Testing PC performance can be complex and time-consuming. As an IT professional, you face unique challenges each day. You likely need to know how to:

• Standardize PC purchasing decisions based on performance.

• Validate new hardware and Windows configurations to determine system stability.

• Quantify the performance impact of OS image changes and application updates.

• Identify poorly performing systems.

• Test and measure the real-world performance of PCs against baselines.

Standardizing your performance testing and reporting can help simplify these tasks and processes. That's where benchmarks come in

A benchmark tests how well a product performs a specific function and how that performance compares across similar products. Benchmarks provide a quantitative differentiator for PC performance testing. A computer benchmarking program runs a series of well-defined tests to measure PC performance. A benchmarking program scores a PC system's performance of common tasks: the higher the score, the better the performance. Comparing benchmark scores is easier than comparing complex technical specifications, allowing for informed, rapid decisions to deliver PC performance, cut hardware costs and save testing time.

A good benchmark has three important qualities

Accuracy: Consistently produces true and precise results.

Relevance: Measures the most important performance elements.

Neutrality: Is free of any product or vendor bias.

Benchmarks at the enterprise IT level

Benchmarks support every stage in the life cycle of your PC assets, easing PC lifecycle management for IT teams. Benchmarks provide support for:

- Planning and procurement
  - o Simplify PC performance comparison and cost justification
- Validation and standardization
  - o Test and compare the performance of new PCs against user-defined baselines.
- Operations and management
  - o Efficiently automate remote performance testing to provide reliable insights and reporting
- Optimization or replacement
  - o Make informed PC life-cycle decisions based on benchmark results stored in your central database

Which benchmark should I use?

Benchmark tests are typically designed for a specific setting (home or office) and a certain class of device (desktop PC, laptop, tablet or smartphone).

Choose a benchmark that best matches the needs of your end users. For PCs for general office use, choose a benchmark that measures PC performance with a comprehensive set of tests that covers the wide variety of tasks performed in the modern workplace. You can evaluate the overall performance with the benchmark score, while sub-scores focus on performance for specific activities.

Common tests measure performance and battery life for everyday office productivity tasks and such digital content activities as: web browsing, video conferencing, time to start apps, working with documents and spreadsheets and video editing

Choosing a reference benchmark score for RFPs

Setting a minimum benchmark score in a request for proposal (RFP) helps you judge the relative performance and value of different systems and compare competing offers from your suppliers. Specifying performance with a benchmark score rather than a reference system gives your suppliers more freedom to configure cost-effective alternatives that you might not have otherwise considered. But what factors decide an appropriate minimum score? Start by testing your existing systems. The Procyon user guide will help you produce accurate results. Benchmark old PCs that are ready to be replaced along with the new systems replacing them. The score comparisons provide good baselines. If you're still shopping, ask a supplier to benchmark their systems to see if they meet your performance needs and expectations.

Procyon User Guide:

UL Procyon is a growing suite of benchmark tests for professional users in industry, enterprise, government, retail and press roles. Each Procyon benchmark shares a common approach to design, user experience and features to better meet the needs of professional users.

Each benchmark is designed for a specific use case and uses real applications where possible. UL works closely with its industry partners to ensure that every Procyon benchmark is accurate, relevant and impartial.

UL Procyon benchmarks combine the relevance of real apps with the convenience of a standardized test that produces consistent, repeatable results every time. What's more, the UL Procyon benchmarks are also easy to install and run from the UL Procyon app or the command line with no complicated configuration required.

Each benchmark produces a score, with higher scores indicating better performance. You also get a sub-score for each test and fine-grained workload metrics. You can compare up to four results side by side in the app. You can export result files to PDF for reporting or as XML files for integration with other analysis tools.

The UL Procyon benchmark suite has flexible licensing that lets you pick and choose the individual benchmarks that best meet your needs. You can buy just one benchmark or add more in any combination.

Start benchmarking with UL Procyon

- **UL Procyon AI Computer Vision Benchmark for Windows**

- **UL Procyon Battery Life Benchmark**

- **UL Procyon Office Productivity Benchmark**

- **UL Procyon Photo Editing Benchmark**

- **UL Procyon Video Editing Benchmark**

- **UL Procyon AI Inference Benchmark for Android**

- **UL Procyon AI Image Generation Benchmark**

Activate a Procyon benchmark license key

In the application

You must add a valid Procyon benchmark license key to the application before you can start benchmarking. Your license key is provided with your purchase. If you have misplaced your license key, please contact our sales team for assistance.

1. Install the UL Procyon application on your PC.

2. Open the app.

3. Click on the gear icon to open the Options screen.

4. Enter your license key then click on the Register button.

From the command line

You can also install the application and activate your license from the command line.

