

Welcome

Sensing Terra Incognita

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Content

- Cold Heavy Oil Production (CHOP) in Saskatchewan, Canada
 - “wormholes” – *terra incognita* 600 – 1000 m below ground
- Cognitive sensing
 - *terra incognita* of human perceptual identification and interpretation processes of sensory inputs

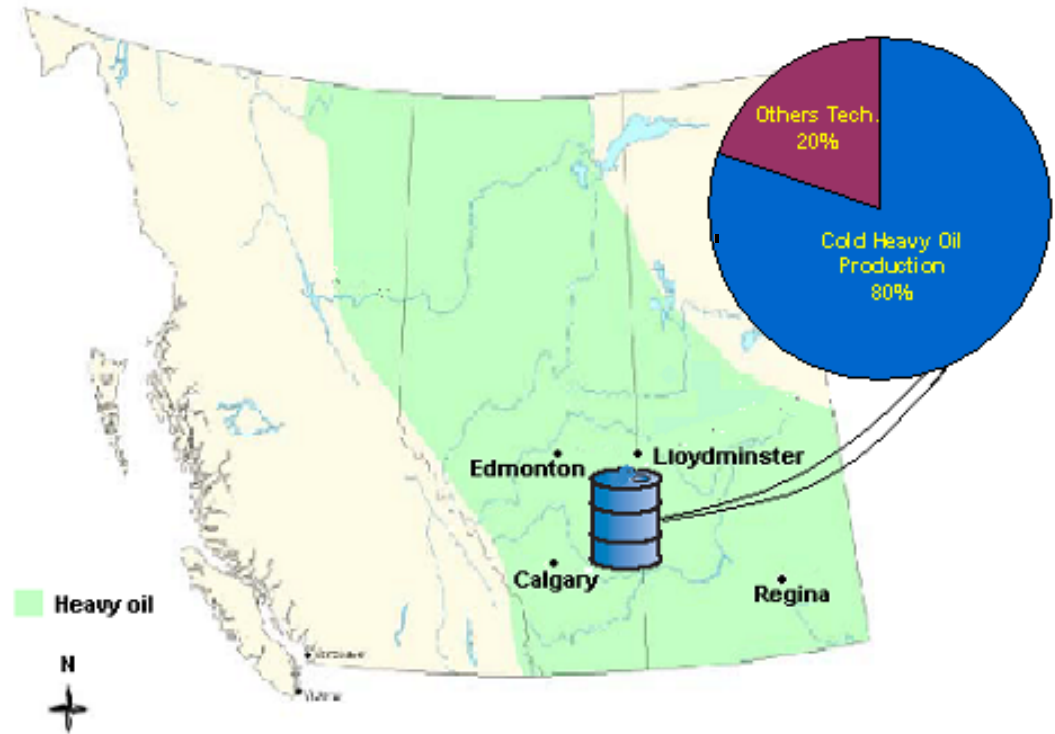
CHOPS in Saskatchewan

Heavy oil reserves (NEB, 2001)

Oil in place: 7,900 million m³

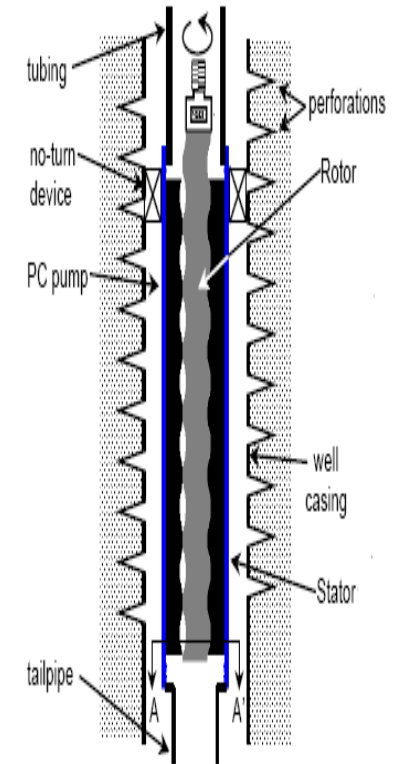
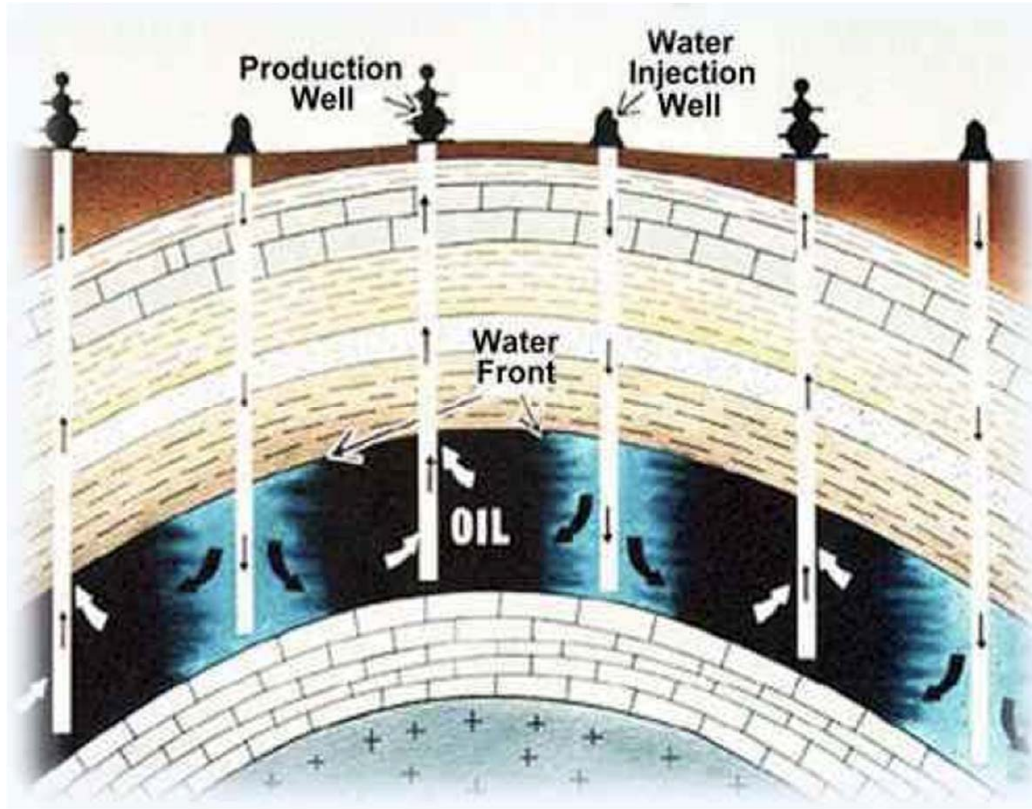
Recoverable: 1,400 million m³

