Our Common Future

Hannover · Essen
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VolkswagenStiftung · Deutsche Messe Hannover · Germany · Stiftung Mercator · Landeshauptstadt Hannover · RUHR.2010

Assistance Systems for the Elderly

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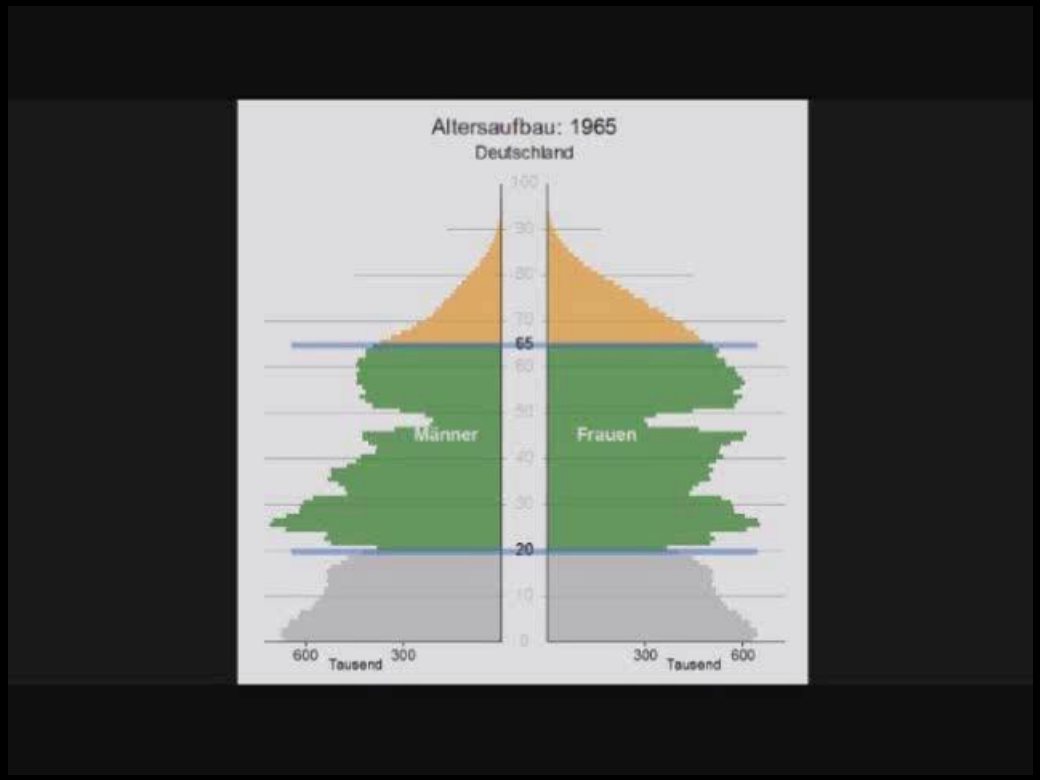
Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI)

The population pyramid (Germany)