My Suite screen

The My suite screen is the default view in the UL Procyon application. From here, you can see which Procyon benchmarks are installed and available to run with your license.
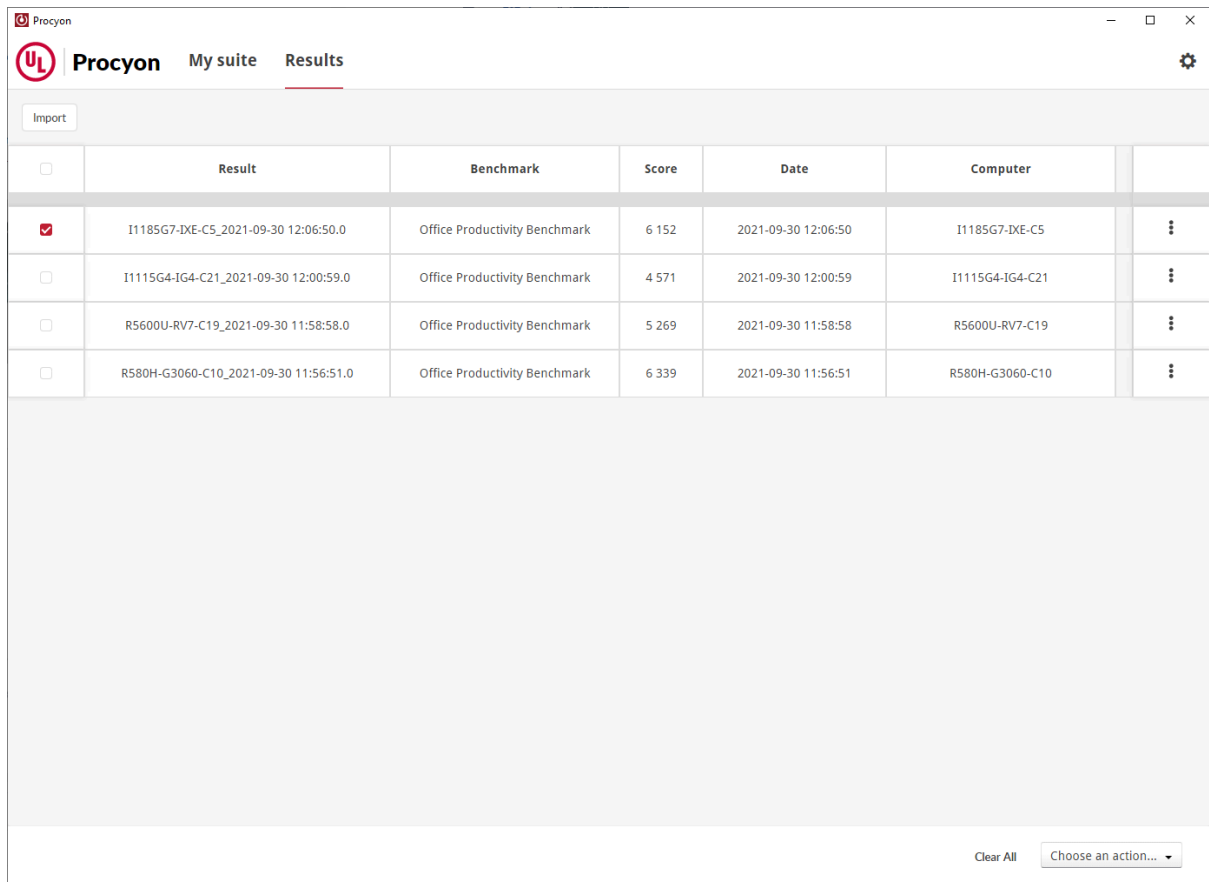
Choose a benchmark

Click on a benchmark to open its benchmark details screen.

Options

Click on the gear icon in the top-right corner to open the Options screen.

Results Database

The Results database screen shows a table of benchmark results saved on the current system.

View a result

There are several ways to view a result.

- Double-click on a result to open the Result screen.

- Click on the checkbox in the leftmost column to select the result. Then select "View result" from the "Choose an action" menu.

- Click on the icon with the three dots in the rightmost column, then click on "View result."

Export a result

You can export your benchmark results in several formats:

- XML—for further analysis or reporting in other tools.

- PDF—for reporting and recordkeeping.

- Procyon result file—optionally choosing a new file name and file location.

Compare results

Click on the checkbox in the leftmost column to select two or more results, (four maximum). Then choose "Compare" from the "Choose an action" menu to view the results on the Result Comparison screen. You can compare up to four results side by side in the UL Procyon app.

Import results

Click on the Import button to add a saved result—such as a result from another system, for example—to the table.

Remove results

Click on the checkbox in the leftmost column to select the result. Then select "Delete" from the "Choose an action" menu.

Alternatively, click on the icon with the three dots in the rightmost column, then click on "Delete."

Note that these actions only remove the result from the table view. The result file is not deleted from the system and can still be imported again if needed.

Result screen

The Result screen shows your benchmark score, detailed workload scores, hardware monitoring charts and system details.

Procyon | My suite | Results

Office Productivity score

6 152
0% increase since last test

| CPU: | 11th Gen Intel Core i7-1185G7 |
| GPU: | Intel(R) Iris(R) Xe Graphics |

Application versions

Excel	16.0.14326 (64 bit)
Word	16.0.14326 (64 bit)
Excel	16.0.14326 (64 bit)
PowerPoint	16.0.14326 (64 bit)
Outlook	16.0.14326 (64 bit)

Detailed scores

← Back ☁ Save to cloud 🗋 Show log ⬇ Export as File ⬇ Export as PDF ⬇ Export as XML

Word score	6 512
Word score	6 512
Export to PDF	20.104
Convert from PDF	8.800
Compare documents	3.020
Accept comparison	0.440
Load	0.357
Save	0.246
Add image	0.622
Cut paste	0.156
Copy paste	0.253
Add watermark	0.887
Table of contents	0.760
Image scale	0.129
Image effect	0.360
Embed file	1.085
Copy from Excel	0.118
Find	0.134

Excel score	5 946
Excel score	5 946
Edit cells	0.427
Sort column	0.908
Voter analysis	0.790
Unique pairs	13.496
Solve equations	4.678
Pivot table	0.679
Copy paste	0.611
Save	5.149
Load	2.222
Format table	1.044
Load mortgage	2.231
Modify mortgage	0.571
VLOOKUP	0.378
Export to PDF	0.653
Save as CSV	2.351

PowerPoint score	6 641
PowerPoint score	6 641
Export to PDF	2.253
Export video	23.748
Load	0.188
Copy from Word	0.101
Add image	0.226
Add video	0.712
Add animation	0.177
Save	0.128
Merge	0.379

Outlook score	5 046
Outlook score	5 046
New appointment	0.353
Search mails	9.066
Backup	1.170
Write email	0.211
Move mails	2.538
Save attachments	0.191

Monitoring

Show details

CPU Load (%) GPU Load (%) GPU Temperature (°C) CPU Temperature (°C) GPU Memory Clock Frequency (MHz) CPU Clock Frequency (MHz)

Markers

System information

📟 Processor

CPU	11th Gen Intel Core i7-1185G7
Code name	Tiger Lake-U
Clock frequency	3000 MHz
Max clock frequency	5050 MHz
Cores	4 (8)
Package	Socket 1449 FCBGA
Instructions	MMX SSE SSE2 SSE3 SSSE3 SSE41 SSE42 X86_64 NX VMX
Manufacturing process	10 nm
Core VID	1.219971 V
Max Cache Level	3
Hyper Threading	Yes
Virtual Technology	Yes