Production efficiency: <10%



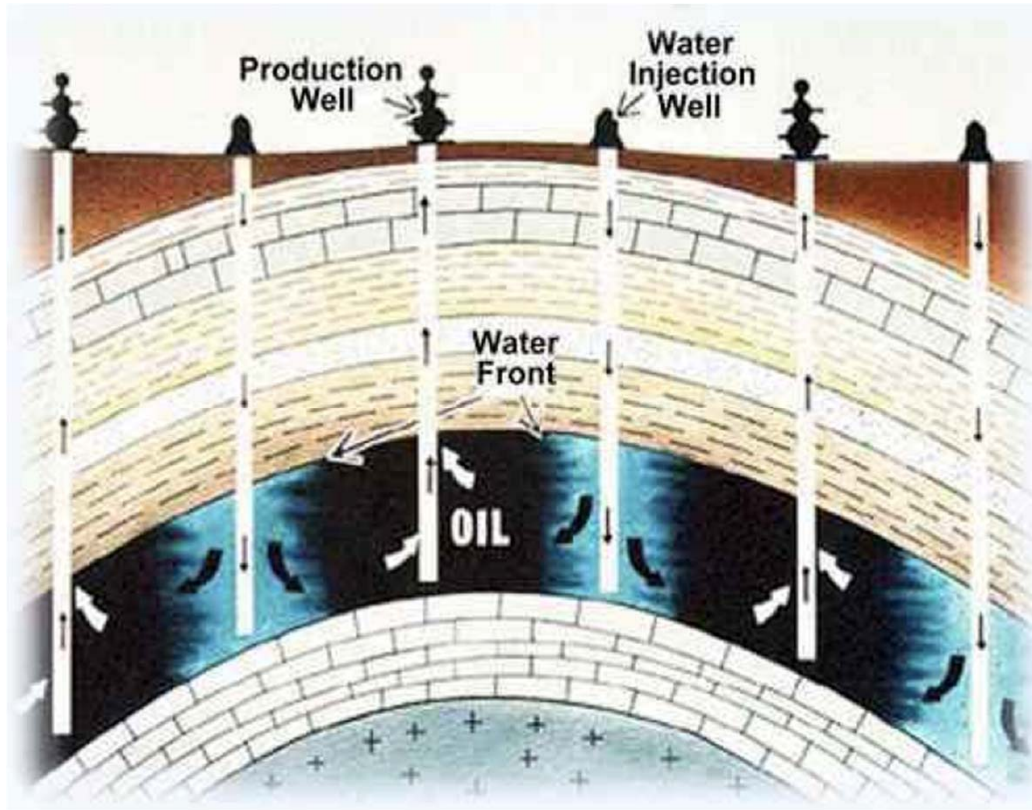
Worldwide 10 trillion m³

CHOPS – water flooding



CHOP well completion and perforations
(Dusseault, 2004)

CHOPS – heavy oil production

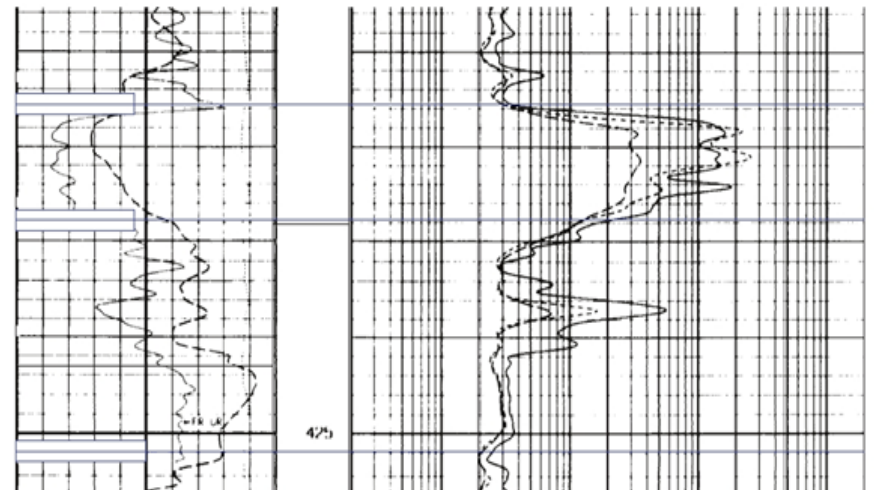


- used to increase recovery from oil reservoirs
- inject water in certain wells and push the oil to adjacent producing wells
- commonly used in heavy oil recovery in Saskatchewan
- (typically CHOPS reservoirs have oil that is too viscous to waterflood)

Mapping reservoirs: Well logs

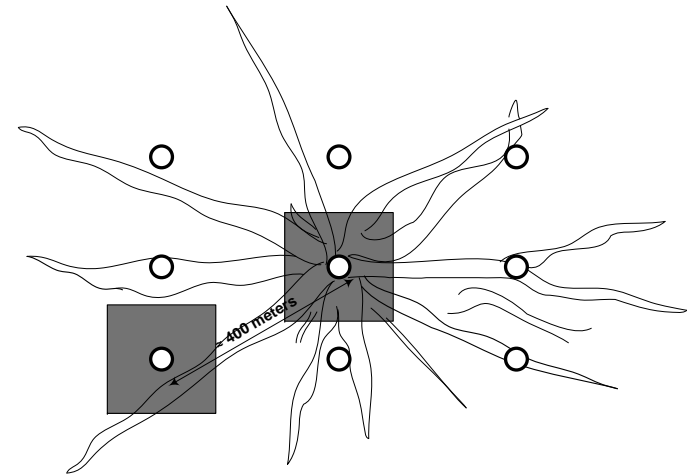
- Gathered for every well
- Various types of logs
- Give an understanding of the reservoir