Animation about the evolution of the population pyramid from 1965 to 2050

2005: 60+ generation represents **25%** of the population

2030: 60+ generation represents **37%** of the population

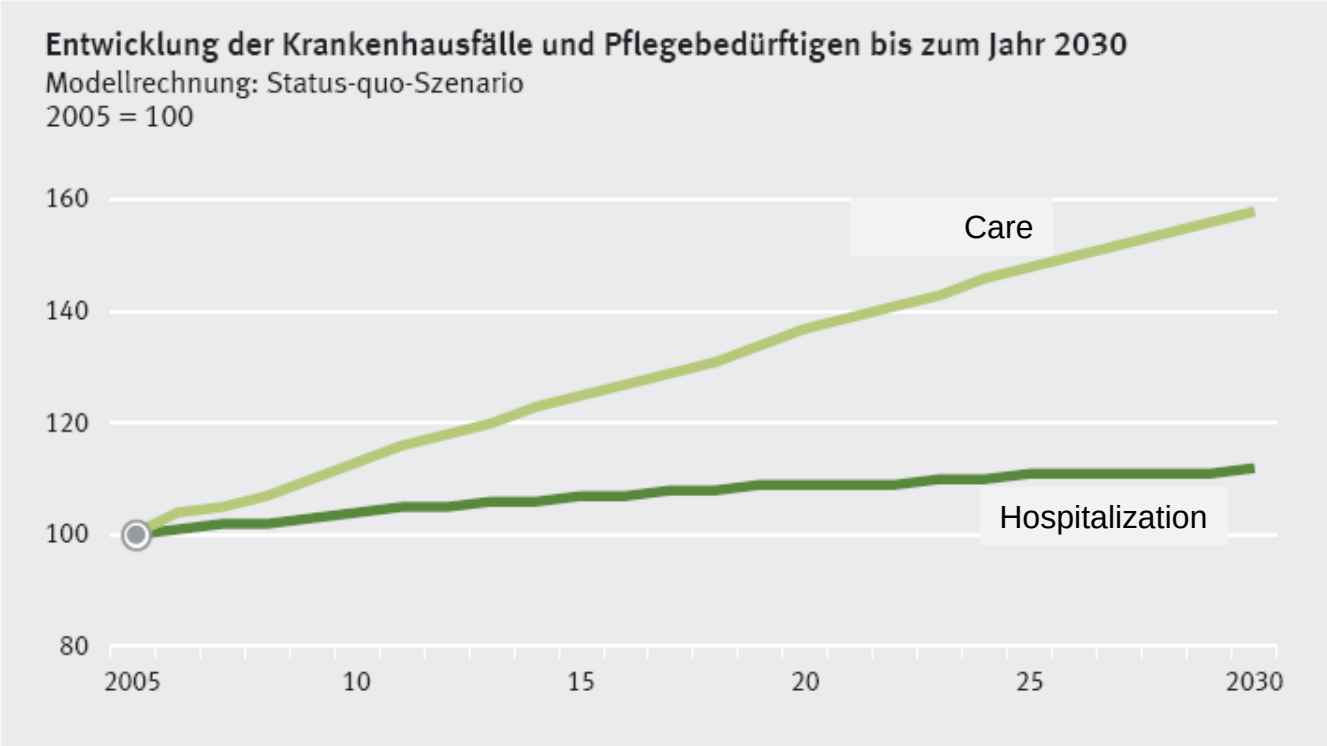


http://www.destatis.de/bevoelkerungspyramide/

Evolution of care demand until 2030 (Germany)

- 2005:
  33 % of the care patients are older than 85 years

- 2030:
  48 % of the care patients are older than 85 years



Statistisches Bundesamt, Gesundheit auf einen Blick, 2009

Challenge: self-management

Assisting elderly people by the mean of intelligent technology

Be safe on the go.

Get well and stay healthy.

Live independently at home for longer.

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Maintaining older people's standard of living from an economic, health and social perspective.

Get well and stay healthy.

Live independently at home for longer.

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Identification of essential factors of health

Cardiovascular health	Improves myocardial performance
	Increases peak diastolic filling
	Increases heart muscle contractility
	Reduces premature ventricular-contractions
	Improves blood lipid profile
	Increases aerobic capacity
	Reduces systolic blood pressure
	Improves diastolic blood pressure
	Improves endurance
	Improves muscle capillary blood flow
Body Composition	Decreases abdominal adipose tissue
	Increases muscle mass
Metabolism	Increases total energy expenditure
	Improves protein synthesis rate and amino acid uptake into the skeletal muscle
	Reduces low-density lipoproteins
	Reduces cholesterol/very low density lipoproteins
	Reduces triglycerides
	Increases high-density lipoproteins
	Increases glucose tolerance
Bone Health	Slows decline in bone mineral density
	Increases total body calcium, nitrogen
Psychological well-being	Improves perceived well-being and happiness
	Decreases levels of stress-related hormones
	Improves attention span
	Improves cognitive processing speed
	Increases slow wave and rapid eye movement sleep
Muscle weakness and functional capacity	Reduces risk of musculoskeletal disability
	Improves strength and flexibility
	Reduces risk of falls
	Improves dynamic balance
	Improves physical functional performance

Cress E et al. 2004

Benefits of physical activity

- An incredible medicine: **Physical activity**
- „Walking is man‘s best medicine“ Hippocrates
- Many studies demonstrated the benefits of physical activity

Health Issue	Benefits of Physical Activity
Cardiovascular health	Improves myocardial performance
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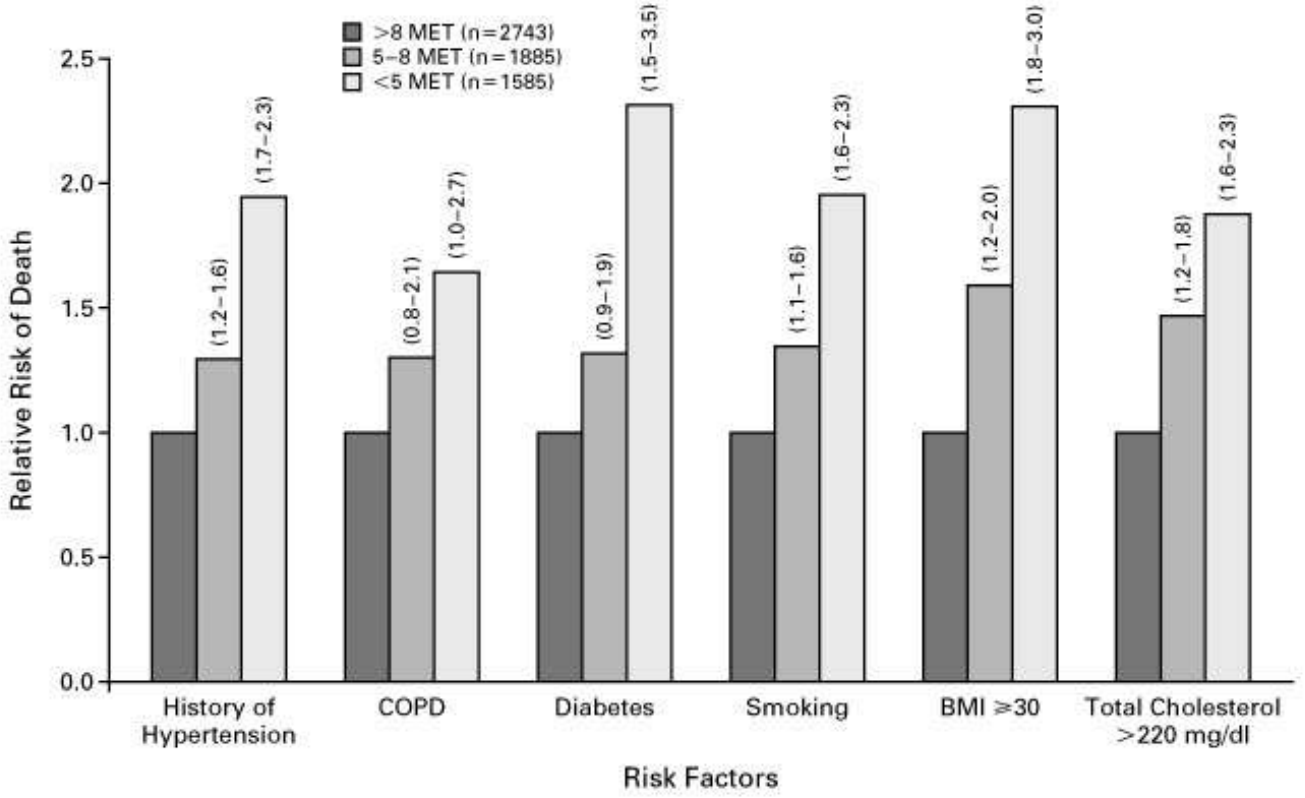
Cress E et al.
Med Sci Sports Exerc 2004

