INTEL DISTRIBUTION FOR PYTHON – ADVANTAGES AND ACCELERATION OF MACHINE LEARNING WORKLOADS

Intel Software Developer Conference – London, 2017

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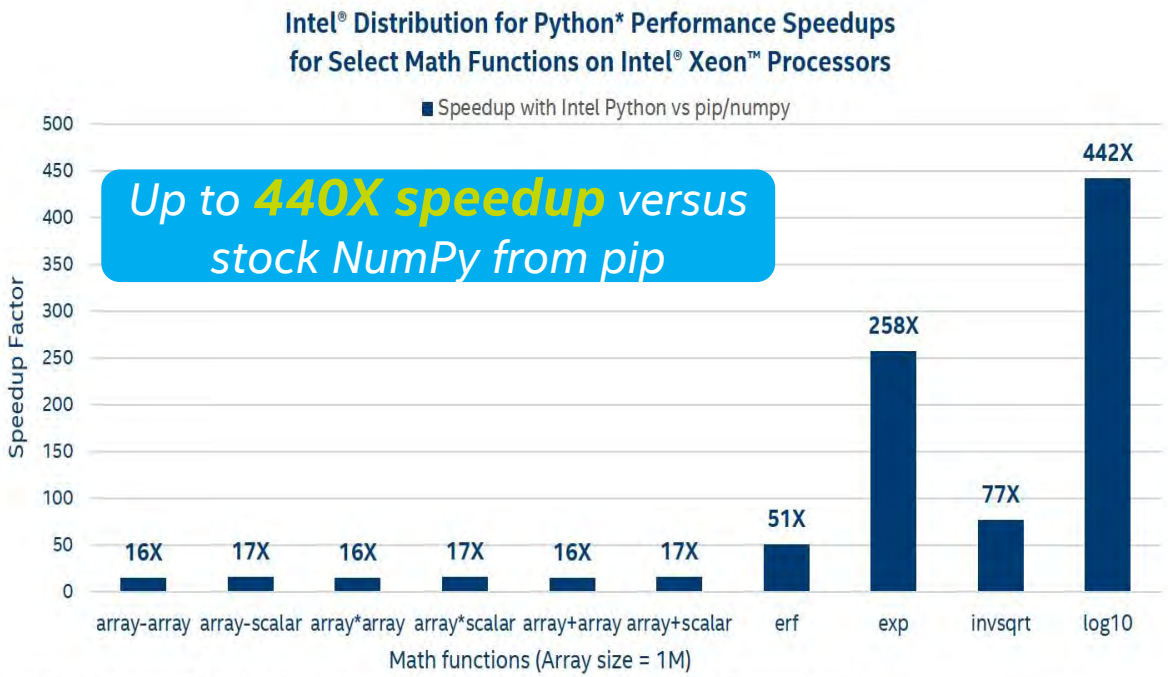
Notice revision #20110804

Faster Python* with Intel® Distribution for Python 2018



Configuration: Hardware: Intel® Xeon® CPU E5-2699 v4 @ 2.20GHz (2 sockets, 22 cores per socket, 1 thread per core – HT is off), 256GB DDR4 @ 2400MHz.
Software: Stock: CentOS Linux release 7.3.1611 (Core), python 3.6.2, pip 9.0.1, numpy 1.13.1, scipy 0.19.1, scikit-learn 0.19.0. Intel® Distribution for Python* 2018 Gold: mkl 2018.0.0 intel_4, daal 2018.0.0.20170814, numpy 1.13.1 py36_intel_15, openmp 2018.0.0 intel_7, scipy 0.19.1 np113py36_intel_11, scikit-learn 0.18.2 np113py36_intel_3

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Learn More: software.intel.com/distribution-for-python

High Performance Python Distribution

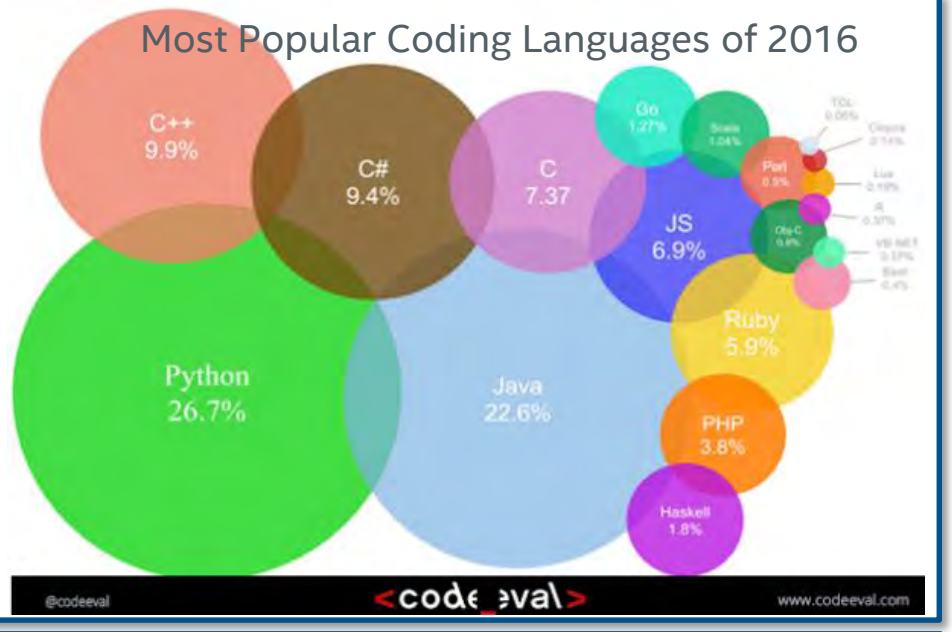
- Accelerated NumPy, SciPy, scikit-learn well suited for scientific computing, machine learning & data analytics
- Drop-in replacement for existing Python. No code changes required
- Highly optimized for latest Intel processors
- Take advantage of Priority Support – connect direct to Intel engineers for technical questions[2]

What's New in 2018 version

- Updated to latest version of Python 3.6
- Optimized scikit-learn for machine learning speedups
- Conda build recipes for custom infrastructure

Python* Landscape

Adoption of Python continues to grow among domain experts & developers for its productivity benefits



