Part XXI

Future of Informatics - Chapter 1

FUTURE (CHALLENGES) of INFORMATICS

(a new era - of Singularity - is coming!?)

CHAPTER 1

INTRODUCTION, FUTURE ?!!, CONTENTS

(What kind of future can we foresee for

information processing and mankind?)

SUMMARY

MAIN POSITIONS

- If you try to reach for the stars you may not always get one, but you won't come up with a handful of mud either.

  Leo Burnett

- One who is serious all day will never have good time, while one who is frivolous all day, will never establish a household.

  Ptahhotpe, 24 century B.C.

- A traveler who refuses to pass over a bridge until he has personally tested the soundness of every part of it is not likely to go far; something must be risked, even in mathematics.

  Horace Lamb

CONTENTS

- What can be expected from this lecture?
- Brief contents of all 13 lectures.
- Basic views of future and their developments
- Why we need and can get deep insides into future?
- Examples of some useful and some wrong predictions
- Abstractions from the past.
- Role of information, ICT and informatics in shaping future of mankind
- Vision of future and the *Black Swan* principle.
- Appendix

WHAT CAN YOU EXPECT TO GET from THESE LECTURES - I.?

- To understand a new view of evolution - as evolving from biological evolution to information-technological one and to their merge.
- To understand laws of the development of ICT and their impacts.
- To develop a new understanding of informatics and its grand challenges
- To understand potentials and impacts of GNR-revolution.
- To see that convergence of ICT and biology has reached a point to achieve simulation of the human brain and the development of a brain-computing.
- To envision a future in which information technology and science have advanced so far and so fast that they would enable humanity to transcend its biological limitations and that will transform our lives in ways we cannot yet imagine.
- A thought provoking envisages the future, which is closer than most people realize, in which mankind transcendents our biological limitations and that will have important and hard to imagine impacts.

WHAT CAN WE EXPECT to get from THIS LECTURE II?

- A clear-eyed and sharply focused vision of not so far ahead future, especially concerning our information and knowledge producing and processing future.
- Stunning, looking almost an utopia vision of the near future when machine intelligence outpasses that of our biological brains.
- An attractive and well guiding picture of a plausible future.
- A plausible vision of technology developments and their impacts and consequences for humans.
- To get a plausible vision of future in which information technologies develop so far and so fast that they enable humanity to transcend its biological limitations.

WHY ALL THAT CAN HAPPEN?

- Because improvements in information related technologies and methodologies (very) is and will rapidly accelerate.
- As a consequence the power of important ideas and technologies to transform the world is and will also rapidly accelerate.
- In particular, rapidly will accelerate development of non-biological intelligence and a merge of human and machine intelligence

Though many people may readily agree with these observations only very, very few really fully appreciate their profound implications.

BRIEF CONTENTS of ALL 13 LECTURES

Chapter 1: INTRODUCTION, SUMMARY, FUTURE

- What can you expected to get from this lecture?
- A brief content of the lecture.
- Why we need to know future?
- Deep views about future.
- How much we can envision future and what we can do for that?
- Story of the attempts to make predictions.
- How to get quite reliable predictions?
- Grounds for our predictions.
- Appendix - references

Chapter 2: EVOLUTION - FROM BIOLOGICAL to NON-BIOLOGICAL and to THEIR MERGE

A detailed analysis of the following six epochs of biological and non-biological evolution and their impacts:

- Epoch 1: Information is stored in basic physical and chemical structures.
- Epoch 2: Information is stored in DNA. Carbon-based compounds became more and more intricate until complex aggregations of molecules formed self-replicating mechanisms. Life originated and biological systems developed.
- Epoch 3: Information is in neural patterns and the brain develops as qualitatively new tool to store and process information.
- Epoch 4: Brain is used to develop intelligence and that in turn is used to develop various technologies to store and process information.
- Epoch 5: Non-biological intelligence develops and a merge of biological and non-biological intelligence follow.
- Epoch 6 Universe will be saturated with knowledge, non-biological intelligence and its processing.