Benefits of physical activity – chronic disease

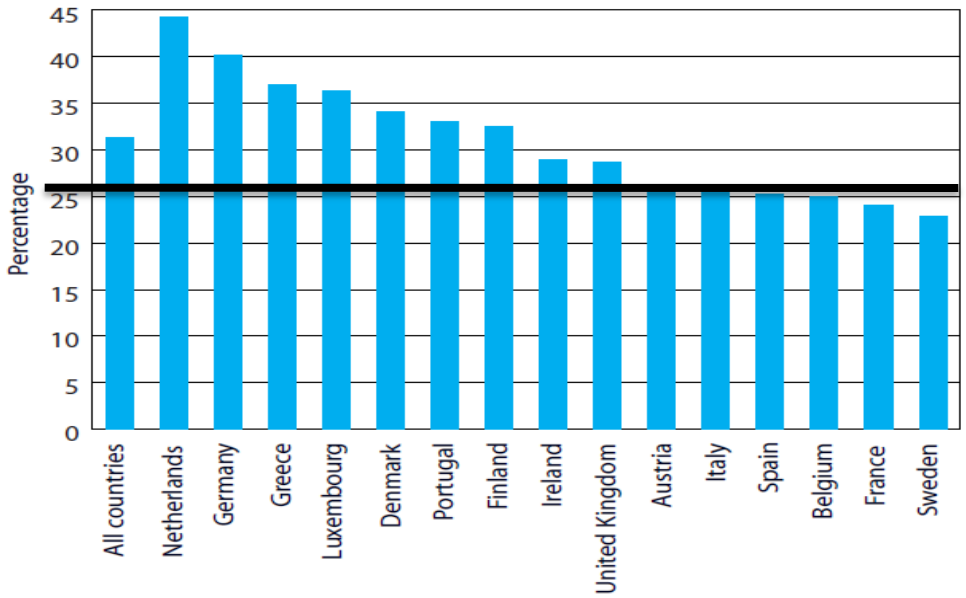


MET = Metabolic Equivalent of Task

Myers J. et al, NEJM 2002; 346: 793-801

Physical activity statistics

Fig. 1. Proportion of adults (aged 15 years or over) in the EU classified as sufficiently active, 2002



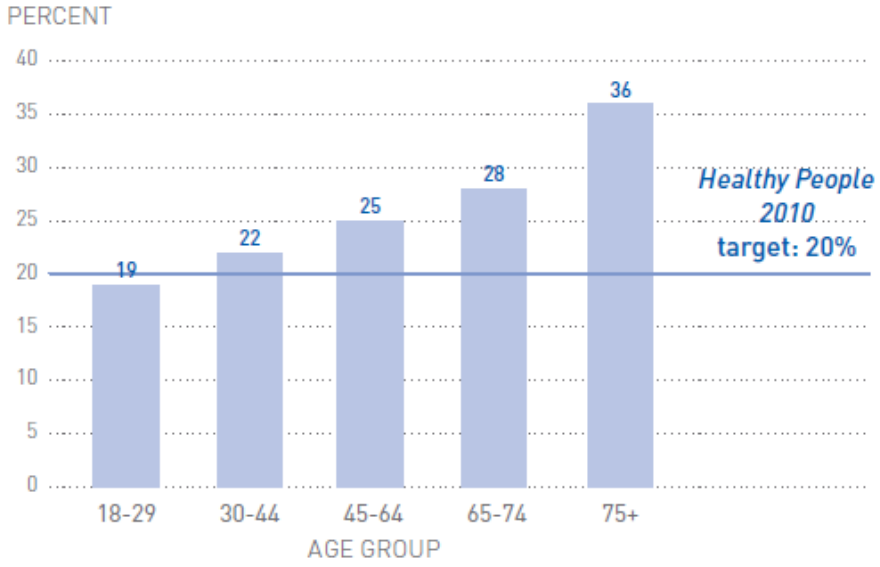
Source: Sjöström et al. *(8)*.