TENSION KG		SHALLOW INDUCED RESISTIVITY OHMM	
5000	0	0.2	2000.0
GAMMA RAY API UNITS		MEDIUM INDUCTION OHMM	
150	300	0.2	2000.0
0	150		
SPONTANEOUS POTENTIAL mV		DEEP INDUCTION OHMM	
-4	10	0.2	2000.0
1:240 REPEAT SECTION			



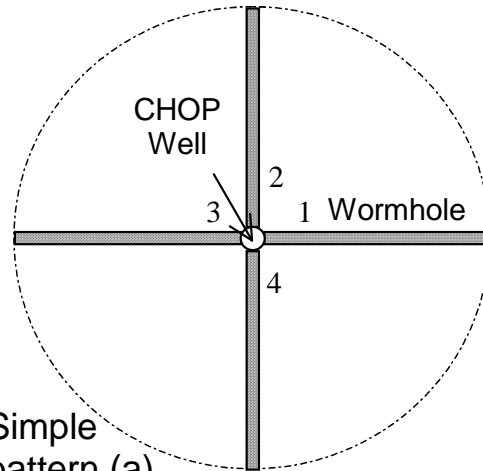
425

Wormholes: *terra incognita*

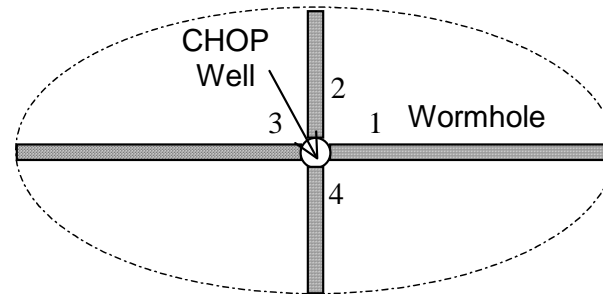


- Produce massive amounts of sand from some CHOPS reservoirs
 - Know from reservoir tests that we have preferential permeability between wells
 - Know in waterfloods that water breaks through faster in certain directions
 - Know in solvent floods, we have recovery preferentially in certain directions
-

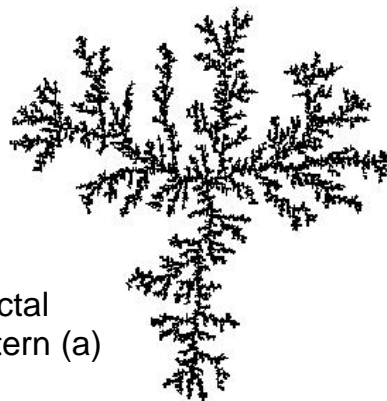
CHOPS – sensing *terra incognita*



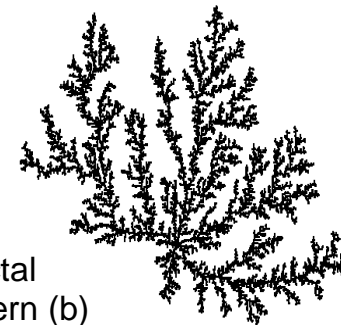
Simple pattern (a)



Simple pattern (b)

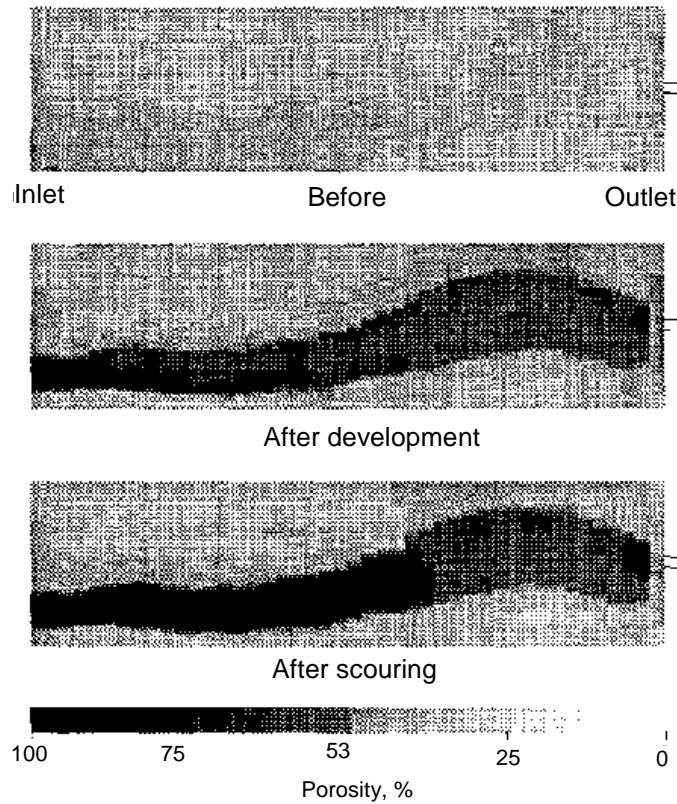


Fractal pattern (a)



Fractal pattern (b)

CHOPS – the wormhole issue



Wormhole development process
(Tremblay *et al.* 1997)

Photo of foamy oil (Chen, 2004)

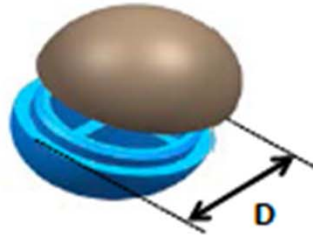
CHOPS's – μ -sensor approach

(C. Vogt – van Haarlem, E. Talnishnikh, G. Meinders)

- **layer exploration at 600 m – 1000 m below ground**
 - confirm worm hole hypothesis
- **feature extraction through injection of μ -sensors (WiseMote's)**
 - sensor dimensions < 12 mm
 - measure & store critical parameters (e.g. temperature, pressure)
 - measure & store position while floating?
 - intercommunicate ?
 - share tasks (swarming approach) ?
- **feasibility study 2012**
 - explore injection/extraction mechanisms
 - optimize mechanical dimensions
 - verify stability conditions