Chapter 3: LAW of THE ACCELERATING RETURN for INFORMATION-DRIVEN TECHNOLOGIES

- An increase of order and complexity as main features of evolution
- The law of accelerating returns.
- Moore-law and its variations and fulfilment.
- Examples of the exponential growth of information processing technologies (ICT).
- Evolution as a sequence of paradigm shifts
- Five paradigm shifts behind ICT developments.
- Short history of information storing, transmission and processing
- Epilogue: the law of accelerating returns as an economic theory.

Chapter 4: NEW PERCEPTION of SCIENTIFIC INFORMATICS

- Old and new views of computer science
- Why are old views no longer acceptable and new needed?
- Information processing in nature - biological and quantum.
- Four basic components of Informatics.
- Basics of scientific Informatics.
- Grand challenges of scientific Informatics.
- Case studies.
- Informatics as a queen and servant of sciences.
- Other big challenges of scientific Informatics.
- What we can learn from history of Mathematics.
- Messages from the history of Physics.

Chapter 5: NEW PERCEPTION of ENGINEERING/TECHNOLOGICAL INFORMATICS

- Basics of engineering informatics
- Main grand challenges of engineering informatics.
- Relations between scientific and engineering informatics
- Other grand challenges of engineering informatics.
- Basics of applied informatics
- Grand challenges of applied informatics.

Chapter 6: VISIONS, ROAD and IMPULSES to a NEW PERCEPTION of INFORMATICS

- New perception of Informatics- its vision and its roots
- Growing understanding of the key importance of Informatics.
- Needs of the drive to knowledge society
- Informatics as a tool for cross-fertilization in research.
- Informatics as blurring out differences between pure and applied sciences
- Informatics as driving force of new education.
- Informatics as a support of multidisciplinarity
- Information processing as a driving force of life.
- Thoughts from physics community and lessons from history.
- Needs to develop meta-science and engineering of science
- Convergence of sciences to informatics.

Chapter 7: NEW, INFORMATICS-DRIVEN METHODOLOGY

- Main current methodologies of science
- Basic components of the new methodology.
- Power of the new methodology
- Case study I - Algorithms design and analysis; complexity theories.
- Case study II - Modeling and simulation
- Case study III - Visualisation.
- Grand challenges of new methodology

Chapter 8: MODELING and SIMULATION of HUMAN BRAIN and MIND

- Prologue
- New megaproject of EU: Human Brain Project.
- Towards new, sixth, paradigm of modern computing - 3-D molecular computing
- Information processing capacity of human brain?
- Can and when computers will reach information processing potential of human brains?
- Ultimate physical limits of computation.
- Information processing and life, cells and brain
- Reverse engineering of human brain.
- Modelling and simulation of the human brain - why can this be done?
- Pre-history of attempts to understand our own understanding.
- Building models of human brains.
- Interfacing brains and machines
- Getting Cyborg.
- Uploading the human brain (mind).
- Consciousness and information processing.
- Human Brain Project of EU revisited - more on goals

Chapter 9: GNR REVOLUTION AS a BASIS of SINGULARITY I.

- Prologue.
- Three overlapping revolutions, in Genetics, Nanotechnology and Robotics (strong AI), as paving the way to Singularity
- Genetics: the intersection of Biology and Informatics
- Biochemical information processing systems creating, reproducing and controlling the life
- Can we live "forever"?
- Biotechnology-driven ways to stop aging
- Cloning technologies and their potential.

Chapter 9: GNR REVOLUTION AS a BASIS of SINGULARITY II.

- Nanotechnology: the intersection of physics and informatics
- Nanotechnology goals and tools
- History of nanotechnology.
- Drexler's ideas
- Potential of nanotechnology in biology and medicine.
- Other potentials of nanotechnologies.
- Nanobots and their potentials.
- Vision of the developments of nanotechnology through citations and patents

Chapter 9: GNR REVOLUTION AS a BASIS of SINGULARITY III.

