NOKIA Bell Labs

The Future of Software Development

How Open Source and AI are reshaping the way the world builds software

Tom Van Cutsem
Nokia Bell Labs
@tvcutsem

Bell Labs: the global innovation engine of Nokia

9 Nobel Prizes

4 Turing Awards

3 Emmys

2 Grammys

1 Oscar

Foundations of …

- The entire electronics industry
- The internet, networking and optics
- Mobile and fixed communications

Transistors

Satellite comms

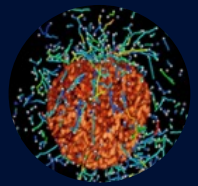
Laser/fiber optics

Unix/C/C++

Solar cells

Coherent optics

Charge-coupled devices



Super-resolution microscopy

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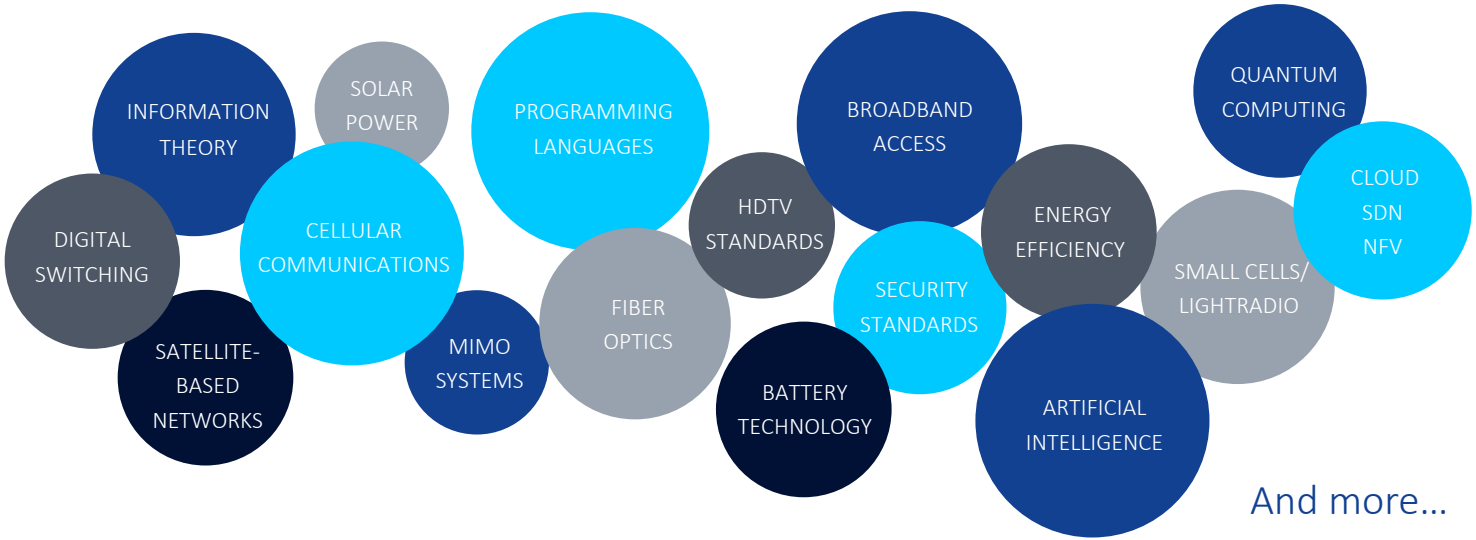
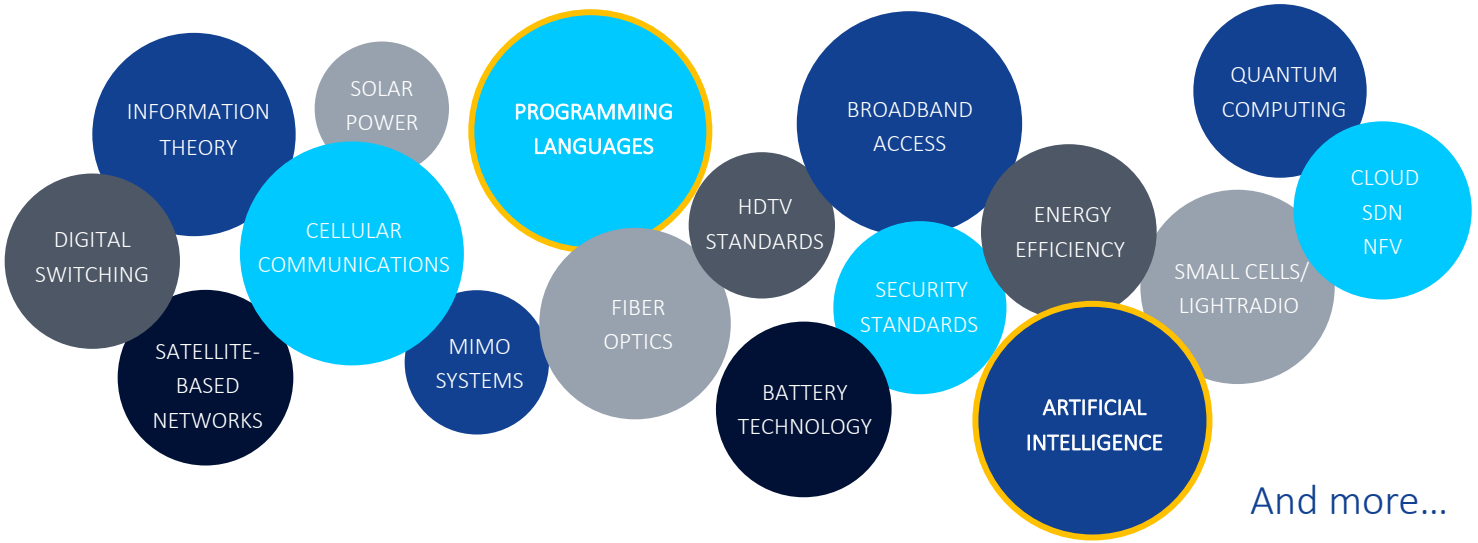
What is Bell Labs working on today?