CHOPS's – μ -sensor feasibility study 2012

- blank WiseMote's - INCAS³ & promise BV - (www.promise.nu)



- outer dimensions 5 – 12 mm (spherical, stretched, cubic)
- wall thickness 0.6 mm – 0.7 mm \Rightarrow space for payload
- max. pressure (design) > 10 MPa (>100 bar) \Rightarrow pumpable
- density 1.01 – 0.96 kg/l (8 – 15 deg API) \Rightarrow floating
- **generic aspects**
 - applications in industrial reactors & pipeline systems
 - **swarming** strategy vs. limited communication & capabilities
 - hierarchy & task sharing

CHOPS – real life



PCP pump test



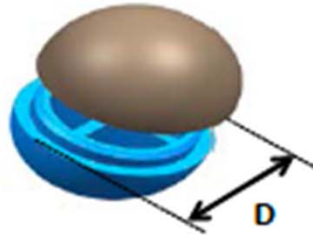
PCP pump test



Blank mote	Inn	Out (intact)	Out (split in two)	Out (crushed)	Lost
5 mm round	5	5	0	0	0
5 mm cube	5	4	1	0	0
5 mm elongated	5	5	0	0	0
9 mm round	5	3	1	1	0
9 mm cube	5	0	0	4	1
9 mm elongated	5	1	2	2	0
12 mm round	5	0	3	1	1
12 mm cube	5	0	0	1	4
12 mm elongated	5	0	1	0	4

CHOPS's – μ -sensor, pump conditions

- blank WiseMote's - INCAS³ & promise BV - (www.promise.nu)



- outer dimensions **5 – 9 mm (spherical, stretched)**
- wall thickness 0.6 mm – 0.7 mm \Rightarrow space for payload
- max. pressure (design) > 10 MPa (>100 bar) \Rightarrow pumpable
- density 1.01 – 0.96 kg/l (8 – 15 deg API) \Rightarrow floating

CHOPS's – μ -sensor test late October 2012

- **inject in water flooded layer at 600 m – 1000 m below ground**
 - blank motes, spherical/stretched, 5,7,9 mm
 - equipped with RF ID tags
- passing through?
- travel time?
- recovery probability

Quality of life – how to measure

Noise exposure in urban environments and Quality of Life:

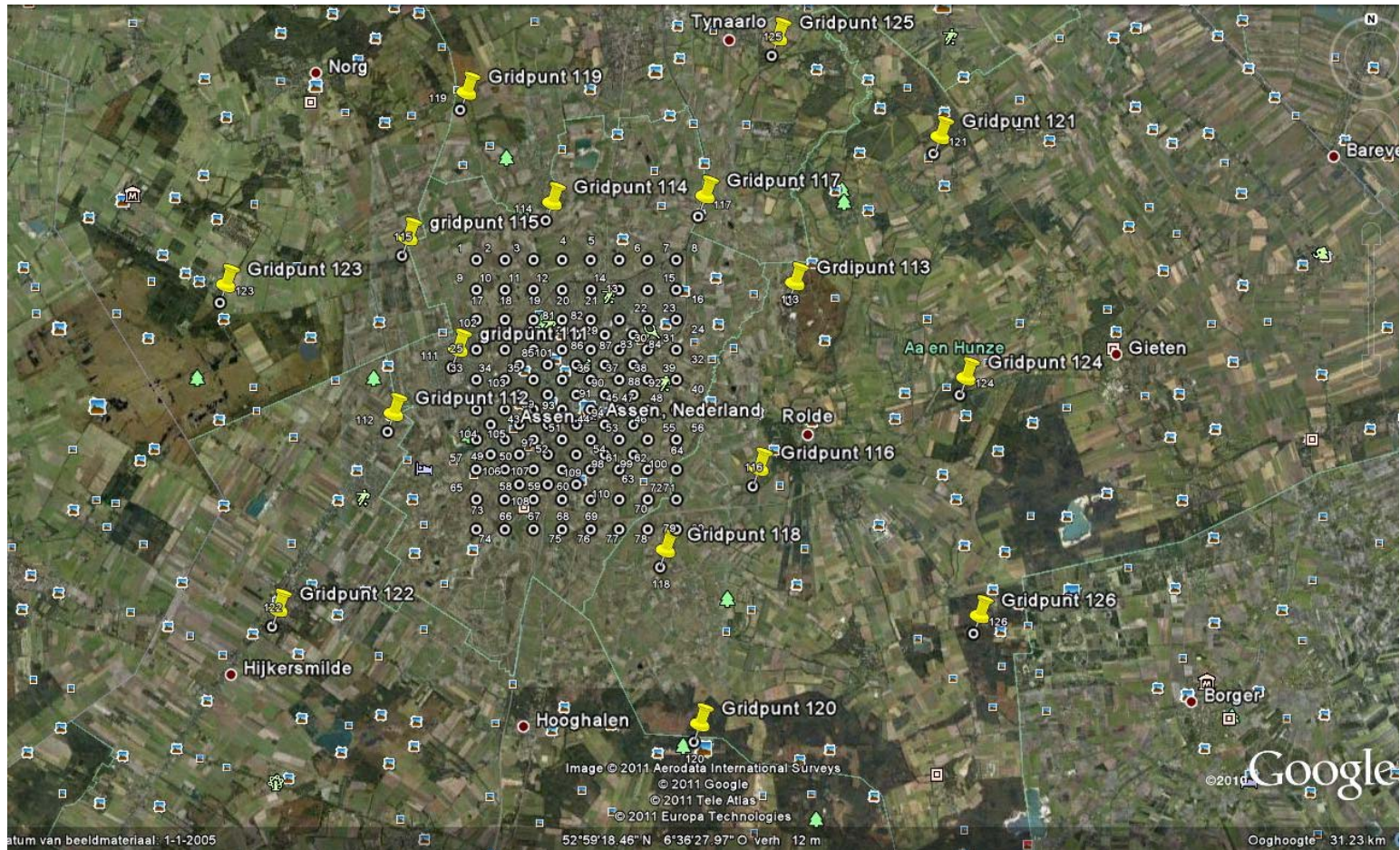
Environmental Noise Directive
(European Parliament & Council, 2002)

“avoid, prevent or reduce, on a prioritised basis the harmful effects, including annoyance due to exposure to environmental noise”
(European Parliament & Council, 2002, pp.L189/13)

“preserving environmental noise quality where it is good”
(European Parliament & Council, 2002, pp.L189/13)

... from quantity (technical state-of-the-art) to
human qualification!