🖥 Graphics adapter

GPU	Intel(R) Iris(R) Xe Graphics
Memory	0 MB DDR4
Available VRAM	8044 MB
Code name	Tiger Lake GT2
Manufacturer	Intel / MSI
Manufacturing process	10 nm
Driver version	30.0.100.9864
Clock frequency	1000 MHz
Boost clock frequency	1350 MHz
Memory clock frequency	2000 MHz
Display 1	\\.\DISPLAY1 (1920 × 1080, 100% DPI scaling)

🖵 General

Motherboard	Micro-Star International Co., Ltd. MS-14C4
North bridge	Intel Tiger Lake-U/Y PCH
Total memory	16384 MB
Module 1	2048 MB
Module 2	2048 MB
Module 3	2048 MB
Module 4	2048 MB
Module 5	2048 MB
Module 6	2048 MB
Module 7	2048 MB
Module 8	2048 MB
BIOS	American Megatrends International, LLC. 09/15/2020
Operating system	Windows 10 64-bit (10.0.19043)
Time	2021-09-30 12:06 +03:00
HPET	Not used
GUI	v2.0.224 64
SystemInfo	v5.43.924
Power plan	平衡
Battery name	BIF0_9
Battery manufacturer	MSI
Battery chemistry	Lithium-Ion
Battery designed capacity	52440 mAh
Battery capacity fully charged	51699 mAh
Battery wear	2 %

🖫 Storage

Total storage	476 GB
Drive 0	6479_A73A_E177_0001. 476 GB

Benchmark score

In the top-left corner panel of the result screen, you see your benchmark score. The higher the score, the better the performance. Beneath that are the model names of the CPU and GPU in the system under test.

Application versions

The Application versions panel shows which versions of the third-party applications were used in the benchmark.

There can be significant performance differences between releases of applications. When comparing benchmark scores from two or more systems, make sure all the results were obtained with the same application version.

Detailed scores

This section shows the sub-scores from the benchmark workload(s).

Buttons

Back

Return to the main screen to choose and run another benchmark.

Save to cloud

Save the result to the online results service on 3DMark.com. Your results are private by default and will not visible to other users.

Show log

Show the activity log for the benchmark run for troubleshooting.

Export as file

Save the current benchmark result optionally choosing a new file name and file location.

Export as PDF

Save the current benchmark result in a formatted PDF document for record-keeping or reporting.

Export as XML

Save the current benchmark result as an XML file for further analysis or reporting in other tools.

Hardware monitoring

Below the benchmark scores, you will find the monitoring section. The charts in this section show how CPU and GPU load, clock frequency and temperature changed during the benchmark run.

Click on the chart legend to see different measurements. Hover the mouse over the chart to see the measured value.

Markers

Use this toggle to show or hide the lines that mark the start of each workload.

Show details

Use this toggle to expand or collapse the monitoring section.

System information

This section of the result screen shows the hardware specification and other relevant information from the system under test. Some parts, such as drive details, can be expanded and collapsed by clicking on the arrow icon.

Result comparison screen

You can compare up to four [results](#) from the same benchmark side by side in the app.
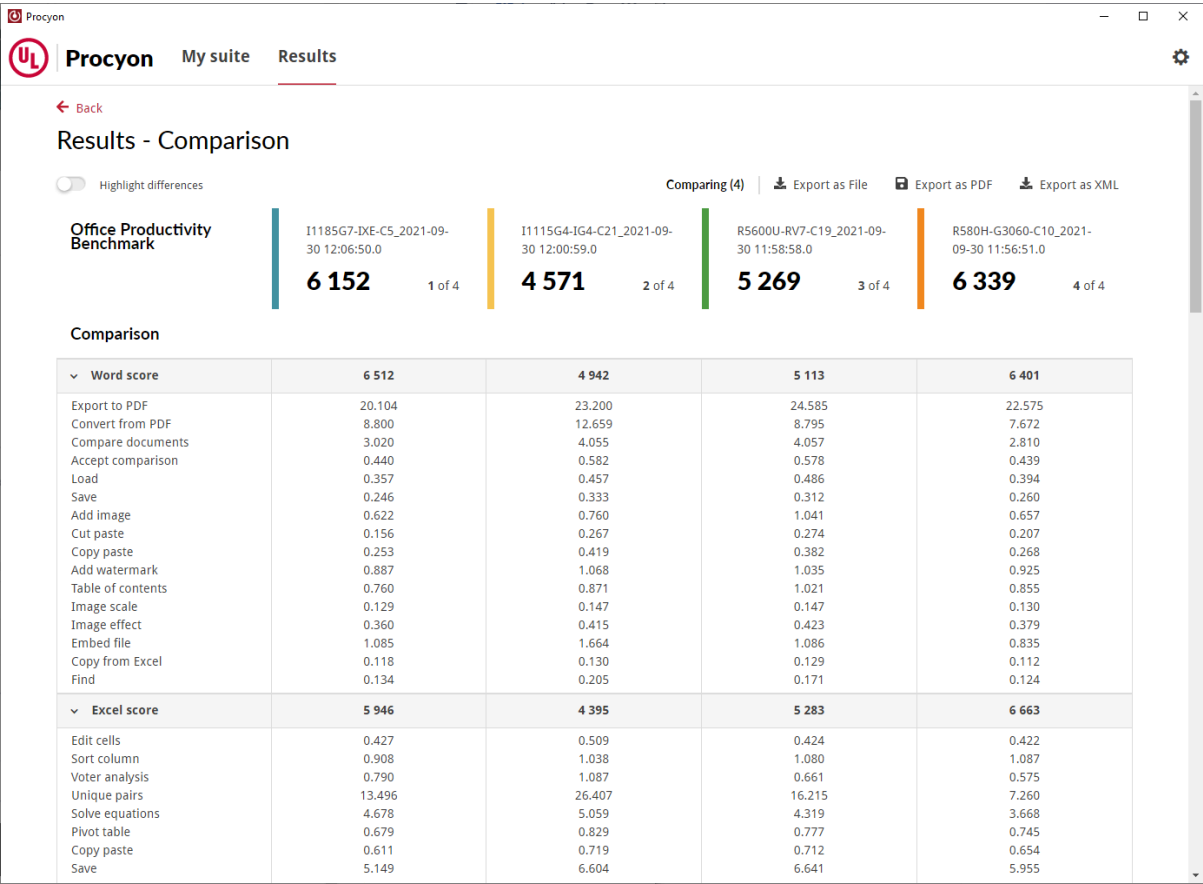
In addition to the benchmark scores, test scores and workload metrics, you can also compare the hardware monitoring charts and the system information from each benchmark result.