Solving the Big Challenges in Information and Communications Technology

NOKIA Bell Labs

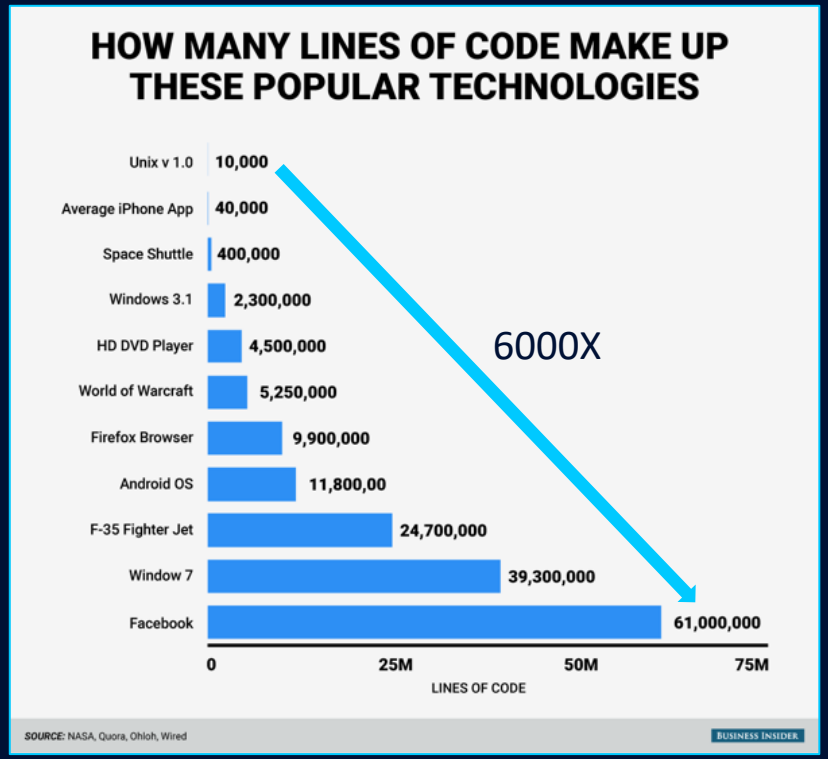
What is Bell Labs working on today?