- Robotics and Strong AI
- Narrow AI - state of the art
- Toolkit of narrow AI.
- From narrow to strong AI
- Strong AI and robotics.
- Why it takes so long for AI to mature?

Chapter 10: SINGULARITY - LIFE AFTER (2045) a MERGE of BIOLOGICAL and NON-BIOLOGICAL INTELLIGENCE

- Deep thoughts
- Singularity and Singularitarians - basic views.
- Roads to Singularity and its visions
- Principles of Singularity.
- Basic impacts of Singularity
- Some key elements of singularity: nanobots and virtual reality.
- Long term impacts of Singularity - saturation of universe with AI
- A word of caution - what can we really expect?

Chapter 11: POTENTIAL DANGERS of GNR-REVOLUTION and WAYS to MANAGE THEM

- Deep observations
- Perils of genetics developments.
- Perils of nanotechnology
- Problems with nanobots.
- Perils of strong AI and Singularity
- Potentials of global and fine-grained relinquishment.
- Defence strategies

Chapter 12: LONGEVITY - LIFE OVER 100 (TILL 150?) - CAN WE FIGHT DEATH? HOW?

- Should and could we try to fight death?
- History of efforts for longevity.
- Why is nowadays longevity on the agenda of mankind?
- Roads to longevity.
- Centenarians
- Earth's ability to handle longer-lived humans.
- Would/can living longer mean living better?
- Family life during longevity.
- Economical and financial implications of longevity
- Religion in the age of longevity.

Chapter 13: HISTORY of INFORMATICS and BLACK SWAN PRINCIPLE

- Roots of the long history of informatics
- Pre-computer and post computer history of informatics.
- History of mathematics as a part of history of informatics
- History of biology and history of informatics.
- History of physics and history of informatics
- Black swan events and principle
- Can we manage unpredictable and uncertainty?
- Attempts to foresee future in the light of black swan principle.

FUTURE ???? - !!!!

CAN WE and NEED WE anticipate FUTURE?

(Especially of Informatics, ICT and mankind?)

and

Is such a question of large importance?

If yes, for whom?

IMPORTANCE of QUESTIONS

At the heart of everything is the question, not the answer.

John Archibald Wheeler (1911 - 2008)

OTHER KEY QUESTIONS

- Can we beat aging? How much and when?
- Can we beat death?
- Will we have computers with information processing power million (billion) times larger than that of human brain (humans brains)?
- Will we have computers (robots) with intelligence thousand (million) time larger than that of humans?
- If no, why? If yes, what afterwards? What impacts can this have?
- Does mankind has good reasons to ask such questions?
- Should "ordinary" people be interested in such questions?
- Should informaticians be interested in such questions?

WHY WE NEED to TRY HARD to FORESEE FUTURE?

- We should all be concerned about the future because we will have to spend the rest of our lives there.

  Ch. F. Kettering, 1949

- Most of you can expected to retire at the age 80 ± 10 and quite a few of you are expected to live over 100 (up to 150??).
- Developments in many aspects of society is no longer linear - it is already for quite a while exponential - knowledge of the past is not enough for forecasting future.

  R. Kurzweil (2006)

- Wisdom of parents is not enough for foreseeing future.

  R. Kurzweil (2006)

FAMOUS VIEWS of FUTURE I

- Nothing gets old as fast as the future.

  T. Grossman

- One of the biggest flaws in the common conception of future is that the future is something that happens to us, not something we create.

  Michael Anisimov

- The future ain't what it used to be.

  Jogi Berra

- The future is widely misunderstood. Our forebears expected it to be pretty much like their present, which had been pretty much like their past.

  R. Kurzweil

FAMOUS VIEWS of FUTURE II

- I have no doubts that the in reality the future will be much more surprising than anything I can imagine. My suspicious is that Universe is not only queerer than we suppose, but queerer than we can suppose.