Challenge#1

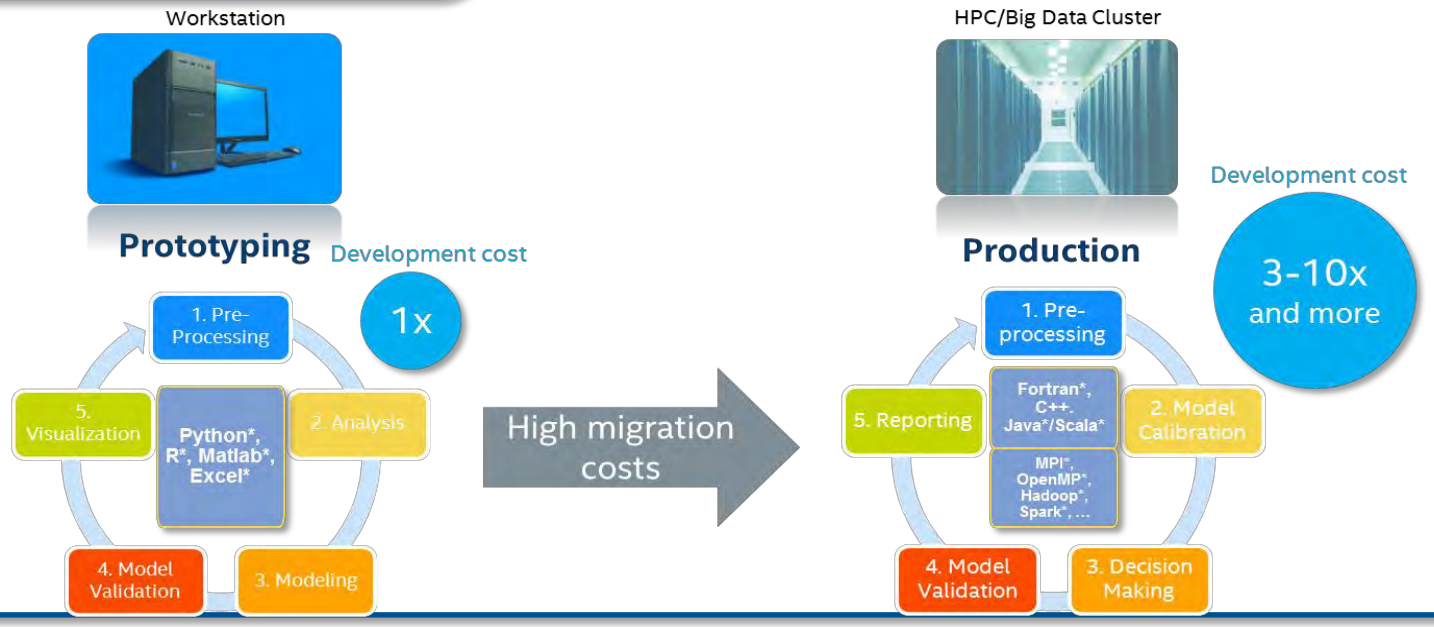
Domain experts are not professional software programmers

Intel's Python Tools

- Accelerate Python performance
- Enable easy access
- Empower the community

Challenge#2

Python performance limits migration to production systems



What's Inside Intel® Distribution for Python

High Performance Python* for Scientific Computing, Data Analytics, Machine Learning

FASTER PERFORMANCE	GREATER PRODUCTIVITY	ECOSYSTEM COMPATIBILITY
Performance Libraries, Parallelism, Multithreading, Language Extensions	**Prebuilt & Accelerated Packages**	**Supports Python 2.7 & 3.6, conda, pip**
Accelerated NumPy/SciPy/scikit-learn with Intel® MKL[1] & Intel® DAAL[2]	Prebuilt & optimized packages for numerical computing, machine/deep learning, HPC, & data analytics	Compatible & powered by Anaconda*, supports conda & pip
Data analytics, machine learning & deep learning with scikit-learn, pyDAAL	Drop in replacement for existing Python - No code changes required	Distribution & individual optimized packages also available at conda & Anaconda.org, YUM/APT, Docker image on DockerHub
Scale with Numba* & Cython*	Jupyter* notebooks, Matplotlib included	Optimizations upstreamed to main Python trunk
Includes optimized mpi4py, works with Dask* & PySpark*	Conda build recipes included in packages	Commercial support through Intel® Parallel Studio XE 2017
Optimized for latest Intel® architecture	Free download & free for all uses including commercial deployment	

Intel® Architecture Platforms

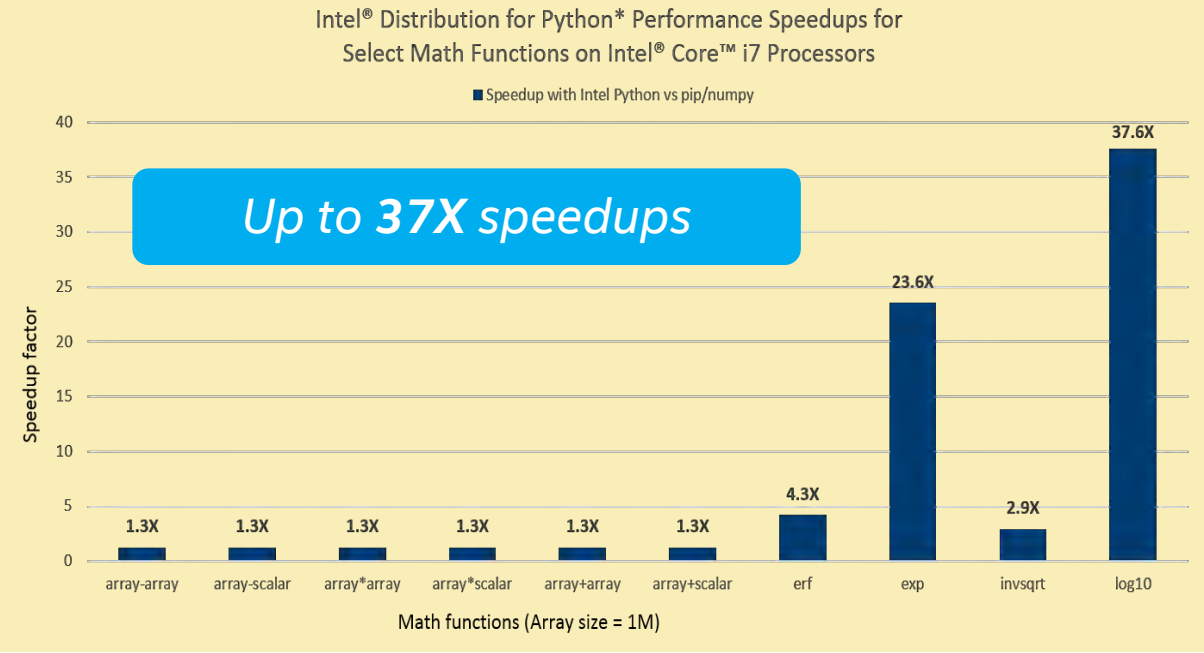
Operating System: Windows*, Linux*, MacOS[1]*

[1]Intel® Math Kernel Library
[2]Intel® Data Analytics Acceleration Library

[1] Available only in Intel® Parallel Studio Composer Edition.