Solving the Big Challenges in Information and Communications Technology

NOKIA Bell Labs

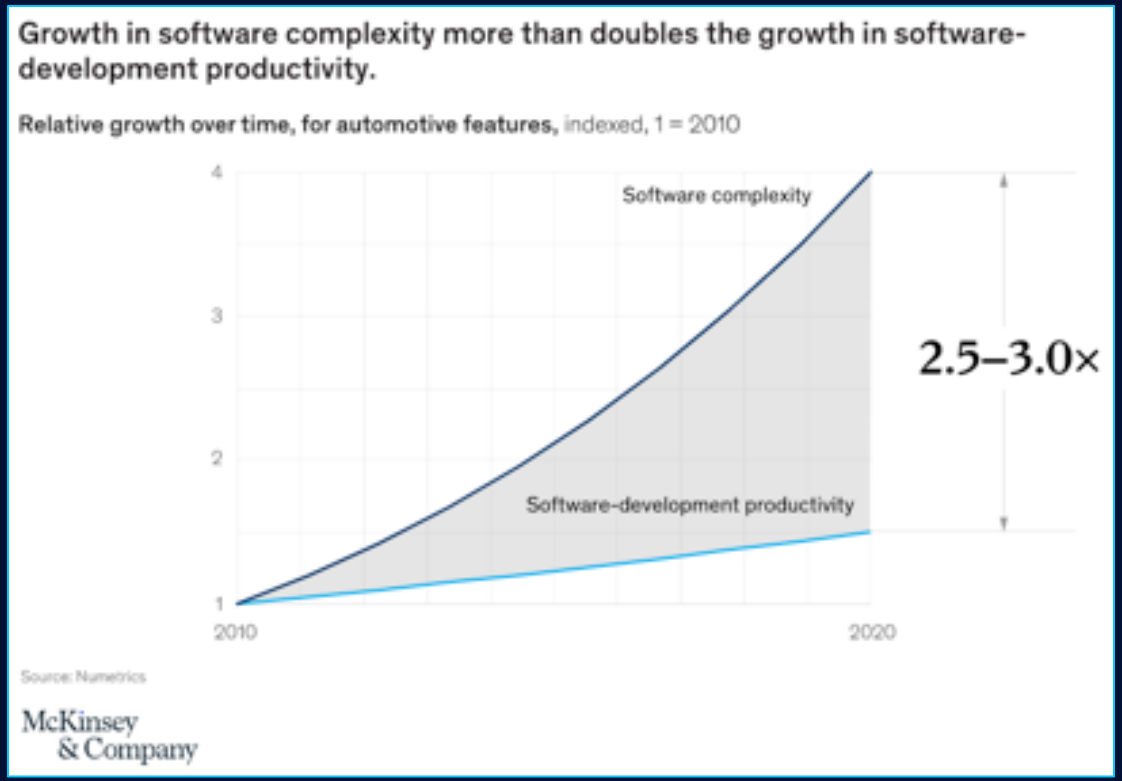
Software is growing ever more complex…



"Google runs on 5000 times more code than the original space shuttle"

(World Economic Forum, 2016)

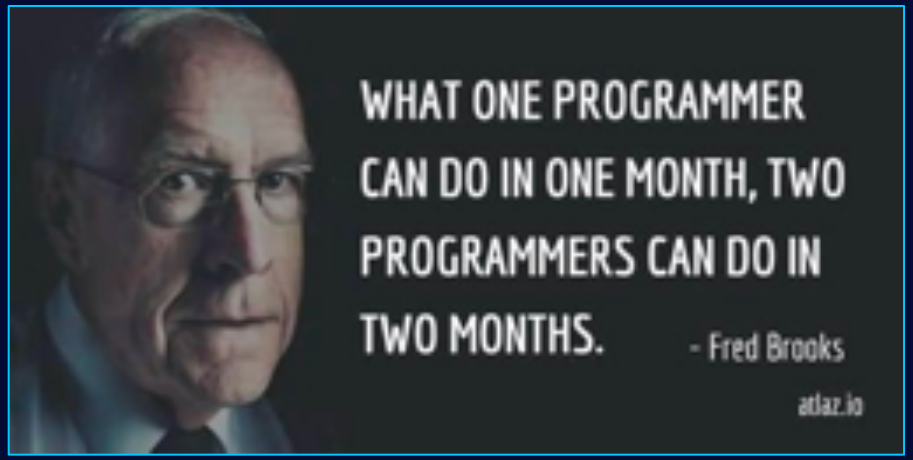
… and humans can’t keep up

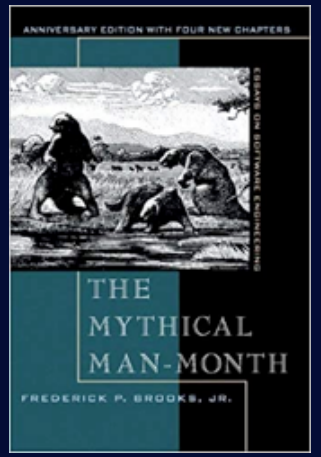



Kronograaf
amserv
amserv-offers
amserv-services
lnpb (andrei)
lnpb-android
codeborne-ta
codeborne-wtb
coreless
edrk
ibank
inwise
panda
pixamo-partner-site
primefinance
slice project
wizener-reader-java
wizener-web


EXIT
DELL

Problem: software does not scale with human labor





Brooks's Law:
"adding manpower to a late software project makes it later"