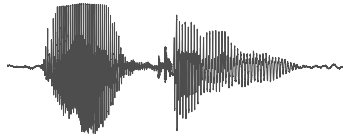
Sensor City Assen – the urban real-life lab



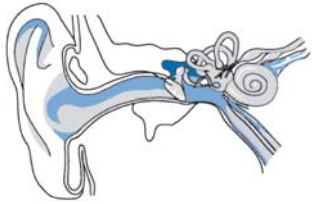
Audio recognition



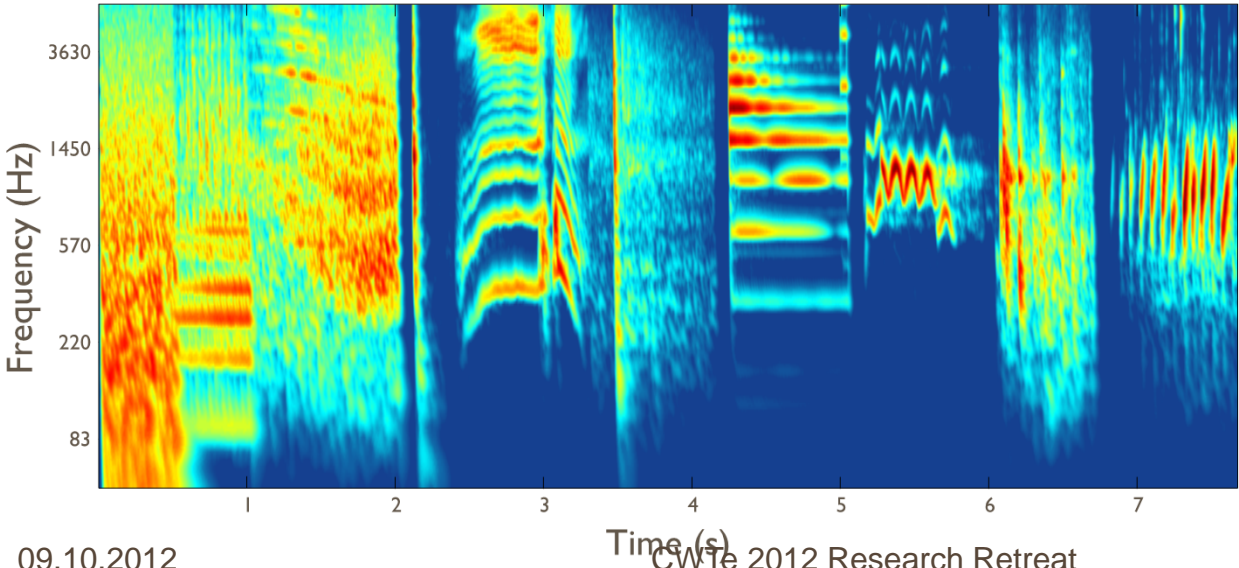
microphone



audio signal



cochlea model



Audio recognition – status

(D-J Krijnders, M. Coler, D. Dubois, Y. Hao, G. ten Holt)

Cognitive Systems: Sensor City Audio System, Phase 1

- Modular, compact, robust sound card development
- Embedded human Cochlea model based processing in real-time, 24/7
- Embedded feature (“event”) recognition in Cochlea data
- On the fly modification of embedded algorithms
- Self calibration and diagnostics
- FFT, Timing, Phase Analysis/Data in parallel

Intelligent system, but not matching human evaluation requirement!

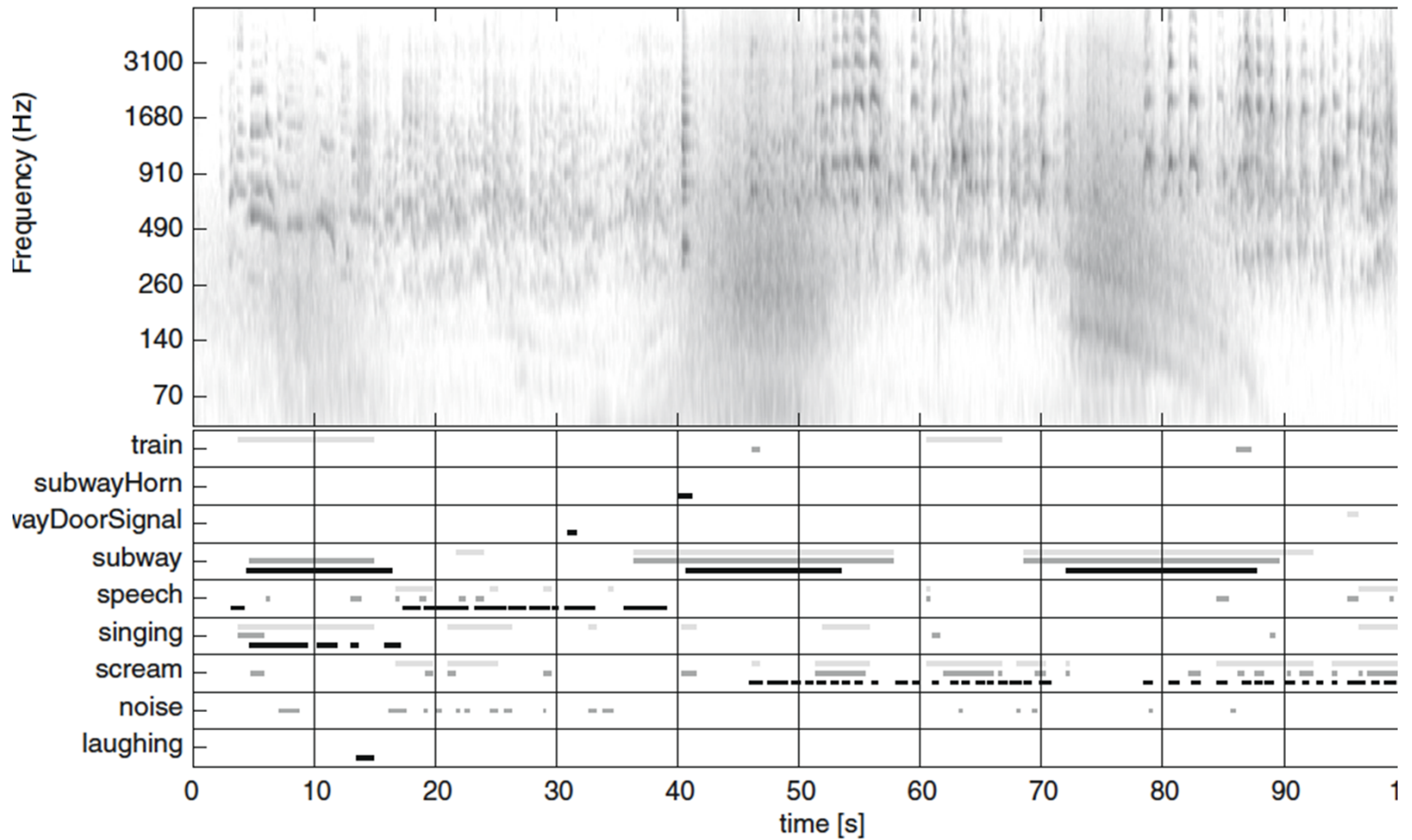
(➡ (expert) system featuring low application potential for 3rd parties!)