UMath Optimizations & Vectorization to Utilize Multiple Cores, Memory Management

Intel® Core™ i7 Processor



Hardware: Intel® Core™ i7-7567U CPU@3.50GHz (1 socket, 2 cores per socket, 2 threads per core), 32GB DDR4 @ 2133MHz. Intel® Xeon® CPU E5-2699 v4@2.20GHz (2 sockets, 22 cores per socket, 1 thread per core-HT is off), 256GB DDR4@2400MHz. Intel® Xeon Phi™ CPU 7250@1.40GHz (1 socket, 68 cores per socket, 4 threads per core), 192GB DDR4 @1200MHz, 16GB MCDRAM@7200MHz in cache mode
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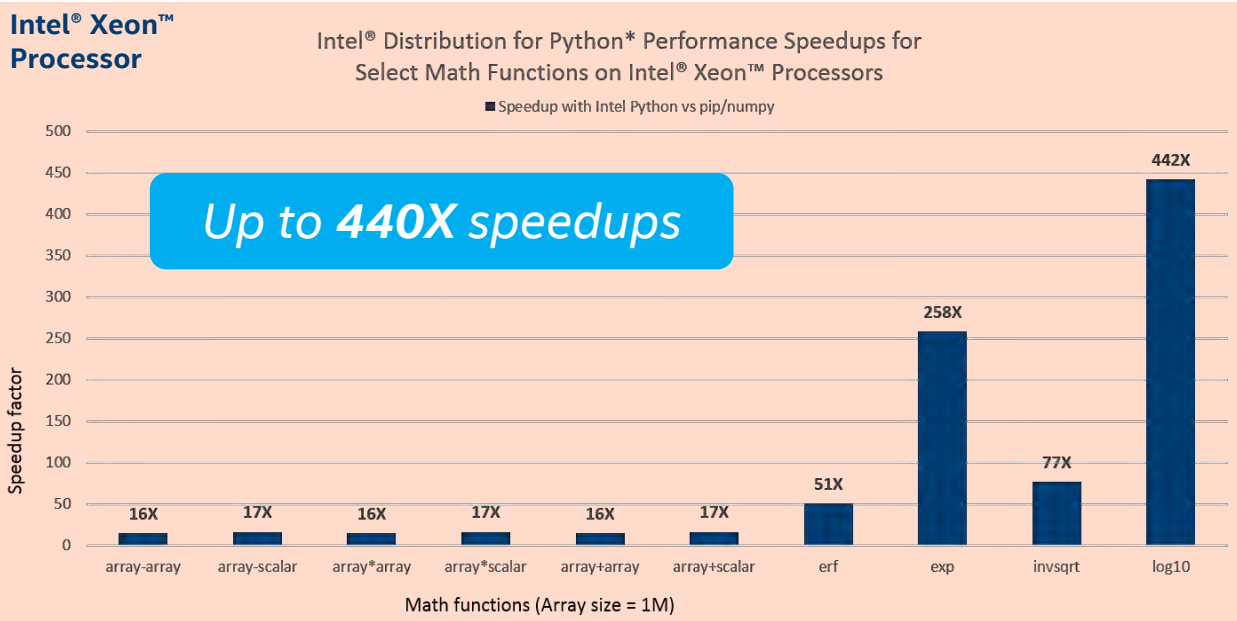
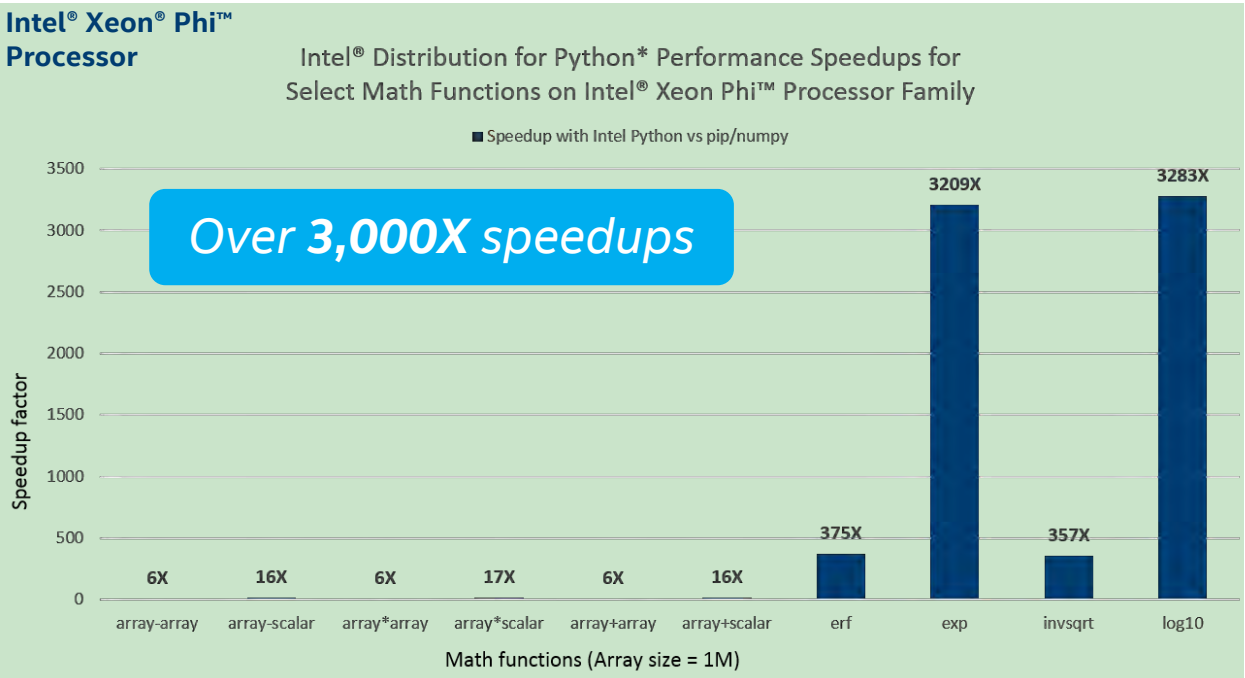
Intel® Xeon™ Processor