pro’·gram·mer

An organism that converts caffeine into code

Developer Tools

Software Systems

UNIX

Make

Spin

Coq

GCC

LLVM

eclipse

jupyter

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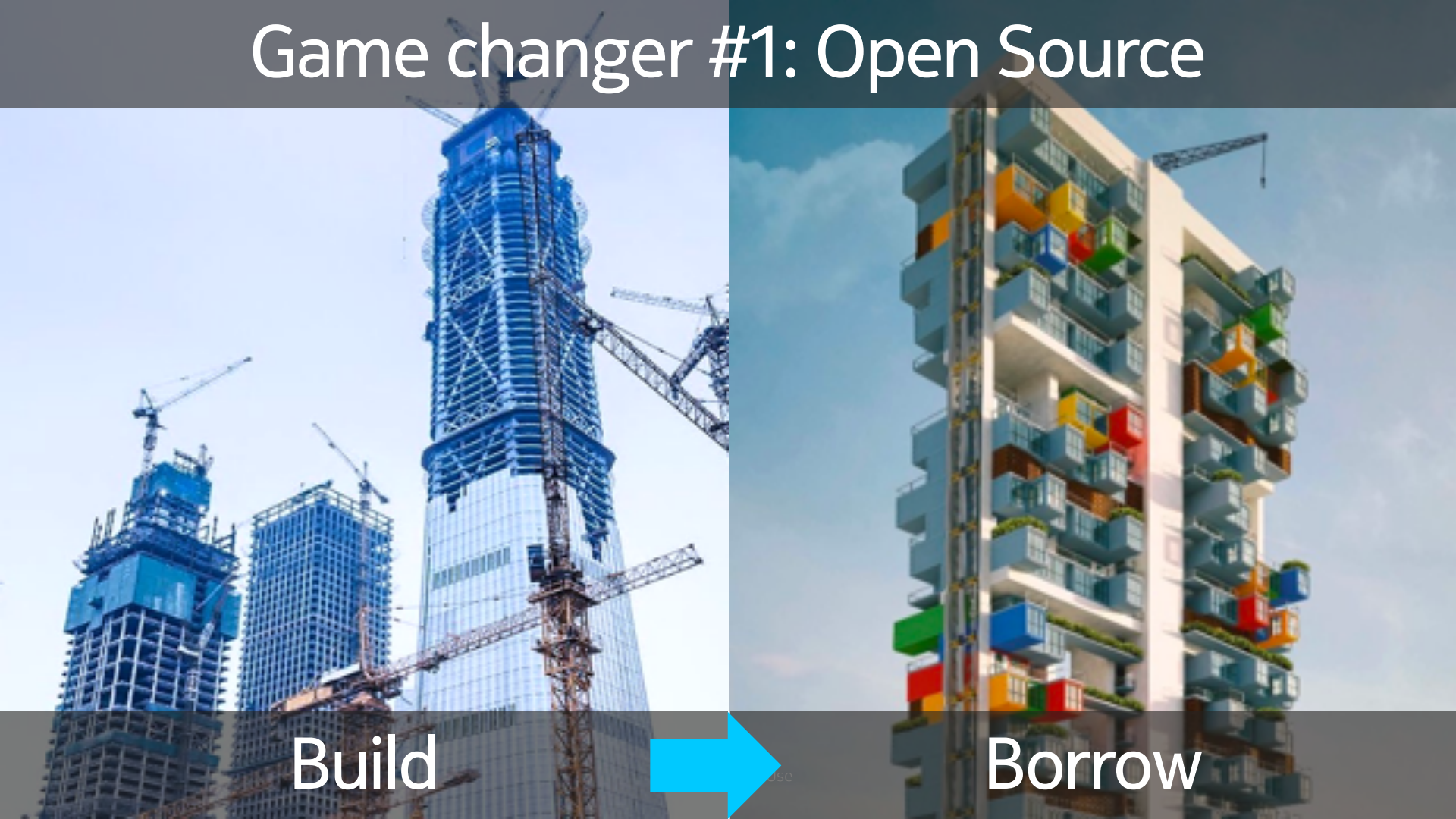
Game changer #1: Open Source



Modern software stacks: powerful, but complex

ML model building & training	scikit learn	Keras TensorFlow	PyTorch mxnet
Data analysis & visualization	matplotlib	Seaborn	Pandas
Vector math	NumPy	SciPy	
Parallel data processing	PySpark	DASK	
Language & Tools	python	jupyter	ANACONDA.

Example: the modern Python machine learning software stack

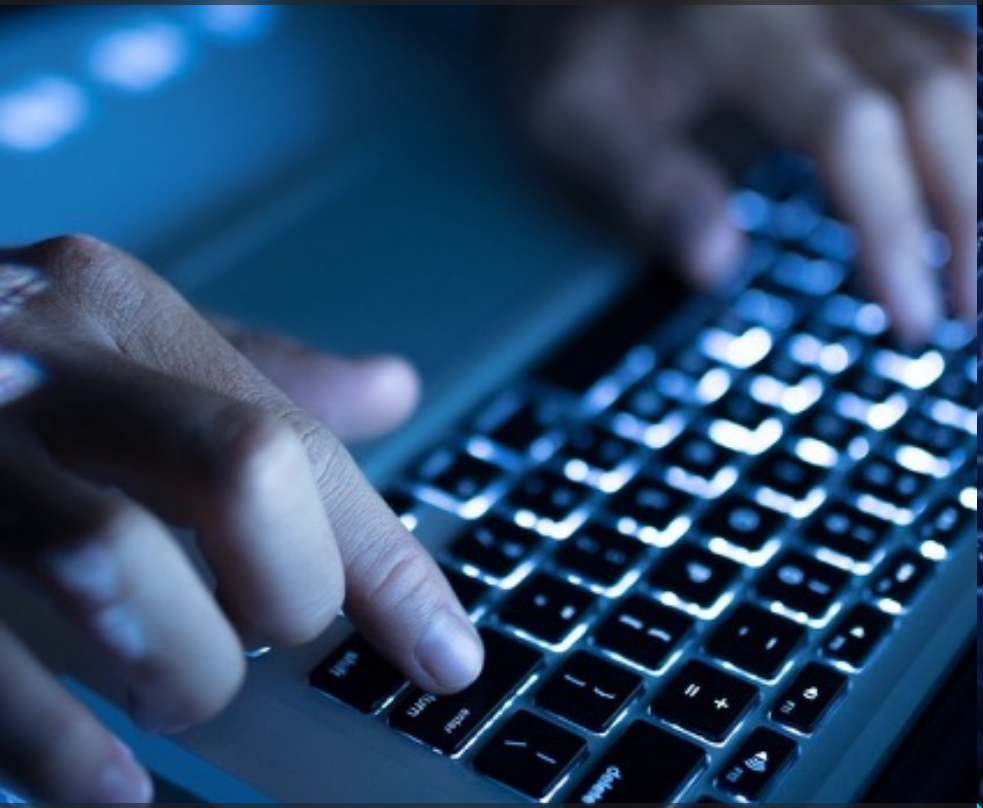
Developers waste significant time on finding and adapting existing code

up to 93%
of developers search for reusable code online
[Hucka et al., J. Systems and Software, 2018]

up to 35%
of developer worktime is spent on code search
[Xia et al., J. Empirical Software Engineering, 2017]

up to 66%
of community answers on StackOverflow are outdated compared to their original source
[Ragkhitwetsagul et al., IEEE Trans. Softw. Eng., 2018]