Estimated cost of physical inactivity about €150–300 per citizen per year (WHO Europe report 2006)

Physical activity

- Balanced physical activities are essential for well-aging
- But: aging ⇨ less physical activity

Prevalence of no leisure-time physical activity increases as Americans age



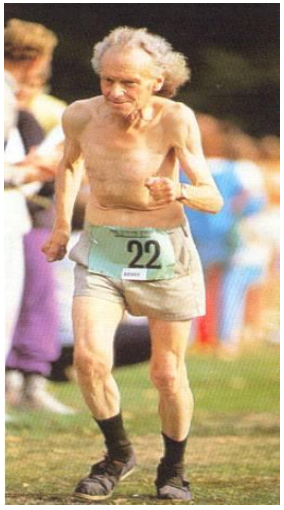
Report The State of Aging and Health in America 2007
Centers for Disease Control and Prevention - U.S. Department of Health and Human Services

Physician & clinician perspective

- Physical training is an unique poly-pill !

- It must and it can be always
  - used in primary prevention
  - prescribed in case of chronic disease
  - prescribed in aging ++

- Physical training must be performed
  - after education by a professional people
  - in safety conditions
  - after physical and medical evaluation
  - with an individual program



Dr. *Francois Carre* of Rennes University Hospital

Monitoring of physical activity: no appropriate technology

Laboratory systems (VO_2 testing)

Costly & not usable

Step-counters, pedometers

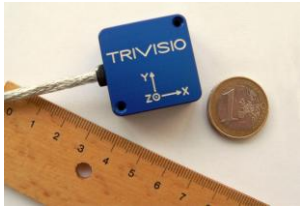
Coarse & only walking

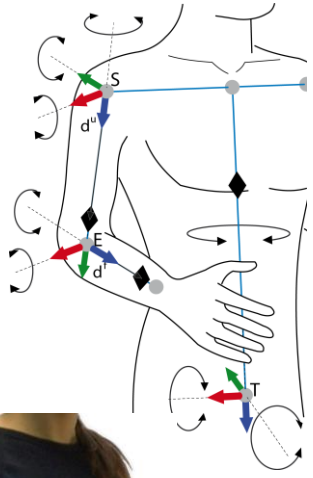
Questionnaires

Subjective

PAMAP: Physical Activity Monitoring for Aging People

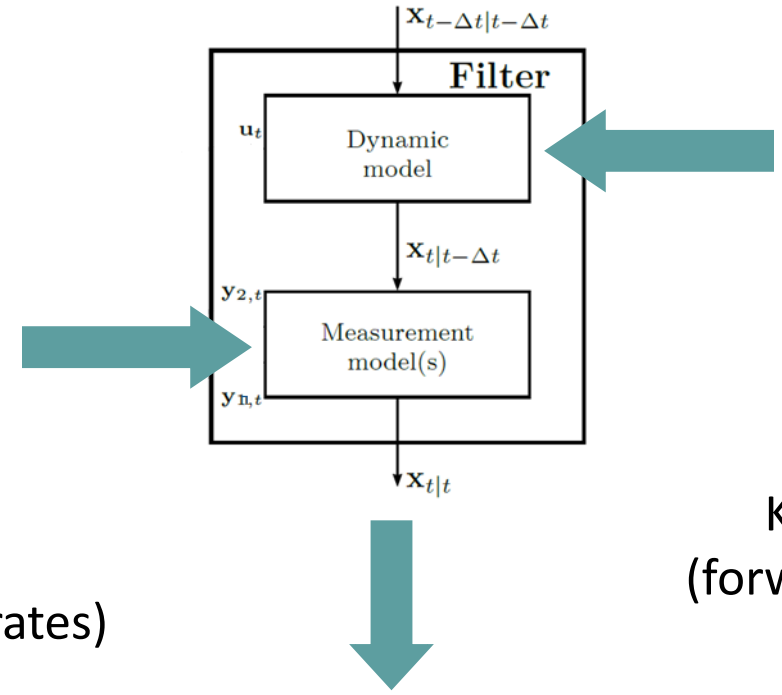
- The basic idea
  - On-body sensor network (accelerometers, gyroscopes, …)
  - Bio-mechanical model of the body
- Musculoskeletal motion analysis
- To infer the muscle activity, and then
  - To compare actual and targeted user's physical activity

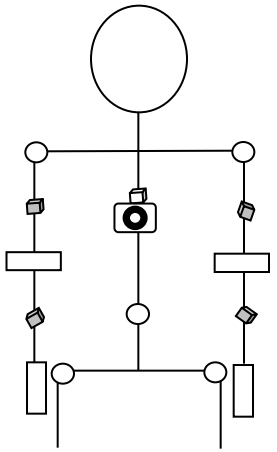




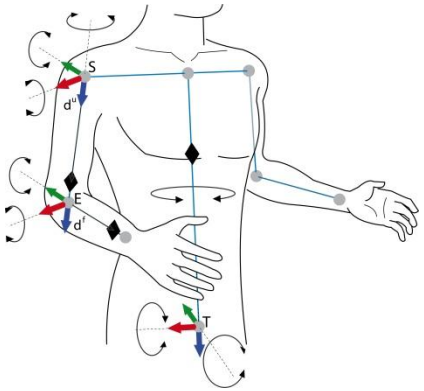
Visual-inertial (body) motion capture

IMUs at strategic positions on body (accelerations, angular rates)