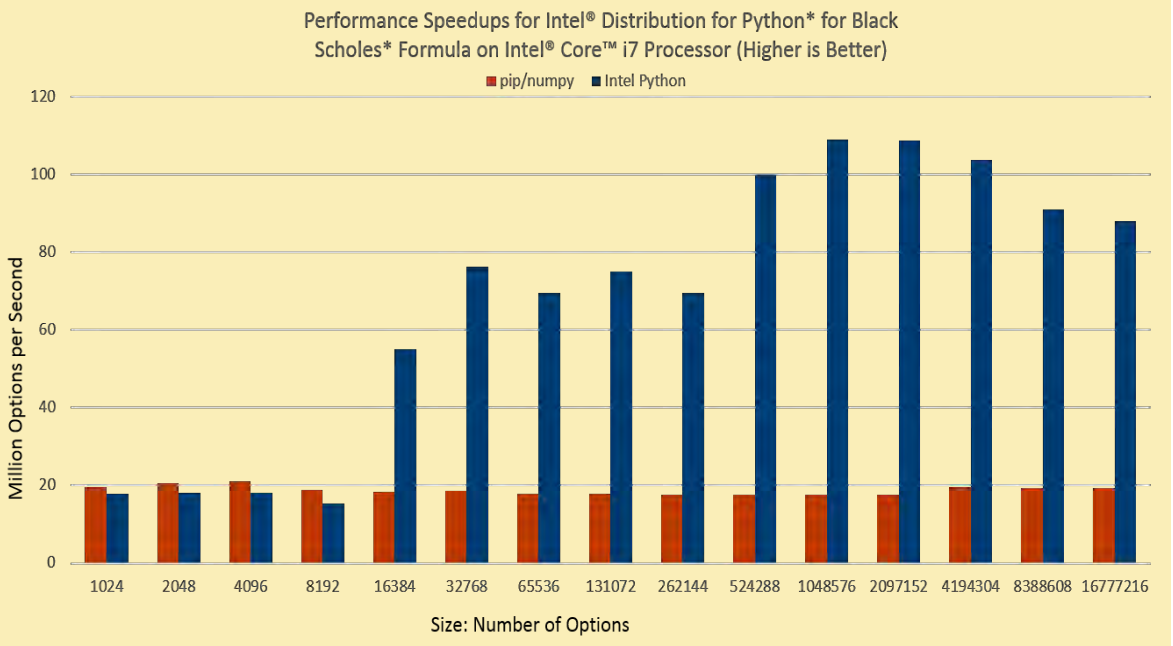


Intel® Xeon® Phi™ Processor



Performance Speedups for Black Scholes Formula

Intel® Core™ i7 Processor



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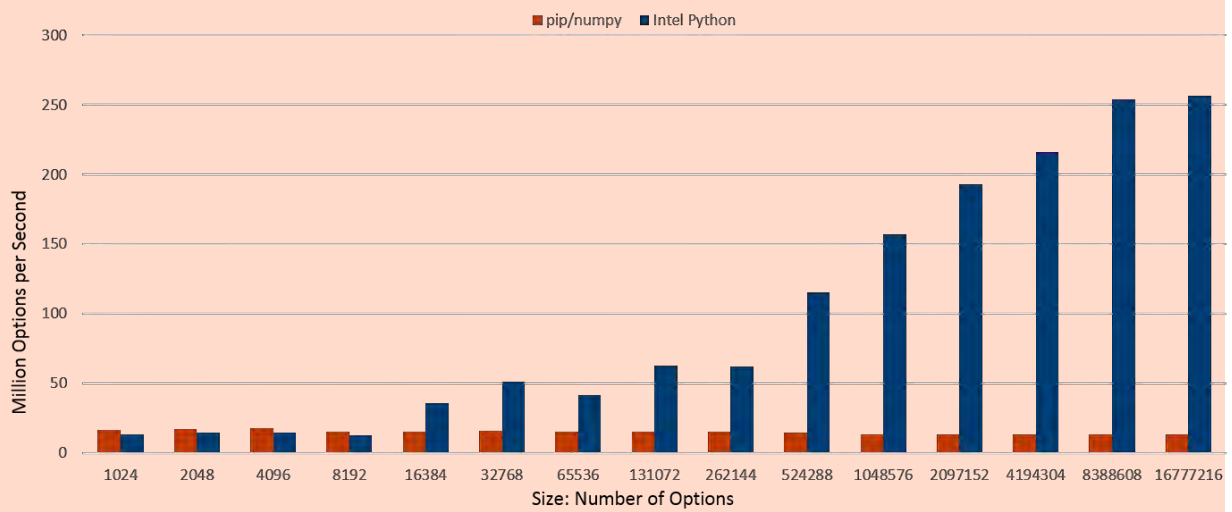

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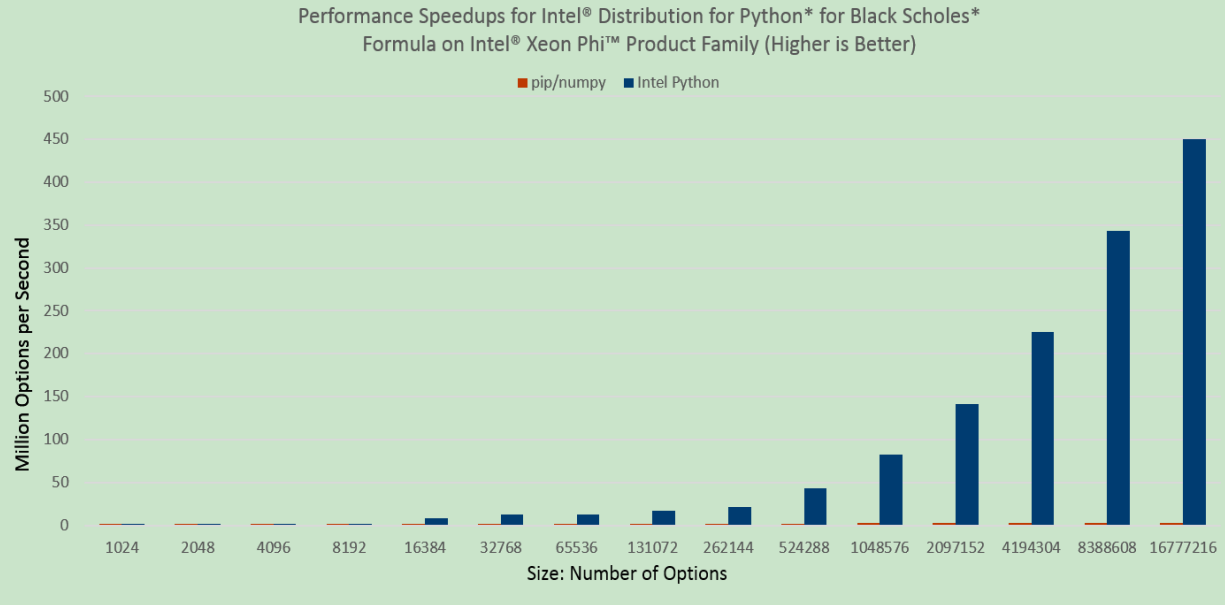

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Installing Intel® Distribution for Python* 2018

Standalone Installer

Download full installer from
https://software.intel.com/en-us/intel-distribution-for-python

Anaconda.org
Anaconda.org/intel channel

```
> conda config --add channels intel
> conda install intelpython3_full
> conda install intelpython3_core
```

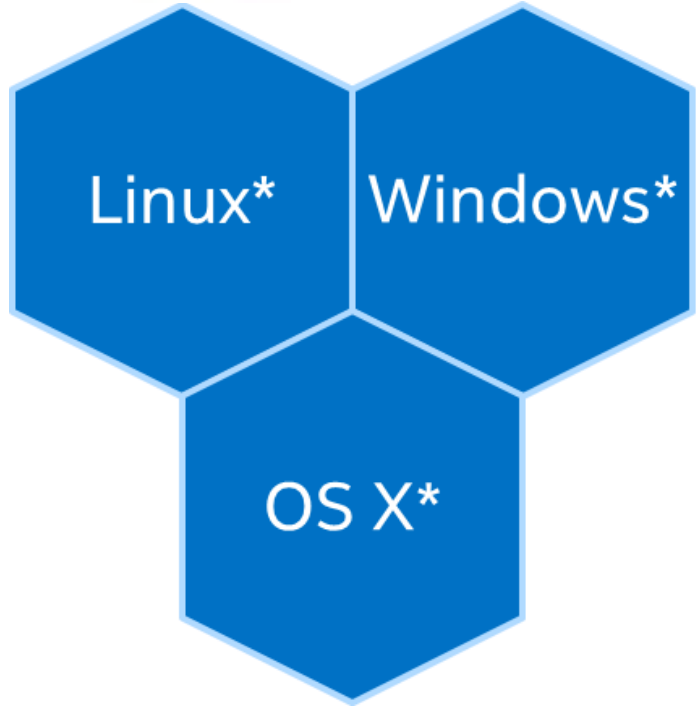
Docker Hub

```
docker pull intelpython/intelpython3_full
```

YUM/APT

Access for yum/apt:
https://software.intel.com/en-us/articles/installing-intel-free-libs-and-python

2.7 & 3.6



But Wait…..There's More!

Outside of optimized Python*, how efficient is your Python/C/C++ application code?

Are there any non-obvious sources of performance loss?

Performance analysis gives the answer!