Game changer #2: AI



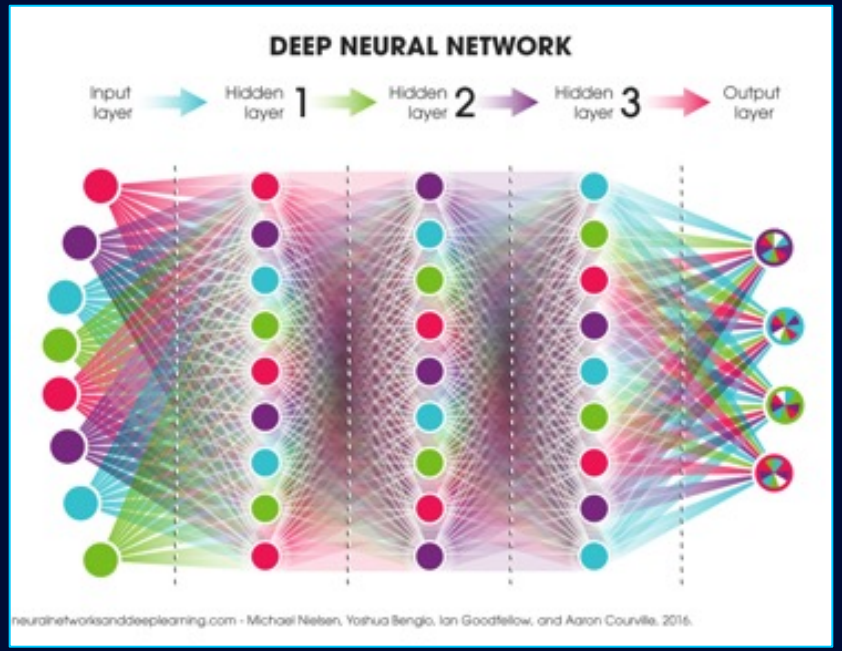
Program

Learn

Machine learning is all about **prediction**

Machine learning is all about **prediction**

Given X

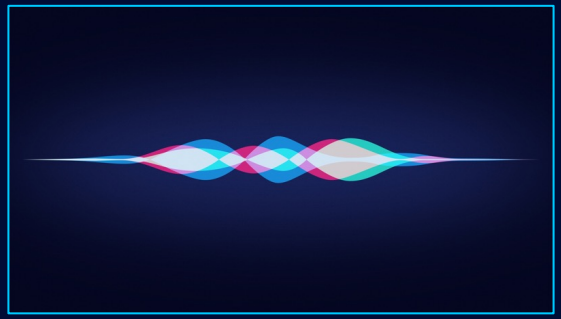


Predict Y

Learn from many (X, Y)