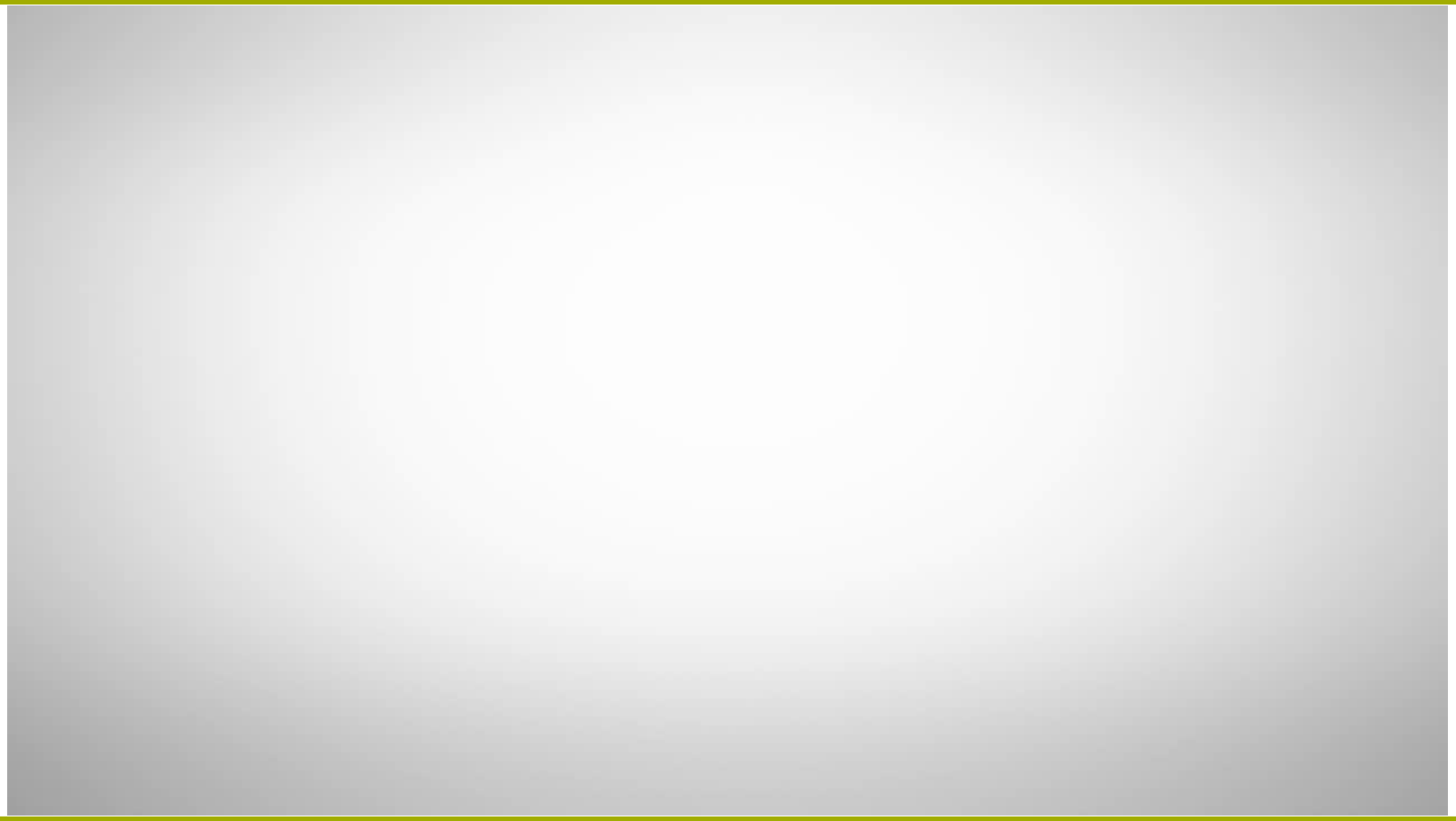


Kinematic body model (forward kinematic equations)