Tune Python* + Native Code for Better Performance

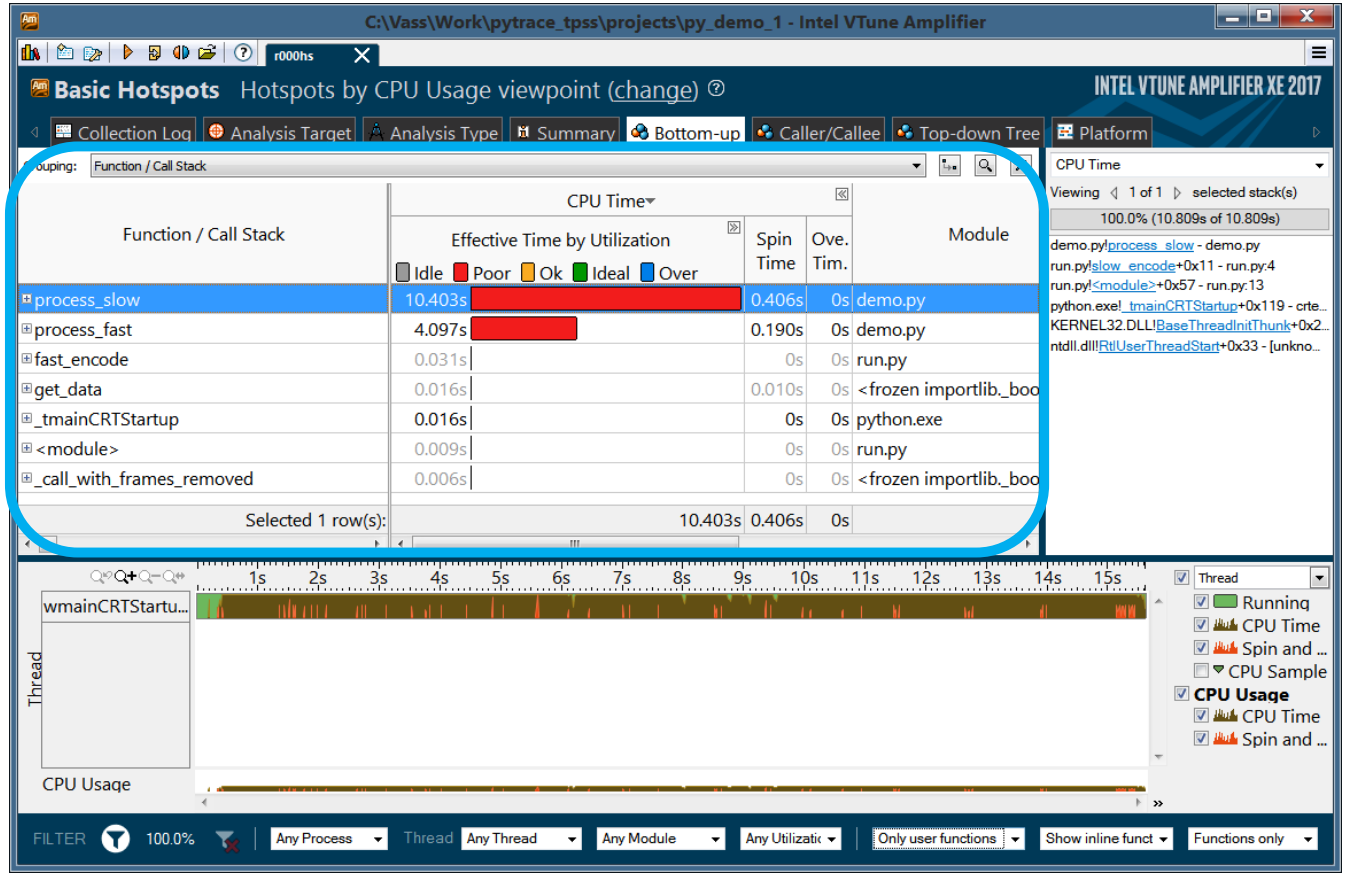
Analyze Performance with Intel® VTune™ Amplifier (available in Intel® Parallel Studio XE)

Challenge

- Single tool that profiles Python + native mixed code applications
- Detection of inefficient runtime execution

Solution

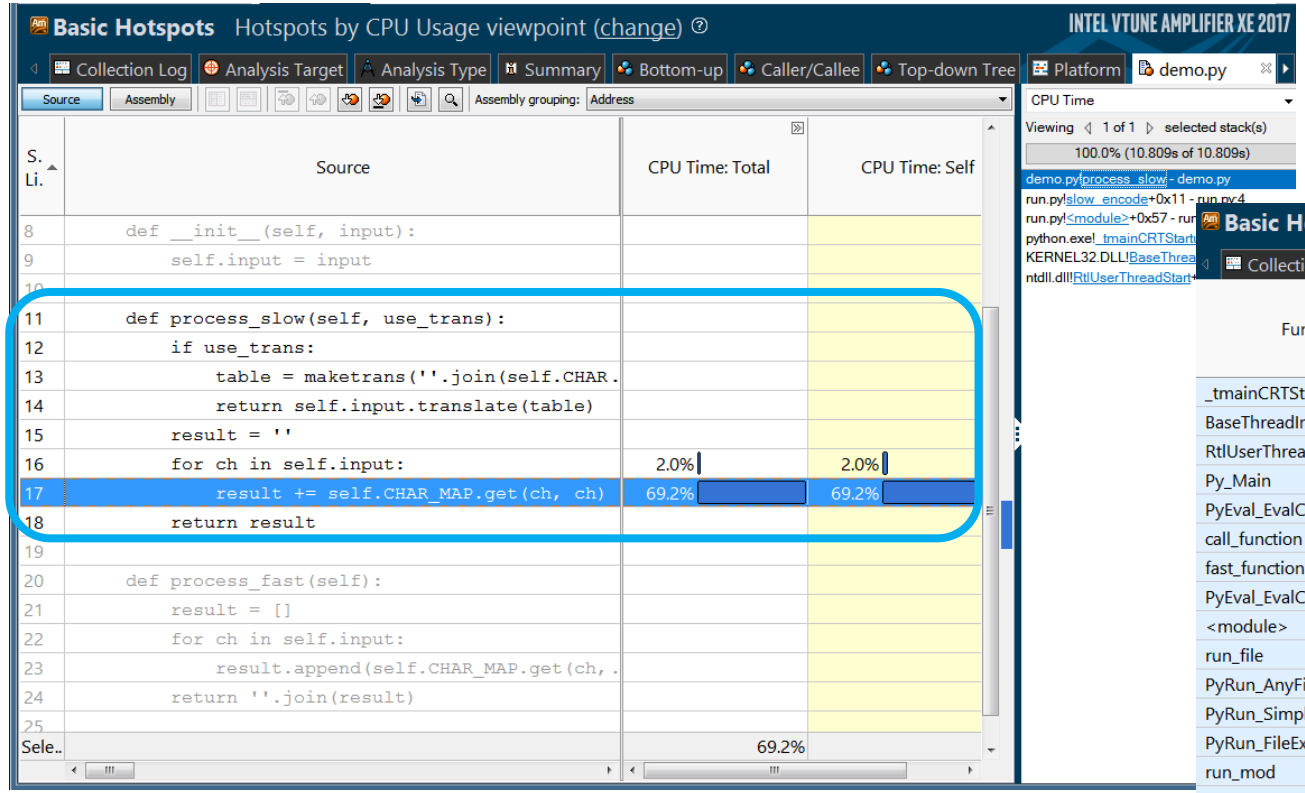
- Auto-detect mixed Python/C/C++ code & extensions
- Accurately identify performance hotspots at line-level
- Low overhead, attach/detach to running application
- Focus your tuning efforts for most impact on performance