Deep neural networks enable computers to work with “natural” inputs

Vision

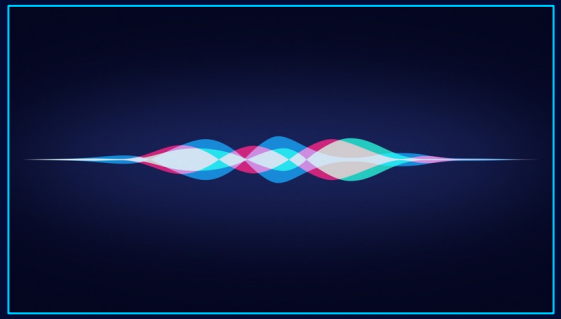


Speech

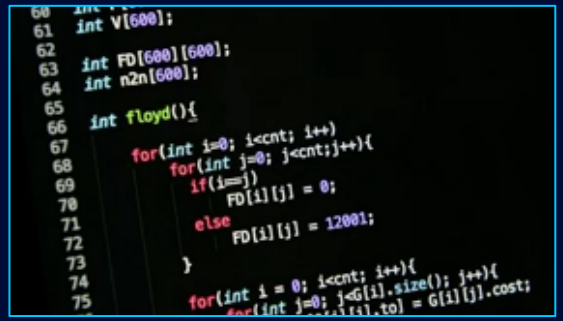
Text

Deep neural networks enable computers to work with “natural” inputs

Vision



Speech



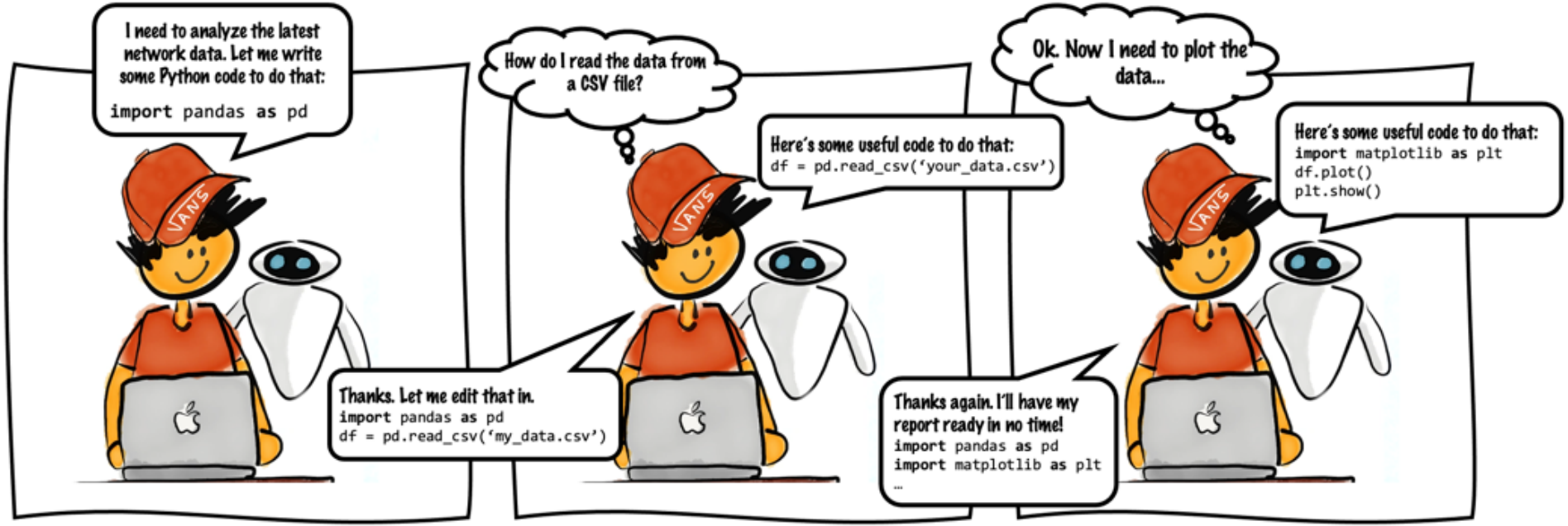
Code?

Bell Labs is betting on AI Pair Programmers

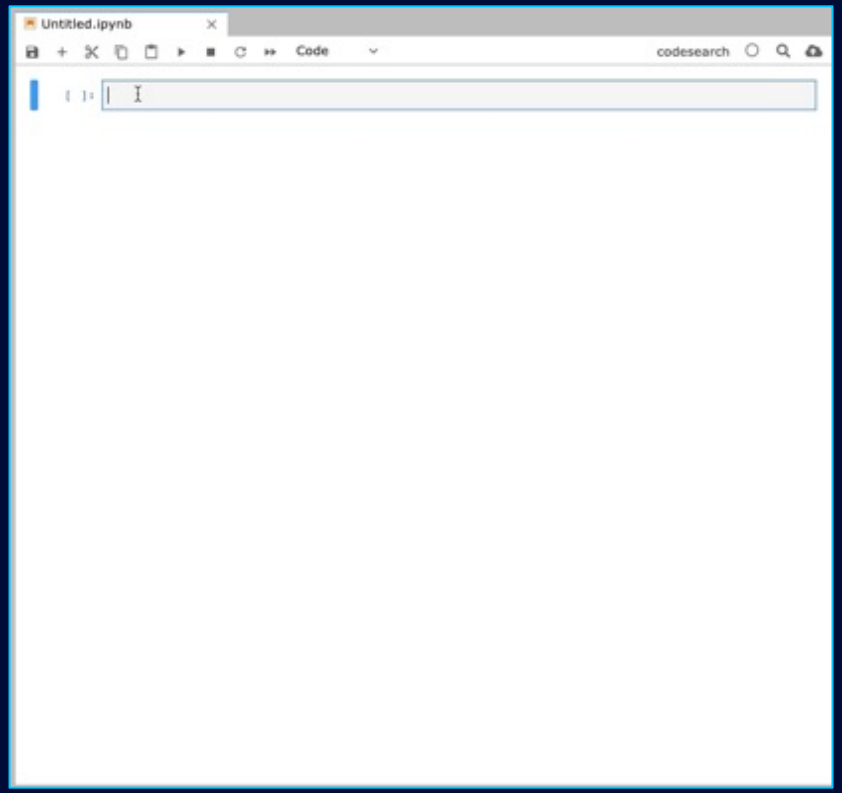
- “Augment” human intelligence with artificial intelligence
- Developer tools that leverage Machine Learning to “understand” existing codebases and API documentation
- Enable developers to write better code, faster

AI Pair Programming

AI Pair Programming



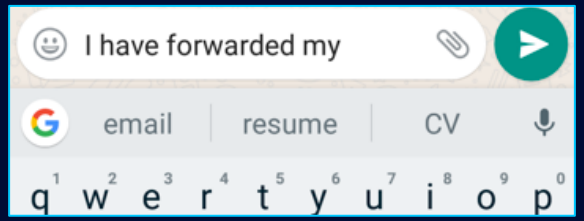
AI Pair Programming



Machine Learning is all about **prediction**

(image credits: kdnuggets.com ; M. Rathore, mohitatgithub.github.io)