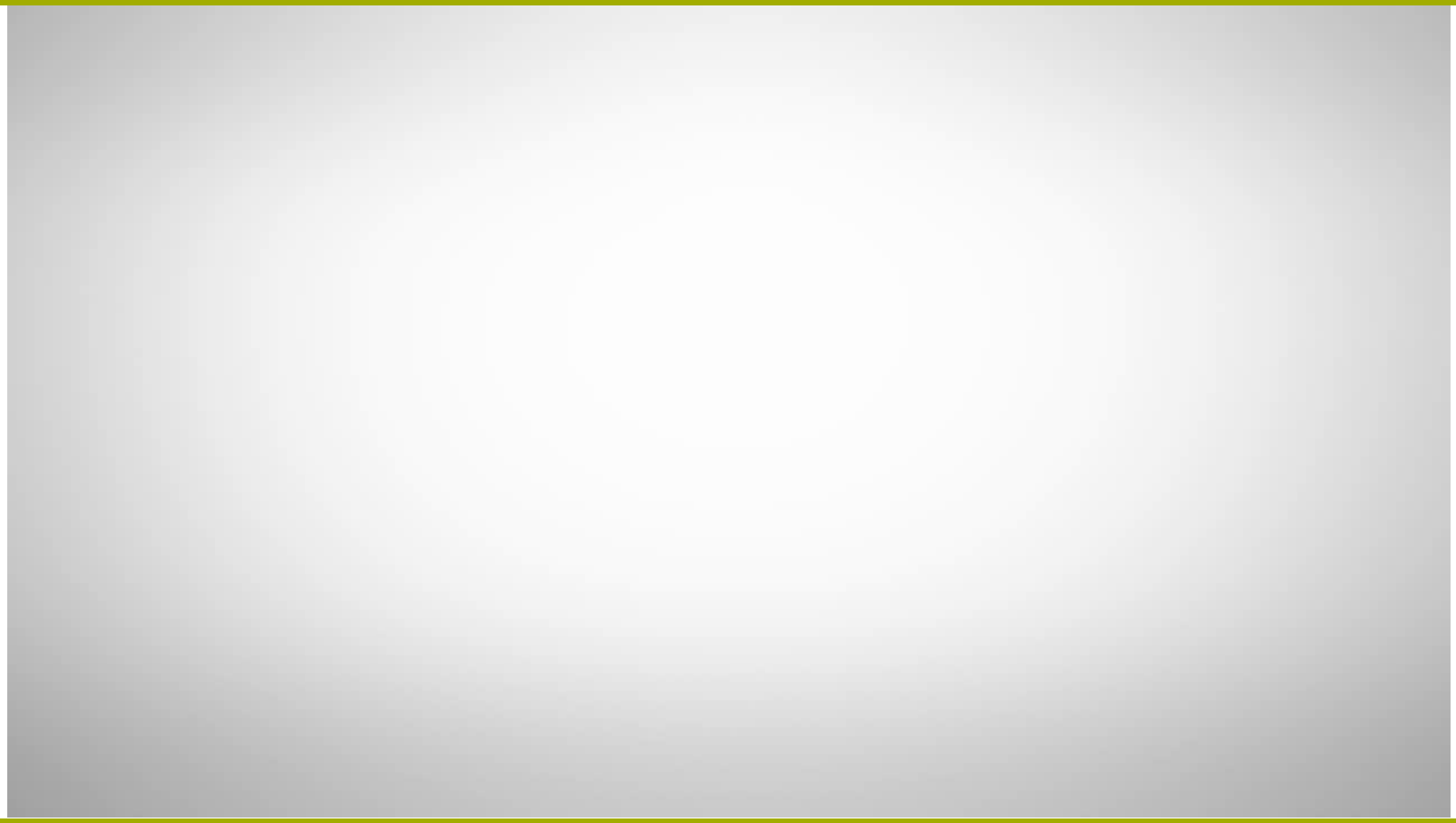


Joint configuration and kinematics

The body sensor network



Use Case: physical rehabilitation @ home



Use Case: over-day activity monitoring

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- Monitor general activity level and walking distance
- Activity level based on kinetic energy
- Rough activity level based on MET (Metabolic Equivalent of Task) tables
- Alternative to inaccurate questionnaires and pedometers

Aminian 2004

Use Case: over-day activity monitoring

Overall performance – recognition rate: 97.00% (with higher-level body model)

- Body model significantly improves the recognition rate:
  - Cycling (92.61% → 98.43%)
  - Nordic walking (84.83% → 91.43%)

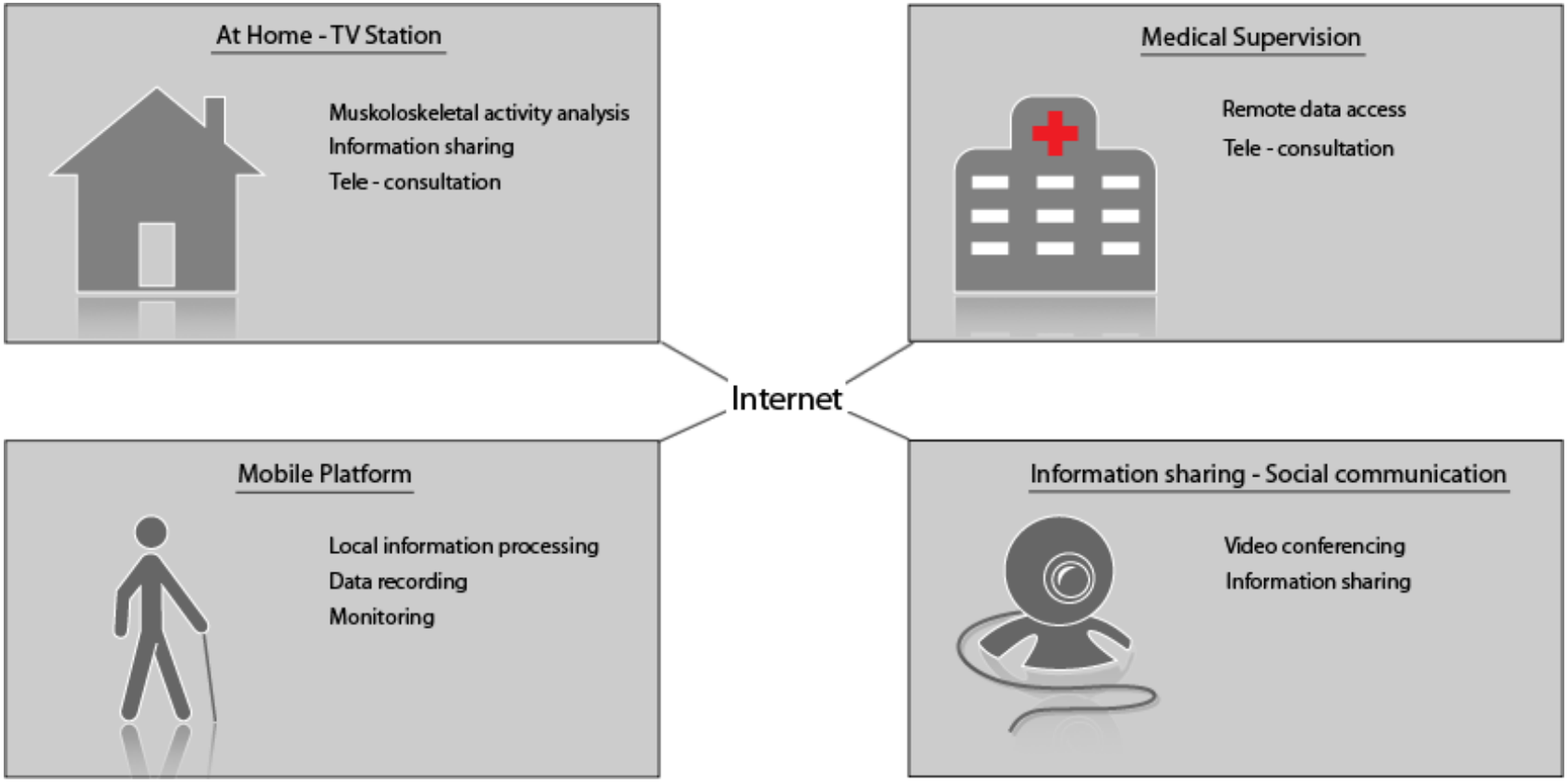
Annotation	Recognized activity: Lie	Sit	Stand	Walk	Nordic walk	Run	Cycle	Ascend stairs	Descend stairs
Lie	3106	0	0	0	0	0	0	0	0
Sit	0	4235	18	0	0	0	0	0	0
Stand	0	42	3007	0	0	0	0	0	0
Walk	0	0	0	3402	0	0	0	97	103
Nordic walk	0	0	0	0	1364	0	0	244	0
Run	0	0	0	0	0	2304	0	0	0
Cycle	0	0	0	0	1	0	1943	0	154
Ascend stairs	0	0	0	103	93	0	28	1531	0
Descend stairs	0	0	0	4	0	0	0	18	1299