Auto detection & performance analysis of Python & native functions

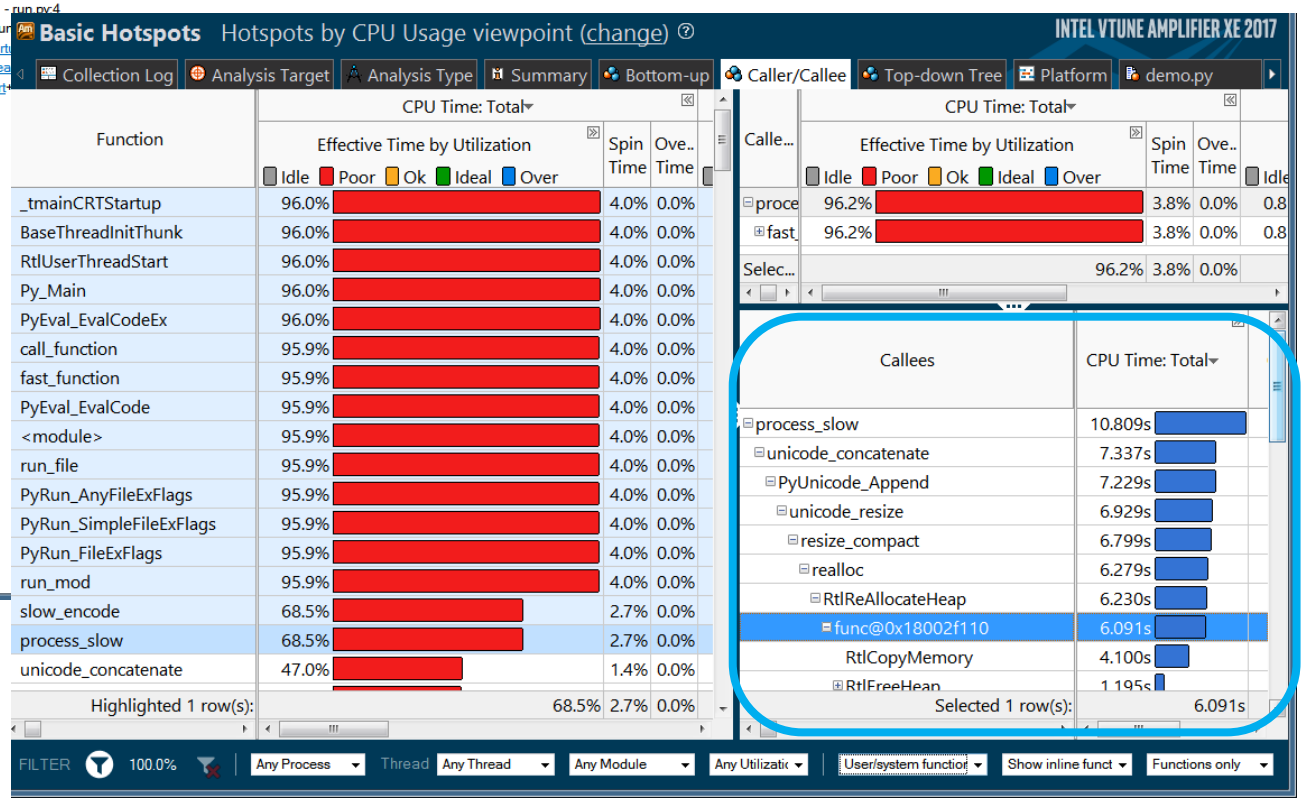
Available in Intel® VTune™ Amplifier & Intel® Parallel Studio XE

Diagnose Problem code quickly & accurately

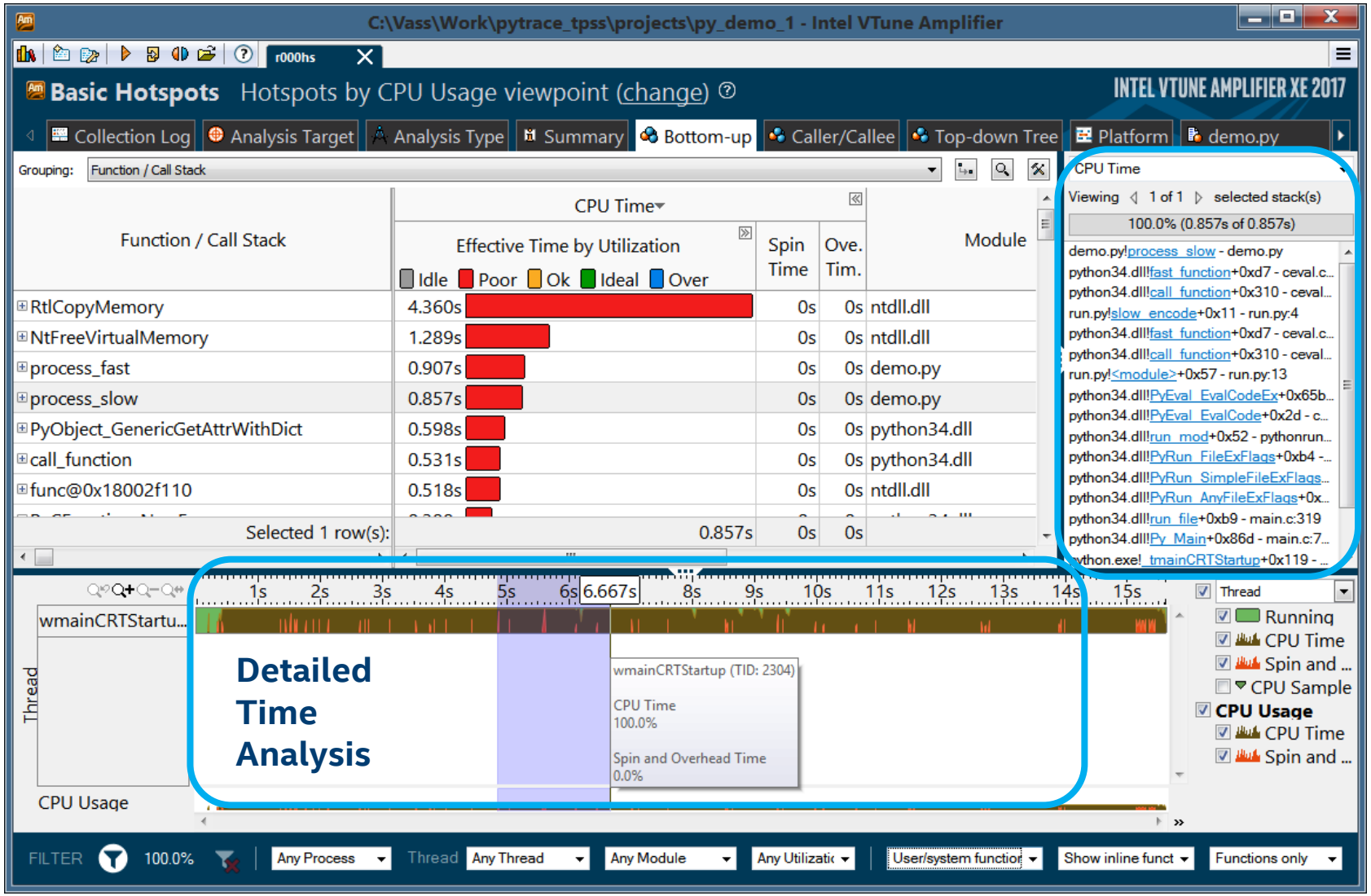


Identifies exact line of code that is a bottleneck

Details Python* calling into native functions



Deeper Analysis for Better Insight



Call Stack Listing for Python* & Native Code

A 2-prong approach for Faster Python* Performance

High Performance Python Distribution + Performance Profiling

Step 1: Use Intel® Distribution for Python

- Leverage optimized native libraries for performance
- Drop-in replacement for your current Python - no code changes required
- Optimized for multi-core and latest Intel processors

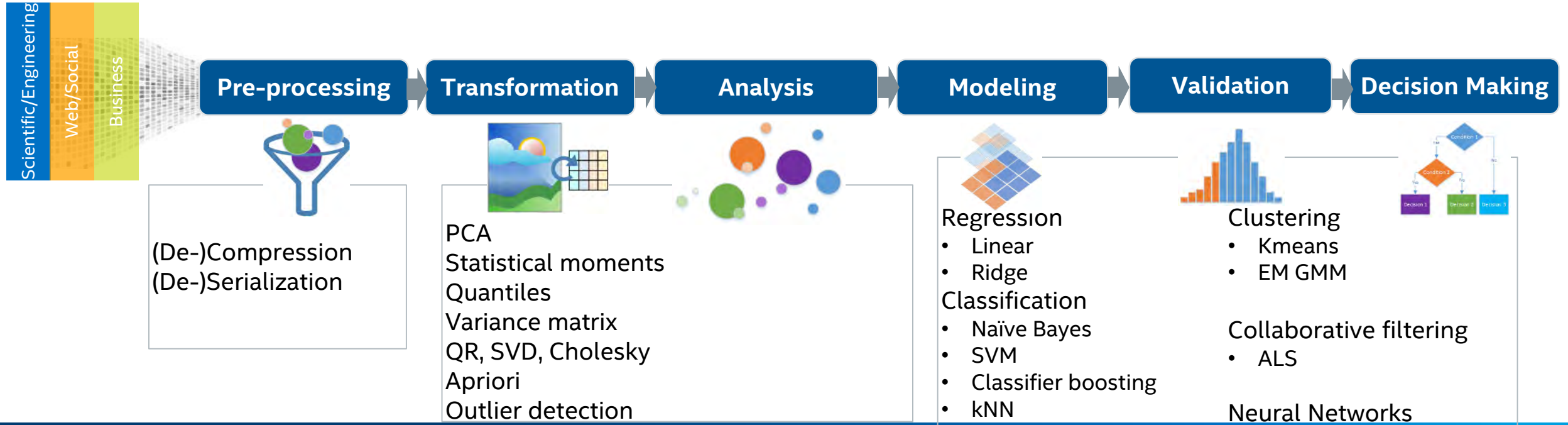
Step 2: Use **Intel® VTune™ Amplifier** for profiling