Machine Learning is all about **prediction**



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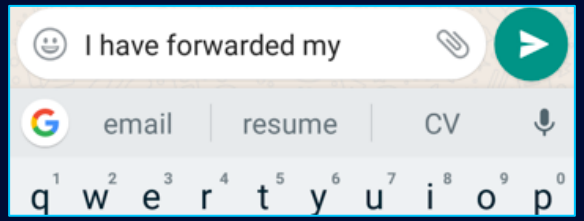


```
for (i = 0; i < n; ____ )
```

(image credits: kdnuggets.com ; M. Rathore, mohitatgithub.github.io)

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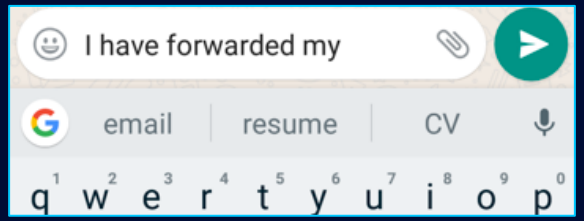
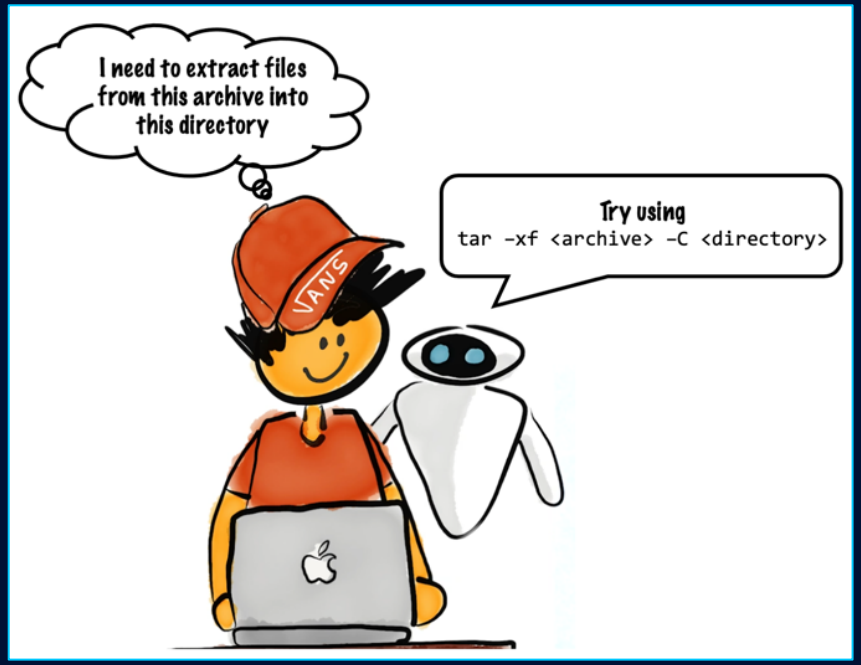



```
for (i = 0; i < n; i++ )
```

(image credits: kdnuggets.com ; M. Rathore, mohitatgithub.github.io)

AI Pair Programming on the command line



AI assistant that can translate natural language commands into CLI commands

NLC2CMD Leaderboard

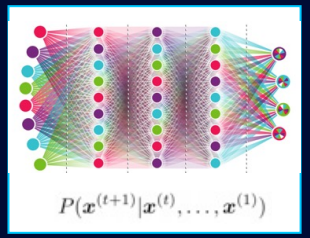
Team Name	Accuracy	Energy (mW)
Magnum	0.532	682.3
Hubris	0.513	809.6
jb	0.499	828.9
AICore	0.489	596.9
DeepBlueAI	0.482	670.7

- 2020 Summer internship by **KU Leuven** student
- Won **2nd Place** in NLC2CMD AI competition (organized by IBM)
- Invited to present at **NeurIPS** workshop
- github.com/nokia/nlc2cmd-submission-hubris

Bell Labs AI Pair Programmer tools

Source **code** and API documentation

Train AI **models**

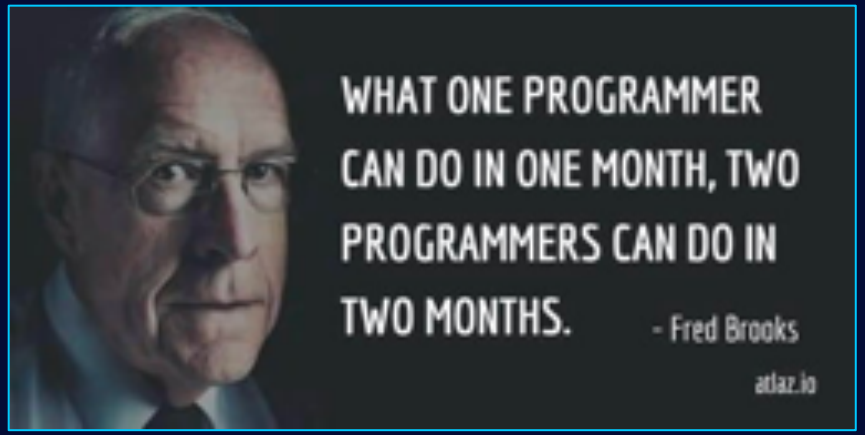


Actionable **tools** for Nokia R&D

Summary

- Software is growing ever more complex… and humans can’t keep up
- Machine Learning enables us to reimagine developer tools
- Bell Labs is building AI Pair Programmers to augment human programmers