You can expand and collapse each section as needed.

Highlight differences

Use this toggle to display or hide the effect that highlights the differences between the results.

Export results

Click an export option to save the individual results in the chosen format together in a ZIP file.

Options screen

To open the Options screen, click on the gear icon in the top right corner of the app.
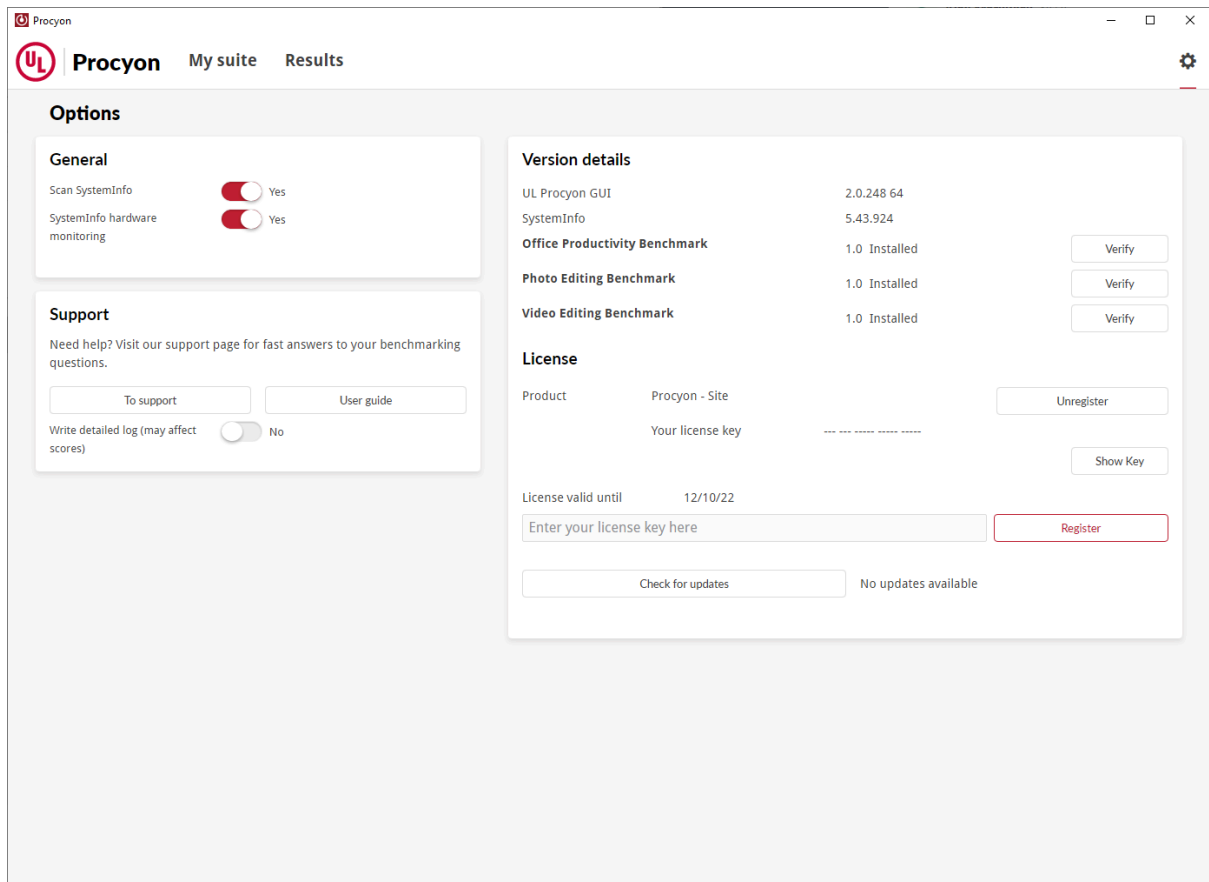
General

Write detailed log

This setting enables detailed logging while the benchmark is running. It is disabled by default. Since detailed logging can affect your benchmark score, you should only use this setting when requested to resolve a customer support request.

Scan SystemInfo

SystemInfo is a component used in UL benchmarks to identify the hardware in your system or device. It does not collect any personally identifiable information. This option is selected by default.

SystemInfo hardware monitoring

This option controls whether SystemInfo monitors your CPU temperature, clock speed and other hardware information during the benchmark run. This option is selected by default.

Support

Write detailed log

This option is disabled by default since it can affect performance. You should only use this option when instructed as part of resolving a support request.

Version details

This section shows the version number of the application, SystemInfo and the benchmarks.

Check for updates

Click the button to see if there are updates available for the application and the benchmark tests. If a new version is available, you will be able to download and install it from this screen.

License

You must register a valid license key before you can use the benchmark. Enter your license key into the box and press the Register button.

Show key

Click the button to show your license key. Click the button again to hide your key.

Unregister

Click the Unregister button to remove your license key, for example, to move a single-seat license to a different system.