- Get detailed summary of entire application execution profile
- Auto-detects & profiles Python/C/C++ mixed code & extensions with low overhead
- Accurately detect hotspots - line level analysis helps you make smart optimization decisions fast!
- Available in Intel® Parallel Studio XE Professional & Cluster Edition

PYDAAL

Intel® Data Analytics Acceleration Library (Intel ® DAAL)

- Targets both data centers (Intel® Xeon® and Intel® Xeon Phi™) and edge-devices (Intel® Atom)
- Perform analysis close to data source (sensor/client/server) to optimize response latency, decrease network bandwidth utilization, and maximize security
- Offload data to server/cluster for complex and large-scale analytics



Computational Aspects of Big Data

Volume

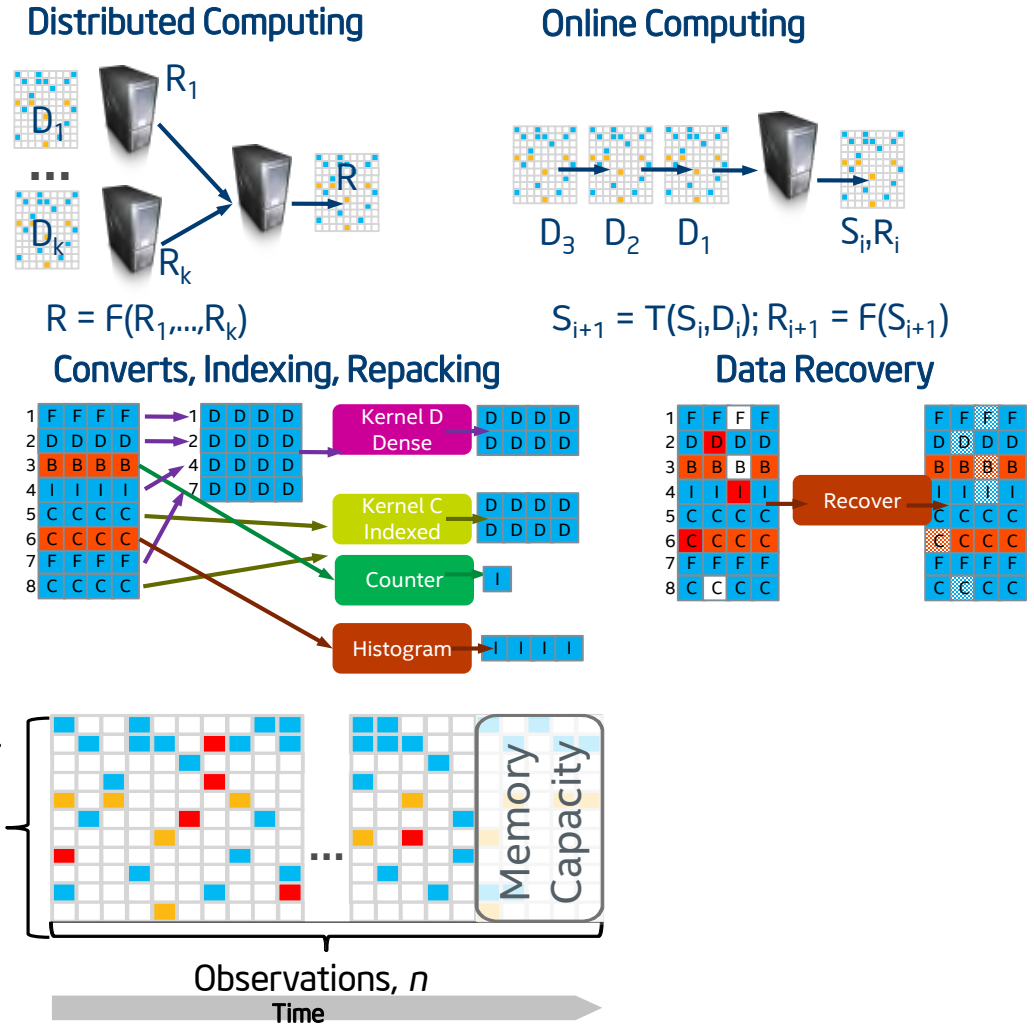
- Distributed across different nodes/devices
- Huge data size not fitting into node/device memory

Variety

- Non-homogeneous data
- Sparse/Missing/Noisy data

Velocity

- Data coming in time



Regression

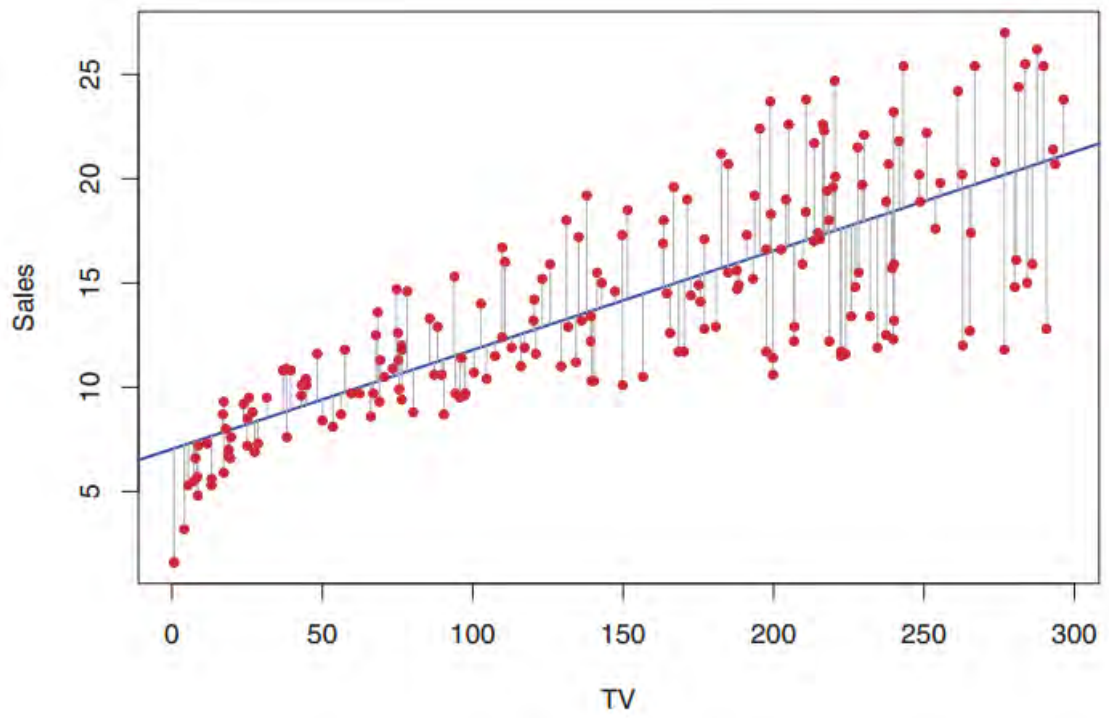
Problems

- A company wants to define the impact of the pricing changes on the number of product sales
- A biologist wants to define the relationships between body size, shape, anatomy and behavior of the organism