Audio recognition – beyond intelligence

Audio System, Phase 2 – Stepping Beyond Intelligence

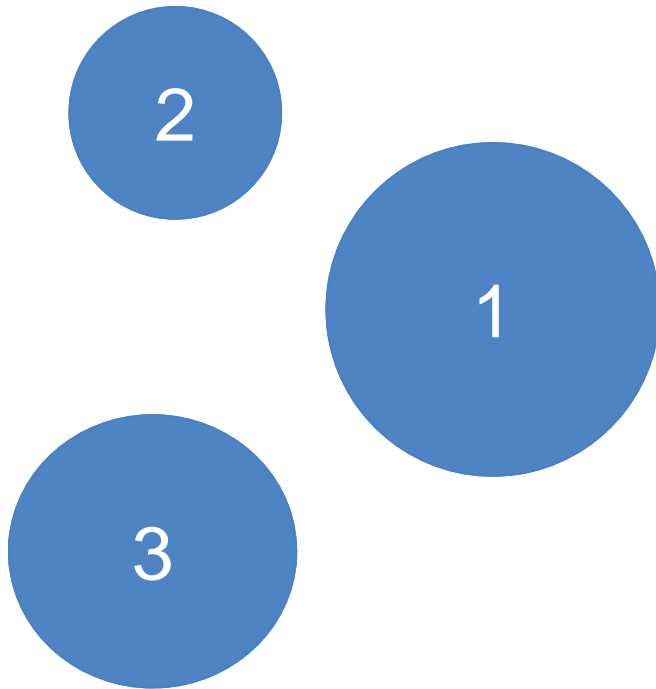
- Human annotation and categorization of sound (events) (Dubois)
- Linguistic analysis for aural experiences & knowledge (Coler, Dubois)
- (Semi) automatic linguistic analysis (Coler, Dubois)

Cognitivity – *Terra Incognita*

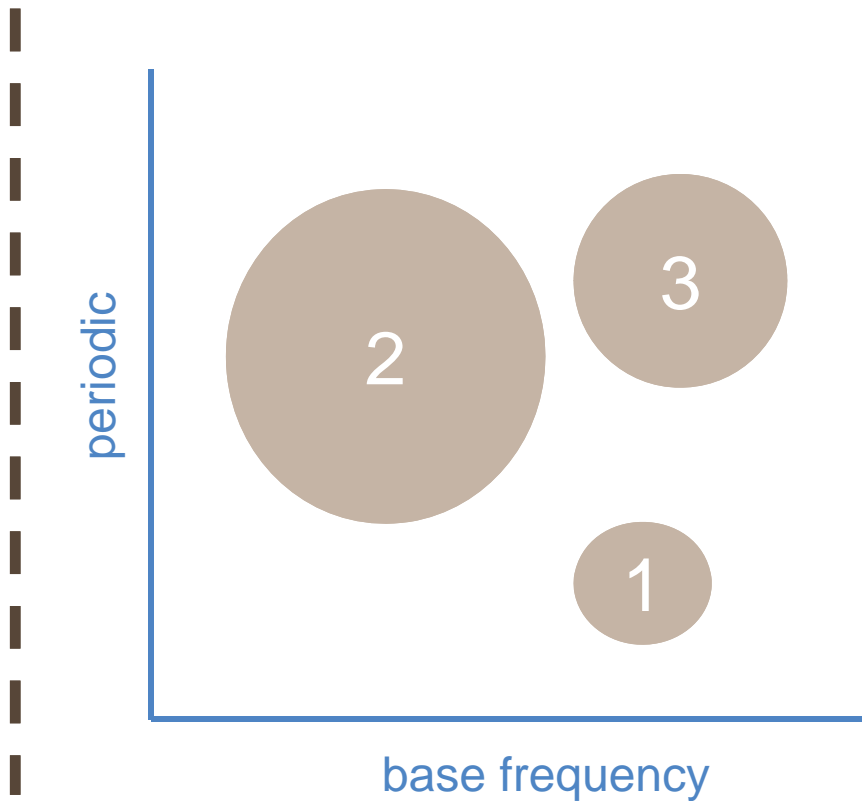


Audio recognition – cognitivity

human grouping of sensory experience



correlated physical properties



Audio recognition – cognitivity

Audio System, Phase 2 – Stepping beyond intelligence

- Human annotation and categorization of sound (events) (Dubois)
- Linguistic analysis for audial experiences & knowledge (Coler, Dubois)
- (Semi) automatic linguistic analysis (Coler, Dubois)