  J. B. S. Holding (1892-1964) British evolutionary biologist

- The future enters into us in order to transform itself in us long before it happens.

  Rainer Maria Rike

- "The future cannot be predicted' is a common refrain....But, when this perspective is wrong it is profoundly wrong.

  John Smart

FAMOUS VIEWS of FUTURE III

- Change is the law of life. Those who look only to the past or presence are certain to miss the future.

  John F. Kennedy

- Any sufficiently advanced technology is undistinguishable from magic

  Arthur Ch. Clarke

- Everyone takes the limits of his own vision for the limits of the world.

  Arthur Schopenhauer

- Almost everyone has linear view of the future - namely that development in the next X years will be similar to the one during last X years.

  R. Kurzweil

FAMOUS VIEWS of FUTURE IV

- Why it is so difficult to see future? Because people in general tend to overestimate what can be achieved in short terms (because we tend to leave out of our considerations many essential details) and they tend underestimate what can be achieved in long terms (because the exponential growth is ignored).

  R. Kurzweil (2006)

- People find it easier to be the consequence of the past than the course of the future.

  R. Kurzweil (2006)

FAMOUS GOOD PREDICTIONS

- Predictions are difficult, especially about the future.

  Niels Bohr (1885-1962

- Science fiction literature - Julius Verne (1828-1905), Herbert George Wells (1866-1946), Stanislaw Lem (1921–2006), Arthur Ch. Clarke (1917-2008), Isaac Asimov (1920-1992) ...
- Science fiction movies

Science fiction predictions are good because they are stimulating by showing as to-be-possible what is not known to be impossible.

Famous wrong predictions of famous Lord Kelvin (1824-1907)

- X-rays will prove to be a hoax.
- Radio has no future.
- Heavier-than-air flying machines are impossible.
- In science there is only physics; all the rest is stamps collecting.
- There is nothing new to be discovered in physics now.

Famous wrong information processing and communication predictions

1939 The problem with television is that people must sit and keep their eyes glued to the screen; the average American family hasn't time for that. *New York Times editorial*

1943 I think there is a world market for maybe five computers. Thomas Watson, 1943)

1949 Where a calculator on ENIAC is equipped with 18 000 vacuum tubes and weights 30 tons, computers in the future may have only 1000 vacuum tubes and weight no more than 1.5 tons (A visionary Popular mechanics article);

1957 I have traveled the length and breadth of this country and talked with the best people, and I can assure you that data processing is a fad that won't last out the year. (The editor in charge of business books for Prentice Hall);

1977 There is no reason anyone would want a computer in their home. (Ken Olson, president, chairman and founder of Digital Equipment Corp.);

1981 640K ought to be enough for anybody (Bill Gates)

Famous wrong or questionable predictions III

- Numerous The end of the world is coming predictions.
- Famous prophetess (Delphi in Greece)
  - Question of a women: What I will have, boy or girl?
  - Answer of the Oracle: Boy no girl.
  - Interpretation I: "Boy, no girl"
  - Interpretation II: "Boy no, girl"
- Astrologers, numerologers

FAMOUS CORRECT PREDICTIONS

- Cooking
- Sex of a to be born child
- Impacts of atomic bombs
- Internet around 1966

WHEN THERE IS a CHANCE TO MAKE GOOD/DEEP PREDICTIONS?

- When resources for new developments start to be available.
- When a new law of nature is discovered.
- When a new powerful resource in nature is discovered.
- When a new scientific discovery is made.
- When a significantly new technological achievement is made.
- When a way is found to see local developments from a global perspectives. (For example weather forecast on the basis of photos from satellites.)

WAYS to MAKE PREDICTIONS

- Religious believes
- Astronomy (movements of celestial bodies, eclipse on the sun/moon),...
- Astrology - even Newton and other famous scientists of that time believed in astrology
- Science (laws of physics (of motion, ...); differential equations, probability and statistics, Bayesian rule, economics, finances,
- From deterministic to probabilistic predictions.