Proxy Settings

UL Procyon v2.6.1059 adds support for UL Procyon application to connect to the internet through proxy to confirm licenses, update, and submit benchmark results. You can find find the proxy settings section in the bottom left corner of the UI options page.
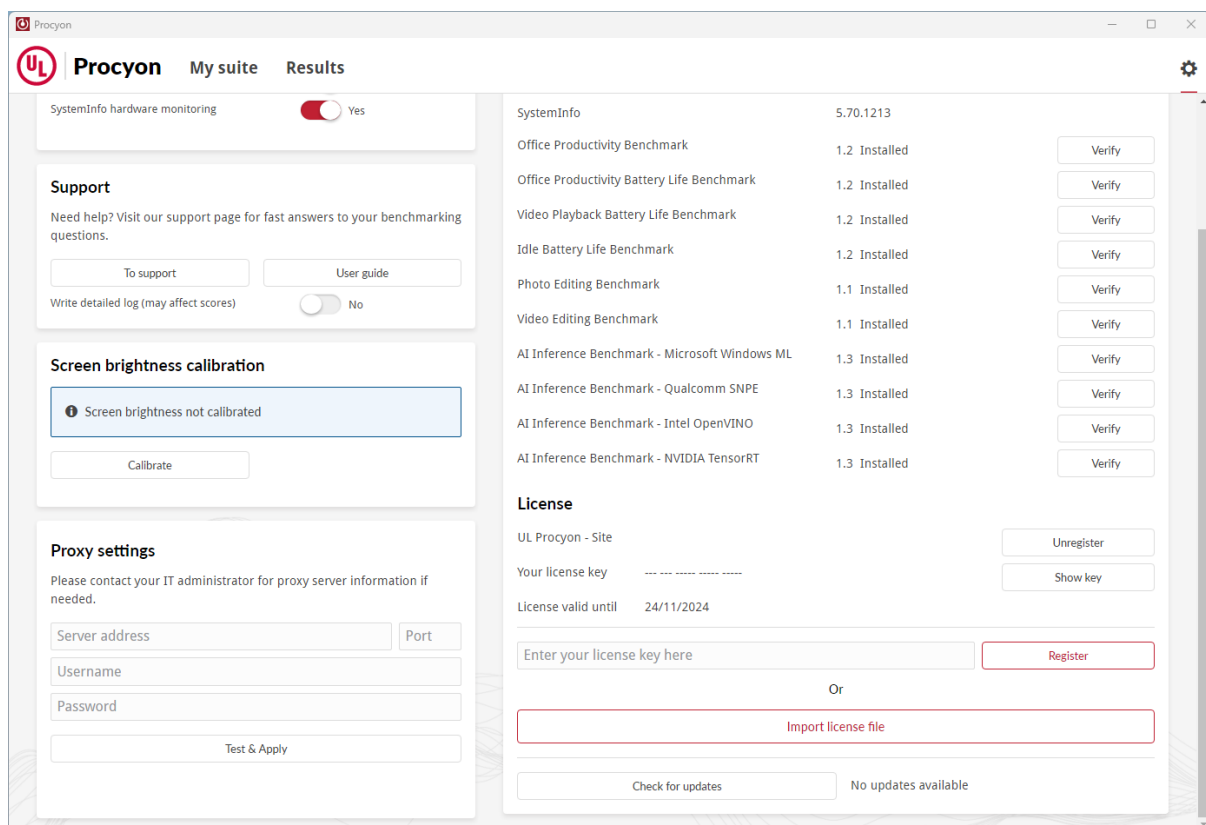
Setting proxy credentials for the first time

Enter the credentials as prompted by the text fields & you should be greeted with a success message upon successful application of the proxy settings.

Proxy settings

Please contact your IT administrator for proxy server information if needed.

Delete   Edit   Test & Apply

Proxy connection is in use

Changing proxy credentials

Please note that if you decide to change the proxy credentials. you must restart the application in order for the new settings to take effect.

Proxy settings

Please contact your IT administrator for proxy server information if needed.

███████████   ████
███████
●●●●●●

Delete   Edit   Test & Apply

Proxy connection is in use

> ⓘ Device proxy settings have changed. Some functions requiring an internet connection may not function correctly until the UL Procyon client is restarted.

How to report UL Procyon benchmark scores

Each UL Procyon benchmark produces a score, which you can use to compare similar devices or systems. Scores from different Procyon benchmarks, such as Office Productivity and Photo Editing, are not comparable.

P   *"The laptop computer scored 5,000 in the UL Procyon Office Productivity Benchmark."*

Í   *"The laptop computer scored 5,000 in the UL Procyon benchmark."*

Always include details of the hardware setup you used to obtain the score. Be sure to include the operating system, system hardware, and the version numbers of the relevant third-party applications. You can find this information on the benchmark result screen.

UL Procyon benchmarks use real applications whenever possible. Updates to those applications can affect your benchmark score. When comparing two or more systems, be sure to use the same version of each application on every system you test.

Using UL Procyon benchmark scores in marketing material

You must not disclose or publish UL Procyon benchmark results, nor may you use the UL logo or other UL assets in your sales and marketing materials, without prior, written permission from UL. Please contact UL.BenchmarkSales@ul.com for details.

Using UL Procyon benchmark scores in media reviews

We provide complimentary UL Procyon licenses to members of the press working for established and reputable publications. Contact us at UL.BenchmarkPress@ul.com to request a license for your publication.

Press can use our benchmark scores in their hardware reviews. We kindly ask you to include a link to https://benchmarks.ul.com/ whenever you use our benchmarks in a review, feature or news story.

UL Procyon trademark

On the first mention of UL Procyon in marketing text, such as an advertisement or product brochure, please write "UL Procyon® benchmarks" to protect our trademark. For example:

"We recommend UL Procyon® benchmarks."

Please include our legal text in your small print.

Procyon is a registered trademark of Futuremark Corporation, a UL Solutions company.

UL Procyon Office Productivity Benchmark User Guide

Overview of UL Procyon Office Productivity Benchmark

The UL Procyon Office Productivity Benchmark uses Microsoft Office apps to measure Windows PC and Apple Mac computer performance for office productivity work. The benchmark workloads feature relevant, real-world tasks using Microsoft Word, Excel, PowerPoint and Outlook.

This multi-platform benchmark combines the relevance of testing performance with the same apps that office workers use every day with the convenience of a standardized test that produces consistent, repeatable results. The Office Productivity Benchmark is simple to set up and run. The Windows PC benchmark can be run from the UL Procyon app or the command line. The Apple Mac benchmark can be installed and run from the Testdriver Cloud UI or the command line.

The Office Productivity Benchmark is designed around common tasks from a typical day at the office. The benchmark opens Excel sheets, PowerPoint presentations, Word documents and Outlook emails. These applications are running simultaneously as the focus moves from one task to another. For example, the benchmark copies a chart from Excel and adds it to a PowerPoint slide. It takes text from one Word document and adds it to another.

The benchmark focuses on measuring aspects of performance that affect the user experience, such as providing smooth interactions and processing large tasks quickly.

UL Procyon benchmarks use real applications whenever possible. Updates to those applications can affect your benchmark score. When comparing two or more systems, be sure to use the same version of each application on every system you test.