Relate features/events in Cochlea data to human perception and interpretation and vice versa improve event identification in the data (work in progress)

- ↳ **complex analysis but result according human categories**
- ↳ **system output understandable for non experts**
- ↳ **increased application potential!**

Cognitivity – new business cases

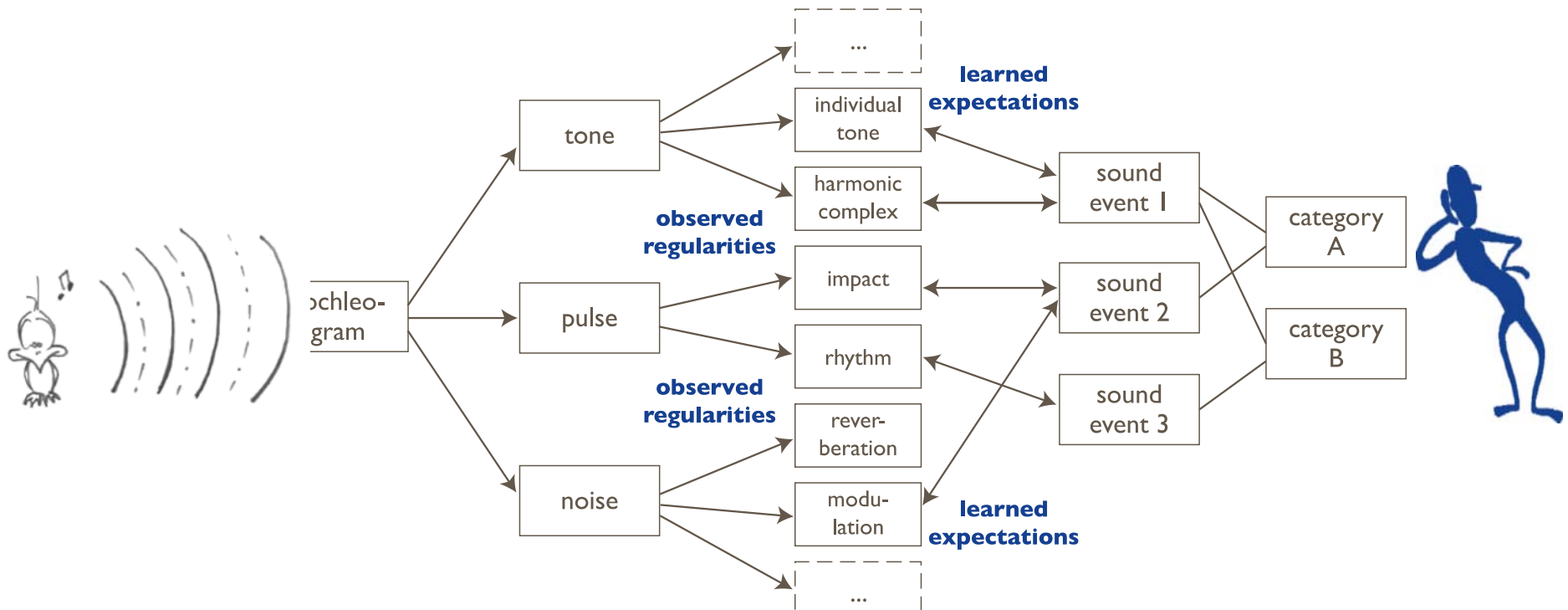
Negotiations with 3rd parties for the Phase 2 system ongoing for:

- audial monitoring and crisis detection in care homes & hospitals (e.g. coughing, snoring, moaning...);
- panic detection (e.g. scream of pain) implemented in farming machines;
(long term perspective: human/robot interaction & robots in open environments);
- security monitoring in urban environments
- anti-noise cancelation for located sources in urban environments