Science has two goals:

- To explain
  - To explain phenomena in its domain.
  - To explain past and presence
- To predict.
  - To predict future of phenomena and processes in its domain.
  - To predict future of mankind

ABSTRACTION (not INDUCTION) from THE PAST DEVELOPMENTS

ABSTRACTIONS from the PAST DEVELOPMENTS

THREE ERAS of MANKIND

Neolithic era: Progress was made on the basis that men learned how to make use of the potentials provided by the biological world to have **food** available in a sufficient amount and whenever needed.

Industrial era: Progress has been made on the basis that men have learned how to make use of the laws and limitations of the physical world to have **energy** available in a sufficient amount and whenever needed.

Information era: Progress is and will be made on the basis that man learns how to make use of the laws and limitations of the information world to have **information** (processing energy) available in a sufficient amount and whenever needed.

VISION - THE FOURTH ERA of MANKIND

Neolithic era: Progress was made on the basis that men learned how to make use of the potentials provided by the biological world to have **food** available in a sufficient amount and whenever needed.

Industrial era: Progress has been made on the basis that men have learned how to make use of the laws and limitations of the physical world to have **energy** available in a sufficient amount and whenever needed.

Information era: Progress is and will be made on the basis that man learns how to make use of the laws and limitations of the information world to have **information** (processing energy) available in a sufficient amount and whenever needed.

Security era: Progress is and will be made on the basis that man learns how to make use of the laws and limitations of the physical and information worlds to have **security** available in a sufficient amount and whenever needed.

ANOTHER VIEW of HISTORY

If we try to see the development of the last three centuries we can discover, from the science and technology point of view, the following common scenarios.

19th century was mainly influenced by the first industrial revolution that had its basis in the classical mechanics discovered, formalized and developed in the 18th century.

20th century was mainly influenced by the second industrial revolution that had its basis in electrodynamics discovered, formalized and developed in the 19th century.

21th century can be expected to be mainly influenced by informatics, especially AI, discovered, formalized and developed in the 20th century.

DEVELOPMENT of VIEWS on COMPUTING

- 19th century

  Computing (information processing) is a mental process.
- 20th century

  Computing (information processing) is a machine process.
- 21th century

  Computing (information processing) are nature processes.

HOW GOOD PREDICTIONS ARE POSSIBLE?

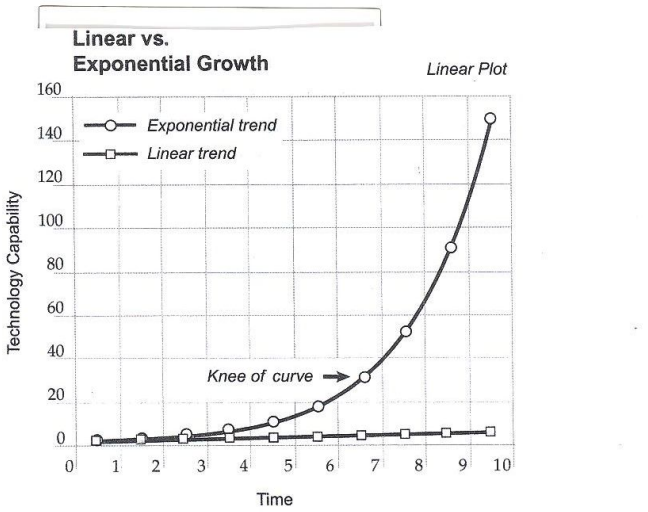
Full and detailed predictions are not always impossible, but when the past, recent and current developments are carefully analysed, and proper abstraction from that is made, quite a bit can be said for future with quite large reliability.