The take-away



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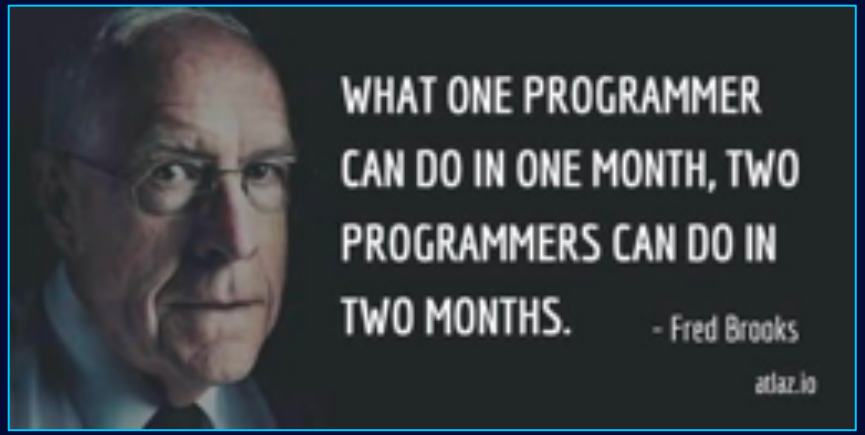

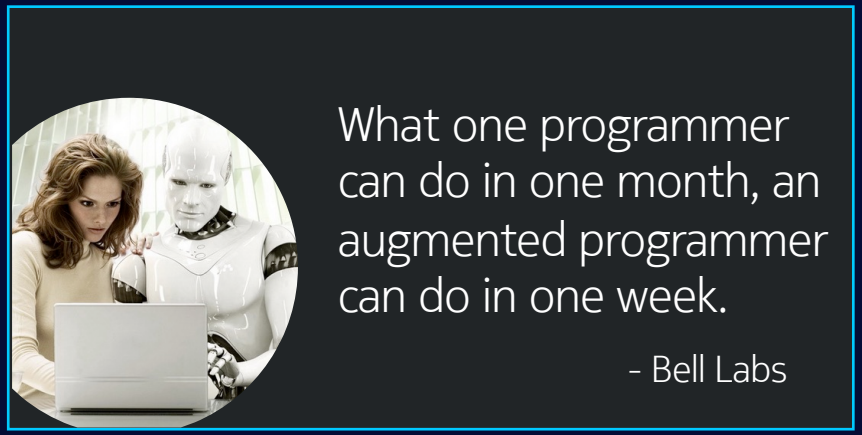

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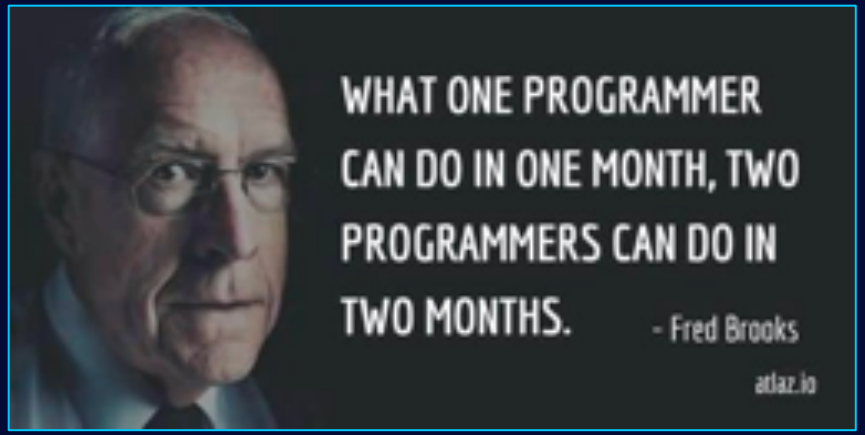

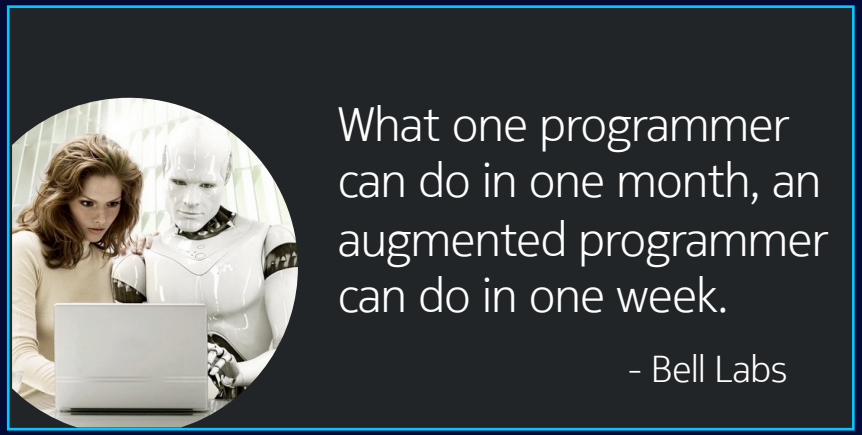

Tom Van Cutsem

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Thanks for listening!

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