UL Procyon Office Productivity Benchmark system requirements

Here are the minimum system requirements for the UL Procyon Office Productivity Benchmark for Windows PC and Apple Mac computers. Please note that the storage requirement does not include the space needed to install the Microsoft applications used in the benchmark.

Windows PC system requirements

OS	Windows 10, 64-bit, version 2004 or later
Processor	2 GHz dual-core CPU
Memory	4 GB
Graphics	DirectX 12
Storage	5 GB

Apple Mac computer system requirements

OS	macOS Monterey or later
Memory	4 GB
Storage	5 GB

Required applications

The UL Procyon Office Productivity Benchmark uses Microsoft Office applications to test and measure PC and Mac performance. The applications are not included with the benchmark. You must install and activate licensed versions of the required applications on every system you plan to test.

The UL Procyon Office Productivity Benchmark is compatible with Microsoft Office 2019 (retail versions only), Microsoft Office 2021 and Microsoft 365 (including trial accounts).

Please note that volume licensed versions of Office 2019, such as Office Professional Plus 2019, are not compatible with the UL Procyon Office Productivity Benchmark.

Microsoft Word
Microsoft Excel
Microsoft PowerPoint
Microsoft Outlook

Ready for Windows 11

UL Procyon benchmarks are compatible with Windows 11. The Office Productivity Benchmark is compatible with Microsoft Office 2021.

Word test

The Word test simulates a sales manager writing marketing material for the sales team. The workload features common tasks such as loading and saving, cutting, copying, pasting and editing content and images, finding and replacing text, inserting graphs from Excel, and comparing documents. This test is available on both Windows PC and Apple Mac computers.

Not included in scoring on Mac as opposed to Windows:

- Add Watermark

- Convert from PDF

- Embed file

- Export to PDF

- Image effect

Office Productivity Word score

The Word test produces an Office Productivity Word score. A higher score indicates better performance. The scaling constant in the score formula is used to bring the score in line with the traditional range for UL benchmarks.

Word score = 3900 / geometric mean of

Measures loading of the source and destination documents. Repeated 3 times. The source document has 12 pages and is 252 KB in size. The destination document has 75 pages and is 971 KB in size.

OfficeProductivityWordLoad result = geometric mean of

OfficeProductivityWordSave

Measures saving of a document. Some of the save operations are repeated. Save sizes are from 1.4 MB to 55 MB. Saving happens:

- After adding the table of contents and first edits.

- After a new image is added.

- After data has been copied from Excel and other edits.

OfficeProductivityWordSave result = geometric mean of

OfficeProductivityWordCopyPaste

Measures copy-pasting between documents. Copying 12 pages of text. Repeated 7 times.

OfficeProductivityWordCopyPaste result = geometric mean of

OfficeProductivityWordCutPaste

Measures cut pasting inside of a document. Copying from 4 to 10 pages per repeat. Repeated 7 times.

OfficeProductivityWordCutPaste result = geometric mean of

OfficeProductivityWordAddWatermark

Measures the adding of a watermark to a document. Repeated 5 times. The image resolution is 4167 × 3334

OfficeProductivityWordAddWatermark result = geometric mean of

OfficeProductivityWordTableOfContents

Measures creating and updating the table of content. Both creating and updating are repeated 5 times. Table of contents contains 168 entries.

OfficeProductivityWordTableOfContents result = geometric mean of

OfficeProductivityWordAddImage

Measures inserting an image into a document. New image for every measurement.

Image resolutions are:

- 3746 × 5617
- 2922 × 3899
- 3712 × 5568
- 3640 × 5464
- 3646 × 5568

OfficeProductivityWordAddImage result = geometric mean of

OfficeProductivityWordImageScale

Measures scaling the 5 new images to the correct size for the page.

OfficeProductivityWordImageScale result = geometric mean of

OfficeProductivityWordImageEffect

Measures applying different effects to the 5 new images.

- Blur
- Color temperature
- Film grain
- Pencil grayscale
- Texturizer
- Watercolor sponge

OfficeProductivityWordImageEffect result = geometric mean of

OfficeProductivityWordEmbedFile

Measures embedding other documents into the Word document. Adds an Excel file of about 6.0 MB in size and a PowerPoint file of around 32 MB in size.

OfficeProductivityWordEmbedFile result = geometric mean of

OfficeProductivityWordCopyFromExcel

Measures time taken to copy data from Excel to the Word document. 5 copies are done.

OfficeProductivityWordCopyFromExcel result = geometric mean of

OfficeProductivityWordExportToPdf

Measures the time taken to export a PDF of the document. The output PDF size is 3.2 MB.

OfficeProductivityWordExportToPdf result = time to taken to export to PDF

OfficeProductivityWordConvertFromPdf

Measures time taken to convert a PDF document to a .docx document format. The new Word document size is 4.5 MB.

OfficeProductivityWordConvertFromPdf result = time taken to convert PDF to .docx

OfficeProductivityWordFind

Find and highlight 4 different words or parts of words. Then find and replace 4 other words.

OfficeProductivityWordFind result = geometric mean of

OfficeProductivityWordCompareDocuments

Measures time taken to compare two documents. Where one document is the original and the other document is a modified version of the original. Both documents are 494 pages and around 1.2 MB in size.

OfficeProductivityWordCompareDocuments result = time taken to compare two documents

OfficeProductivityWordAcceptComparison

Measures time taken to accept all the changes resulting from the comparison.

OfficeProductivityWordAcceptComparison result = time taken to accept changes

Excel test

The Excel test simulates a financial officer performing calculations with several Excel worksheets. The workload features typical spreadsheet tasks like loading and saving, auto-calculation, inserting data, copy and paste, sorting, using a pivot table, exporting to CSV and PDF, and using common formulas. This test is available on both Windows PC and Apple Mac computers.

Not included in scoring on Mac as opposed to Windows:

- Export to PDF

- Solve Equations

- Format Table

Office Productivity Excel score

The Excel test produces an Office Productivity Excel score. A higher score indicates better performance. The scaling constant in the score formula is used to bring the score in line with the traditional range for UL benchmarks.