Confusion matrix of the signal-oriented activity classification

Annotation	Recognized activity: Lie	Sit	Stand	Walk	Nordic walk	Run	Cycle	Ascend stairs	Descend stairs
Lie	3106	0	0	0	0	0	0	0	0
Sit	0	4235	18	0	0	0	0	0	0
Stand	0	42	3007	0	0	0	0	0	0
Walk	0	0	0	3402	0	0	0	79	121
Nordic walk	0	0	0	0	1364	0	0	8	236
Run	0	0	0	0	0	2304	0	0	0
Cycle	0	0	0	0	0	0	2065	0	33
Ascend stairs	0	0	0	78	46	0	28	1603	0
Descend stairs	0	0	0	4	0	0	0	0	1317

Confusion matrix of the combined (signal + model) activity classification

Information platform



Users and usability

- Users with different needs: elderly, clinicians
- User acceptance and usability
- Platform for motivation and collaboration

Challenge: self-management

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BAALL – Bremen Ambient Assisted Living Lab

- Fully equipped appartment for *elderly people*

BAALL – Goals

- To provide a fully functional apartment for 2 persons
  - Usability test for „everyday life“

- “AAL-Ready” paradigm
  - A building-block approach: upgrade, modify the home environment depending on the needs
  - Step by step equipment of the living environment
  - Standardisation and interoperability

- Seniors at home
  - Hidden technology (invisible computer)
  - Natural interaction

BAALL – Four technological domains

- **Mobility-assistance**
  - Intelligent Walker *„Rolland“*
  - Intelligent Wheelchair
- **Smart environment**
  - Building automation, advanced services
  - Interoperability, safety
- **Intelligent furniture**
  - Configurable kitchen elements, ...
  - Doors, bed, bathroom ...
- **Advanced interaction**
  - Speech and dialogue
  - Touchscreen

BAALL – Exemplary scenario

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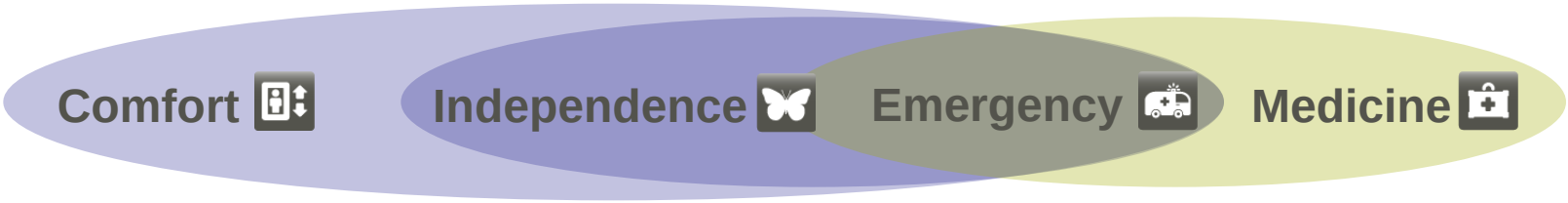
Summary

SmartSenior addresses the full range of needs of older people.



