**
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Christensen, A. N., Supervisor
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Technical University of Denmark
15/10/2016 → 14/10/2019
Award relations: 4D Seisimics for Fracture Characterization
Project: PhD

**Image Analysis for Nanoparticle Guided Radiotherapy**
Christensen, A. N., PhD Student, Department of Mathematics
Conradsen, K., Main Supervisor
Larsen, R., Supervisor
Nielsen, A. A., Examiner
Bech, M., Examiner
Ostergaard, L. R., Examiner
1/3 FUU, 1/3 inst 1/3 Andet
01/10/2012 → 21/01/2016
Award relations: Image Analysis for Nanoparticle Guided Radiotherapy
3D imaging center
Poulsen, H. F., Project Manager, Department of Physics, Neutrons and X-rays for Materials Physics
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Oddershede, J., Project Participant, Department of Physics, Neutrons and X-rays for Materials Physics
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Sanna, S., Project Participant, Department of Energy Conversion and Storage, Electrofunctional materials
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Christensen, A. N., Project Participant, Centre for oil and gas – DTU, Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics
01/01/2016 → 01/01/2021
Collaborators: University of Copenhagen
Project: Research