Excel score = 7900 / geometric mean of

OfficeProductivityExcelEditCells,

OfficeProductivityExcelSortColumn,

OfficeProductivityExcelVoterAnalysis,

OfficeProductivityExcelUniquePairs,

OfficeProductivityExcelSolveEquations,

OfficeProductivityExcelPivotTable,

OfficeProductivityExcelCopyPaste,

OfficeProductivityExcelSave,

OfficeProductivityExcelLoad,

OfficeProductivityExcelFormatTable,

OfficeProductivityExcelLoadMortgage,

OfficeProductivityExcelModifyMortgage,

OfficeProductivityExcelVlookup,

OfficeProductivityExcelExportToPdf,

OfficeProductivityExcelSaveAsCsv

OfficeProductivityExcelEditCells

Measure how long it takes to make minor manual changes to the worksheet.

OfficeProductivityExcelSortColumn

Measures sorting the Excel sheet by one column that is not a numerical column. The worksheet has 150k rows.

OfficeProductivityExcelVoterAnalysis

Measures the time taken to fully recalculate the *VoterAnalysis-complete* worksheet that contains large amount of data and its analysis. The worksheet consists mostly of simple formulas. It has 400k rows.

OfficeProductivityExcelUniquePairs

Performs calculation on a sheet that involves 60'000 rows of IF(COUNTIFS(...)) formula.

OfficeProductivityExcelSolveEquations

The *Evaluate* workbook is tested by launching a linear optimization problem solver that is defined in the workbook's macro. It solves the set of linear equations.

The solve process is first performed with 2 workbooks open in the background, This is repeated four times, with the first result dropped from the result calculation.

Then all background workbooks are closed and the solve process is performed again. This is repeated four times, with the first result dropped from the result calculation.

OfficeProductivityExcelPivotTable

A pivot table is defined and created from a datasheet with several dozen rows and coumns. The data entries for the pivot table are selected based on Excel's suggestions.

OfficeProductivityExcelCopyPaste

Additional data is copied and pasted to the end of the open worksheet. After that, the workbook is saved, closed, then opened again. This cycle repeats 5 times, increasing the amount of data being appended. The worksheet has 400k rows.

OfficeProductivityExcelSave

This score measures how long it takes to save the file. The score is the geomean of 5 save iterations of a worksheet with 400k rows.

OfficeProductivityExcelLoad

This score measures how long it takes to load a large data file. The score is the geomean of 5 load iterations using a worksheet with 400k rows.

OfficeProductivityExcelFormatTable

Measuring the time taken to format 400k rows of plain data as a table with headings.

OfficeProductivityExcelLoadMortgage

Measures much time it takes to open and recalculate the *cal_mortgage_30x.xlsm* file. It contains a rather small amount of data (~1050 rows by ~200 columns) but involves a lot of complex formulas that calculate all the variables for a mortgage for every month based on the starting conditions.

OfficeProductivityExcelModifyMortgage

Performs copy-paste of data between Excel worksheets that results in reevaluating the formulas. The worksheet is ~1050 rows by ~200 columns.

OfficeProductivityExcelVlookup

Performs one million VLOOKUP operations on rows of data. The data is taken from one worksheet to another inside of a single workbook.

OfficeProductivityExcelExportToPdf

Measures how long it takes to export an Excel worksheet with charts to PDF format with common settings. The worksheet is not large and can fit on a single screen, but it is visually heavy, which results in a suitable load for the PDF renderer.

OfficeProductivityExcelSaveAsCsv

Measures how long it takes to export and save an Excel workbook with 400k rows and charts as CSV file.

PowerPoint test

The PowerPoint test simulates a product manager making a project status presentation. The workload loads a document, adds images, copies images and text, adds and previews animations, merges content from other files, saves the file, and exports to PDF and video. This test is available on both Windows PC and Apple Mac computers.

Not included in scoring on Mac as opposed to Windows:

- Add animation
- Export video
- Merge

Office Productivity PowerPoint score

The PowerPoint test produces an Office Productivity PowerPoint score. A higher score indicates better performance. The scaling constant in the score formula is used to bring the score in line with the traditional range for UL benchmarks.

PowerPoint score = 3200 / geometric mean of

OfficeProductivityPowerpointLoad

OfficeProductivityPowerpointCopyFromWord

OfficeProductivityPowerpointAddImage

OfficeProductivityPowerpointAddAnimation

OfficeProductivityPowerpointSave

OfficeProductivityPowerpointMerge

OfficeProductivityPowerpointExportToPdf

OfficeProductivityPowerpointExportVideo

OfficeProductivityPowerpointAddVideo

OfficeProductivityPowerpointLoad

Measures the loading of a presentation. It has 27 slides and the size is around 88 MB. Repeated 6 times. The maximum value is dropped from the result calculation.

OfficeProductivityPowerpointLoad result = geometric mean of

where the maximum value is dropped from the calculation.

OfficeProductivityPowerpointCopyFromWord

Measures copying of one paragraph of text from Word to a presentation. 9 times copied text over.

OfficeProductivityPowerpointCopyFromWord result = geometric mean of

OfficeProductivityPowerpointAddImage

Measures adding of an image to a presentation. Repeated 4 times. The image resolution is 5669 × 3896.

OfficeProductivityPowerpointAddImage result = geometric mean of

where the maximum value is dropped from the calculation.

OfficeProductivityPowerpointAddAnimation

Measures adding of animation to a presentation. Repeated 4 times.

Animations added are:

- PpEntryEffect.ppEffectRandomBarsHorizontal

- PpEntryEffect.ppEffectFlyFromBottom

OfficeProductivityPowerpointAddAnimation result = geometric mean of

OfficeProductivityPowerpointSave

Measures saving of a presentation to a different location. The presentation is saved:

- After adding animation, size 82 MB

- After doing merge, size 5.9 MB

- After adding video, size 98 MB

Each save is repeated three times.

OfficeProductivityPowerpointSave result = geometric mean of

where the maximum value from each of the three saves is dropped from the calculation.

OfficeProductivityPowerpointMerge

Measures merging of two presentations that have a common base and no conflicts.

OfficeProductivityPowerpointMerge result = geometric mean of

OfficeProductivityPowerpointExportToPdf

Measures exporting of presentation to PDF. Size of the output PDF is 1.0 MB

OfficeProductivityPowerpointExportToPdf result = time taken to export to PDF

OfficeProductivityPowerpointExportVideo

Measures creating a video of the presentation. The size of the output video is 14 MB.