- Mobility
- Finding things / places
- Feeling safe
- Building automation
- Staying in touch
- Infotainment

A C

- Getting dressed
- Eating, cooking, drinking
- Taking medicine
- Shopping
- Cleaning
- Fitness / training

C

- Assistance
- Identification
- Prediction
- Prevention

A B C

- Prevention
- Treatment
- Rehabilitation
- After-care
- Care

B C

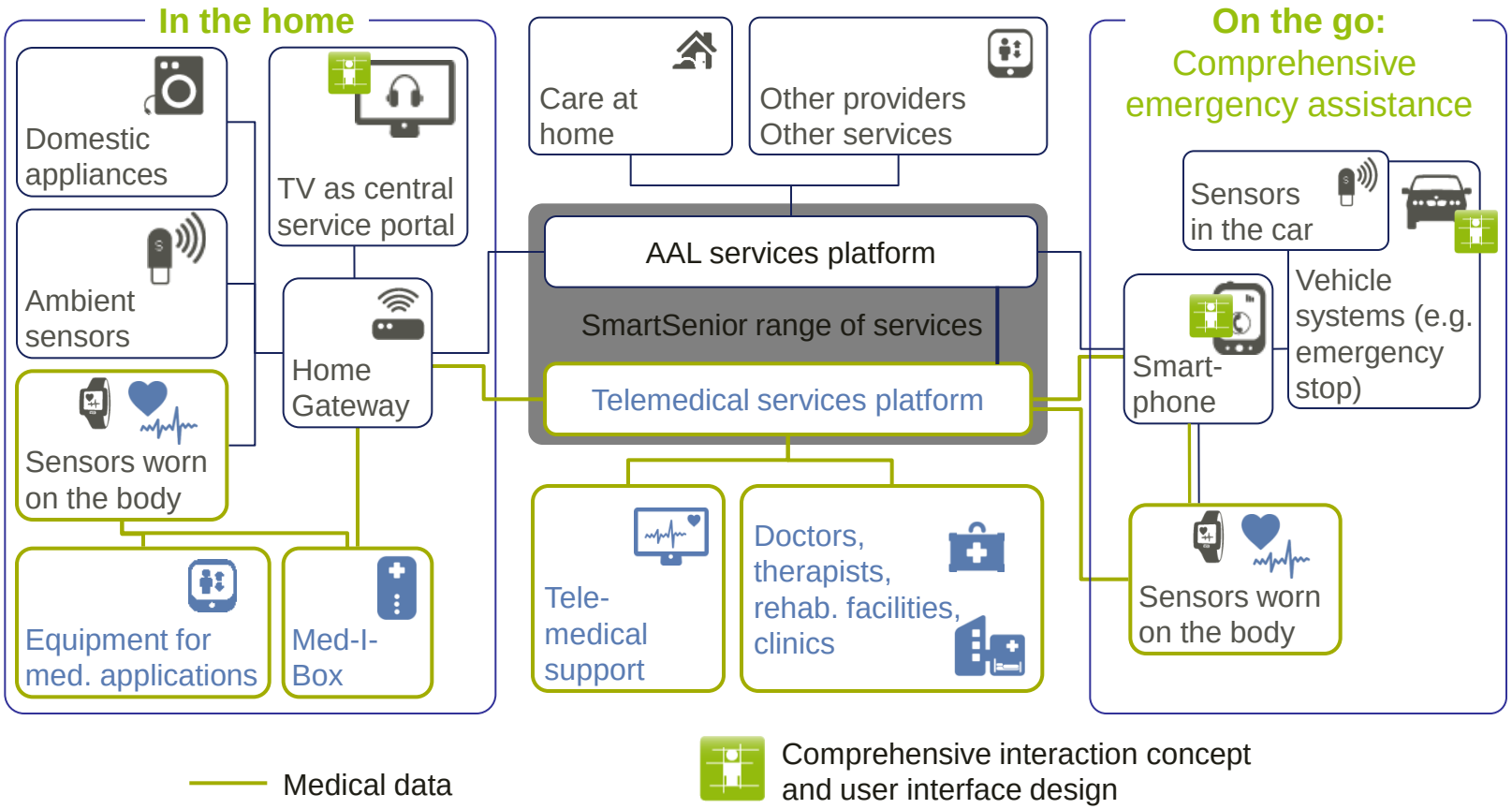
A Be safe on the go.

C Live independently at home for longer.

B Get well and stay healthy.

Based on: Eyman et al.: The Cloud of Care: Ein Bezugsrahmen für die Integration von Technologie und Dienstleistung im Ambient Assisted Living

SmartSenior architecture.



Consortium.

Partners.

Research

Max-Planck-Institut für Bildungsforschung
Max Planck Institute for Human Development

TU berlin

Fraunhofer

DFKI Deutsches Forschungszentrum für Künstliche Intelligenz GmbH

Deutsche Stiftung für chronisch Kranke

Health service providers

Schmerz Zentrum Berlin

Natura Gami Medicus Curat

CHARITÉ Universitätsmedizin Berlin

Vivantes

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GLOBAL HEALTH CARE

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ClinPath

prisma IT comes first.

Infrastructure and network providers

T

Alcatel·Lucent

Mobility service providers

Qiro Schon unterwegs!

BMW Group Forschung und Technik

MINI

Health & care insurance companies *

AOK Die Gesundheitskasse. *

Debeka *

In negotiations with others.

Care and support providers

DIE JOHANNITER

Johanniter Unfall Hilfe

Manufacturers of household appliances *

Miele *

In negotiations with others.

Housing industry

WOHNEN IN POTSDAM GEWOBA

* As associated partners

Thank you!

More under:

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And:

www.pamap.org

www.baall.net

www.smart-senior.de