WHAT WILL the LECTURE BE ABOUT? SUMMARY

- An analysis of the recent and current developments in and due to the progress in the information and knowledge mining, storing, processing, transmission and utilization theory and technology as well as a new informatics-driven methodology.
- Well scientifically and technologically grounded and imaginative speculations on the development and impacts of the information and knowledge mining, storing, processing, transmission and utilization theory and technology, as well as a new informatics-driven methodology .

BASIS of OUR EXPECTATIONS

- Technological knowledge of mankind is fast snowballing with dizzying prospect for future.
- Computers, and IPC technologies, are getting not only faster and faster they are getting faster faster (that is, the rate they are getting faster is increasing). They are not only getting better and better, they are getting faster and faster better.
- ICT performance is expected to keep growing exponentially in all important aspects.
- Tools for making better and better as well faster and faster reverse engineering of our brains also keep improving exponentially.
- Miniaturization of IPC technologies also keep improving exponentially what is expected to have enormous impact on treatment of human bodies.



Linear versus exponential: Linear growth is steady; exponential growth becomes explosive.

- Moreover, we can assume that we are nowadays only at the beginning of the rapidly fast growing exponential curves for all these improvements.
- All that is expected to have, practically for sure, enormous impacts.

A BIG CONSEQUENCE

- As a first consequence, of the increasingly faster development in ICT and AI, one should realize that the development of almost all areas of society will speed up so fast that what would happen in the next 1000 (500) years at the current rate od development will actually happen within next 100 (40) years. It is therefore beyond our full understanding how life will look in 30-40 years. However,...
- Since current informatics students are expected to retire at the age 80 ± 10 years, or more, you can expect that during your (working) life time you can expect what you can now hardly not only expect but also imagine.

ANOTHER FORMULATION of BIG CONSEQUENCE

Now the world is networked, and ideas are having sex with each other more promiscuously than ever, the pace of innovation will redouble and economic evolution will raise the living standard of 21st century to unimaginable heights, helping even the poorest in the world to afford to meet their desires as well as their needs.

M. Ridley, 201O

A WORD of CAUTION - impacts of the Black swan principle

History teaches us that big progress usually comes from discoveries, inventions and events nobody expects - from so-called Black Swan events.

They are events such that

- They are completely unexpected.
- They have enormous impact.
- Once they happen one can convincingly argue that we should have expected them.

How can the Black swan principle goes along with the conviction that we can foresee future concerning information-driven evolution quite a bit?

HOW MUCH CAN INFORMATICS SHAPE FUTURE?

- Very much and this is another point, to be discussed later, for having this lecture

APPENDIX

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Ray Kurzweil I

RAY KURZWEIL II

- Ray Kurzweil is a very prominent inventor (in several fields), companies founder, science writer and a visionary in USA. He is Director of Engineering at Google.
- He received, from the US president Clinton, National medal of Technology, the highest award for technology achievements, he holds 39 US patents got, 12 honorary doctorates, wrote 5 best-sellers books, and gives in average 60 pubic lectures per year.
- In February 2011 Time magazine published about his ideas 8 pages article with title "2045 - the year man becomes immortal"
- He has been in the 5-member Advisory committee for US army for science and technology.
- He is the founder of the Singularity university, series of conferences "Singularity summit".
- Kurzweil made fortune as inventor and engineer. Recipient of 500 000 Lemensoln-MIT prize in 2001. Prominent US-magazine consider him as one of 16 revolutionaries that made America during last two centuries.
- He was first to invent print-to-speech reading machine for the blind, first commercial text-to-speech synthetizer,....

From noise to wisdom - George Santayana

- Noise becomes date when it has a cognitive pattern.
- Data becomes information when assembled into a coherent whole, which can be related to other information.
- Data become information when they are meaningful in a process
- Information becomes knowledge when integrated with other information in a form useful for making decisions and determining actions.
- Order is information that fits a purpose.
- Knowledge becomes understanding when related to other knowledge in a manner useful in anticipating, judging and acting.