Cognitivity – the missing link

knowledge of physics world

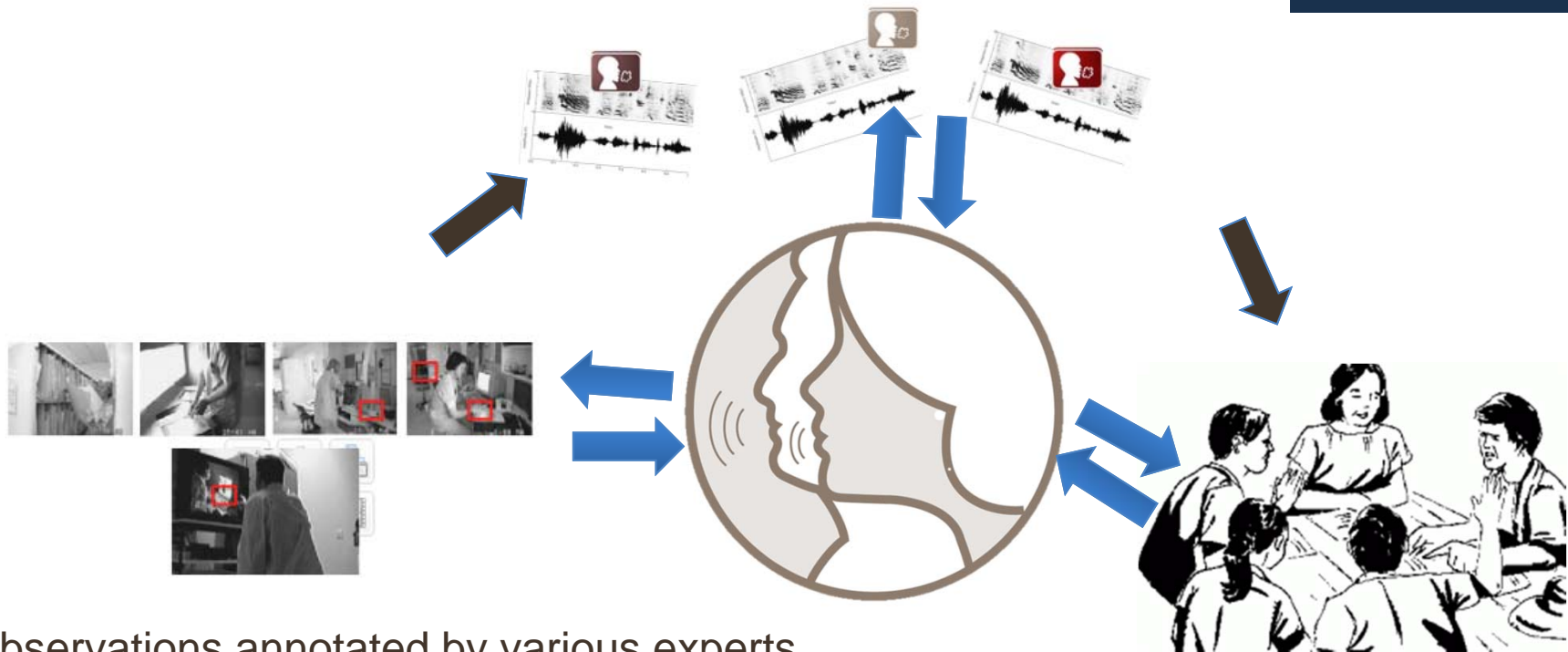
knowledge of peoples knowledge



Multimodal C.

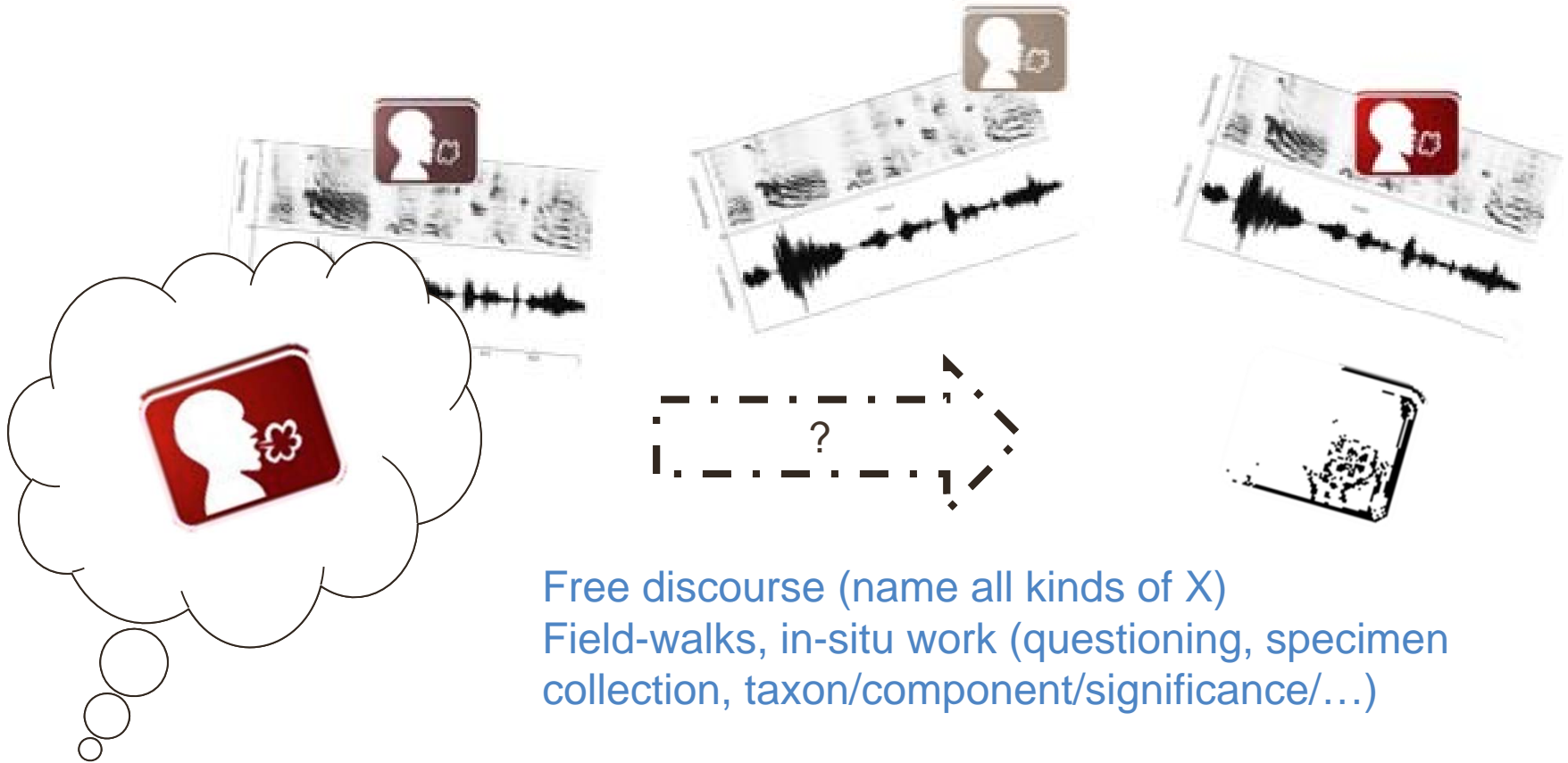
Result

Exemplars/lists



Observations annotated by various experts

Collaborative, group/individual interviews



expert

Material from the corpora will be subjected to semantic analysis, e.g.:



Result

- Increased/refined corpus
- Some idea of categories and inheritance

 ₁ ∈  ( is a member of a cat)

 ⊂ cough ( subclass of coughs)

∀x x ∈  ⊃ productive(x) ∧ hacking(x)

Members of a cat can be recognized by props:

∀x (productive(x) ∧ persistent(x)) ∧ x ∈ 

⊃ x ∈ 



Cognitivity – the missing link

How to realize “cognitivity” on data analysis/system level?

- Sensor City going to deliver 2 TB audio (raw) data per day
- offline analysis requires highly flexible, large scale data base system on PetaByte scale
- data structure and (cognitive) analysis algorithms subject of fundamental research for technical sciences and cognitive sciences
- series of workshops starting 4/2012
- **free sorting tasks:** cognitive sciences, mathematics, ICT
- **optimum data base technology:** cognitive sciences, astronomers, ICT

Thank you



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Ministerie van Economische Zaken



provincie Drenthe



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