Solution: Linear Regression

- A linear model for relationship between features and the response

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \ldots + \hat{\beta}_N x_N$$



Source: Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani. (2014). *An Introduction to Statistical Learning.* Springer

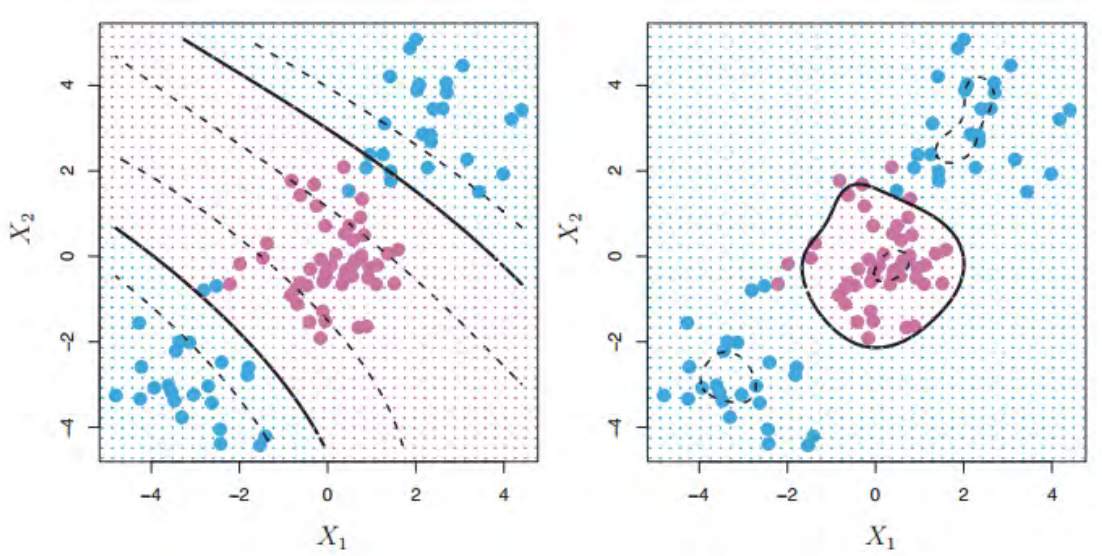
Classification

Problems

- An emailing service provider wants to build a spam filter for the customers
- A postal service wants to implement handwritten address interpretation

Solution: Support Vector Machine (SVM)

- Works well for non-linear decision boundary
- Two kernel functions are provided:
  - Linear kernel
  - Gaussian kernel (RBF)
- Multi-class classifier
  - One-vs-One



Source: Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani. (2014). *An Introduction to Statistical Learning.* Springer

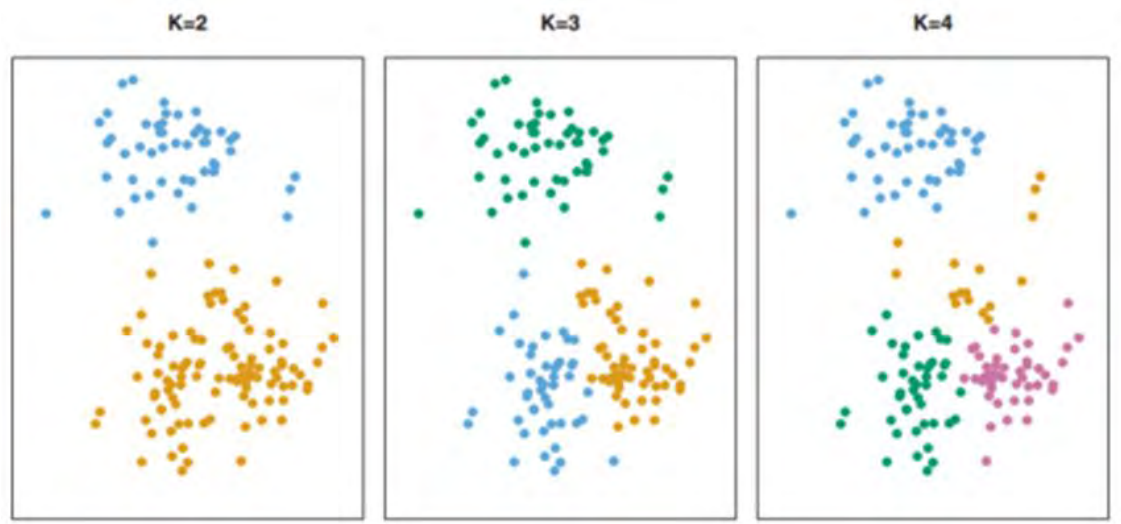
Cluster Analysis

Problems

- A news provider wants to group the news with similar headlines in the same section
- Humans with similar genetic pattern are grouped together to identify correlation with a specific disease

Solution: K-Means

- Pick ***k*** centroids
- Repeat until converge:
  - Assign data points to the closest centroid
  - Re-calculate centroids as the mean of all points in the current cluster
  - Re-assign data points to the closest centroid



Source: Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani. (2014). *An Introduction to Statistical Learning*. Springer

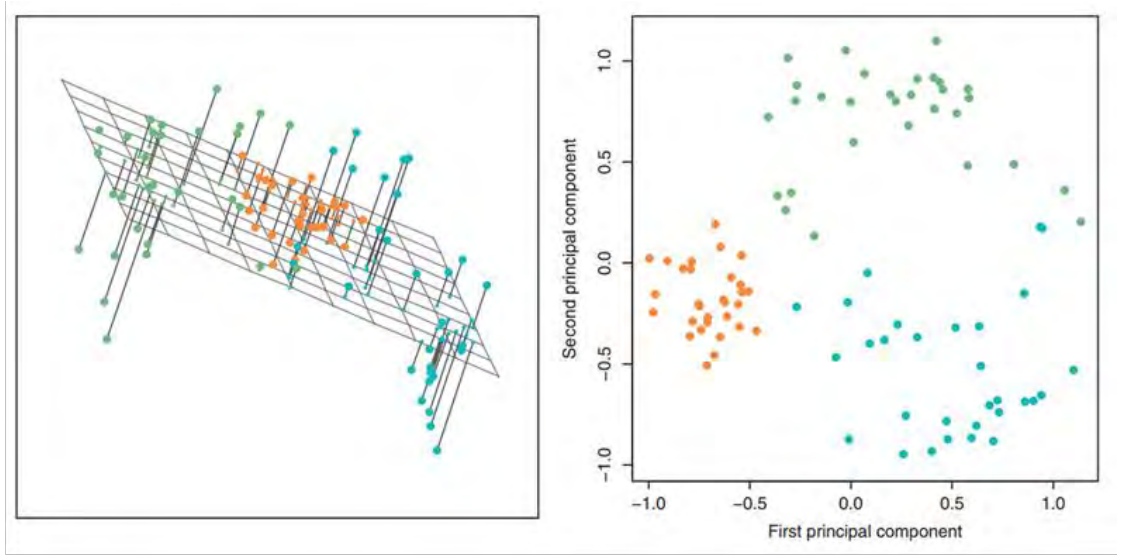
Dimensionality Reduction

Problems

- Data scientist wants to visualize a multi-dimensional data set
- A classifier built on the whole data set tends to overfit

Solution: Principal Component Analysis

- Compute eigen decomposition on the correlation matrix
- Apply the largest eigenvectors to compute the largest principal components that can explain most of variance in original data



Source: Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani. (2014). *An Introduction to Statistical Learning*. Springer

Demo

https://github.com/IntelPython/BlackScholes_bench

https://github.com/daaltces/pydaal-tutorials

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