Video is 3s per slide, includes some animations, transitions. Vertical resolution: 720, frame rate: 30fps, quality: 85

OfficeProductivityPowerpointExportVideo result = time taken to export the video

OfficeProductivityPowerpointAddVideo

Measures adding video to a presentation. Repeated 4 times.

Duration: 10s, resolution 3840 × 2160, frame rate: 23.98fps, data rate: 58423kbps

OfficeProductivityPowerpointAddVideo result = geometric mean of

where the maximum value is dropped from the calculation.

Outlook test

The Outlook test simulates a project manager using email. The workload includes tasks such as creating emails, moving emails, searching for text within an email, saving attachments, making appointments, and backing up folders. This test is currently available on Windows PC.

The Outlook data file is 154 MB in size. It has 128 emails in the Inbox and 8 emails in Sent Items. Some emails include attachments:

- 79 jpg images with sizes from 32 KB to 2.6 MB and a total size of 27.3 MB

- Excel document that is 7.3 MB

- PowerPoint document that is 4.4 MB

- Word document that is 8.5 MB

The Outlook test does not use the network.

Office Productivity Outlook score

The Outlook test produces an Office Productivity Outlook score. A higher score indicates better performance. The scaling constant in the score formula is used to bring the score in line with the traditional range for UL benchmarks.

Outlook score = 4300 / geometric mean of

OfficeProductivityOutlookMoveMails

OfficeProductivityOutlookNewAppointment

OfficeProductivityOutlookSearchMails

OfficeProductivityOutlookBackup

OfficeProductivityOutlookWriteMail

OfficeProductivityOutlookSaveAttachments

OfficeProductivityOutlookMoveMails

Measures moving 136 emails from imported datafile to empty profile. Repeated 7 times.

OfficeProductivityOutlookMoveMails result = geometric mean of

where the maximum and minimum values are dropped from the calculation.

OfficeProductivityOutlookNewAppointment

Measures adding a new appointment with 3 attachments (Excel, PowerPoint and Word documents). Repeated 7 times.

OfficeProductivityOutlookNewAppointment result = geometric mean of

where the maximum and minimum values are dropped from the calculation.

OfficeProductivityOutlookSearchMails

Measures searching string from emails. Repeated 7 times.

OfficeProductivityOutlookSearchMails result = geometric mean of

where the maximum and minimum values are dropped from the calculation.

OfficeProductivityOutlookBackup

Measures data archiving. Copies 128 mails and results in a 150MB data file. Repeated 7 times.

OfficeProductivityOutlookBackup result = geometric mean of

where the maximum and minimum values are dropped from the calculation.

OfficeProductivityOutlookWriteMail

Measures creating an email with 3 attachments (Excel, PowerPoint and Word documents). Repeated 7 times.

OfficeProductivityOutlookWriteMail result = geometric mean of

where the maximum and minimum values are dropped from the calculation.

OfficeProductivityOutlookSaveAttachments

Measures saving attachments from all emails. Writes out 82 files with a total size of 45MB. Repeated 7 times.

OfficeProductivityOutlookSaveAttachments result = geometric mean of

Measurements often contain variable number of high outliers. We eliminate them by applying k-means clustering to 3 clusters and dropping the highest cluster.

How is the Office Productivity Benchmark score calculated?

The UL Procyon Office Productivity Benchmark is designed around common tasks from a typical day at the office. The benchmark opens Excel sheets, PowerPoint presentations, Word documents and Outlook emails. These applications are running simultaneously as the focus moves from one task to another. For example, the benchmark copies a chart from Excel and adds it to a PowerPoint slide. It takes text from one Word document and adds it to another.

The benchmark focuses on measuring aspects of performance that directly affect the user experience, such as providing smooth interactions and processing large tasks quickly.

On Systems running Microsoft Windows, the Procyon office productivity benchmark produces two scores: an "MP Score" allowing comparison between systems running Windows and macOS, and a Windows-only score that is also compatible with scores from Procyon office productivity versions 1.0 and 1.1. These two scores are not compatible with each other.

Office Productivity Benchmark MP scoring (systems running Windows and macOS)

Running the office productivity benchmark on macOS will only generate an MP score. Running the office productivity benchmark on Windows will generate two scores, one of which is an MP score. The Office Productivity MP score is a geometric mean of the scores from each workload.

Office Productivity MP score =

floor_to_thousands(geometric mean(Excel MP score, Word MP score, PowerPoint MP score))

Office Productivity Benchmark scoring (only systems running Microsoft Windows)

The UL Procyon Office Productivity Benchmark produces an Office Productivity score. A higher score indicates better performance. The Office Productivity score is a geometric mean of the results from the Word, Excel, PowerPoint and Outlook tests with weights applied—double weight is indicated by including a score twice in the score formula.

Office Productivity score = geometric mean(

    Excel score,

    Excel score,

    Word score,

    Word score,

    PowerPoint score,

    PowerPoint score,

    Outlook score)

The test score formulas are calibrated to produce an Office Productivity score of 5000 on the reference PC, which is a laptop computer with an 11th Generation Intel® Core™ i5-1135G7 2400 MHz processor.

Benchmark scores

Each benchmark run produces a high-level benchmark score, mid-level test scores, and low-level workload metrics.

The precision of UL Procyon benchmark scores is usually better than 3% when following the steps outlined in this guide. This means that running the benchmark repeatedly on a consistently performing system in a controlled environment will produce scores that fall within a 3% range.

A score may occasionally fall outside the margin of error since there are factors in modern, multitasking operating systems that cannot be controlled completely. There are also devices that simply do not offer consistent performance due to their design. In these cases, you should run the benchmark multiple times, and take an average or a mode of the results.

UL Procyon benchmarks use real applications whenever possible. Updates to those applications can affect your benchmark score. When comparing two or more systems, be sure to use the same version of each application on every system you test.

UL Procyon Office Productivity Benchmark workload version history

A benchmark version number is specific to a test. Benchmark version numbers change rarely and only when absolutely necessary to accommodate changes in third-party applications or bug fixes.

UL Procyon Office Productivity Benchmark v1.2

May 2, 2023

- Added compatibility for systems running Apple macOS. The Procyon Office Productivity Benchmark on macOS uses workloads for Microsoft PowerPoint, Word, and Excel to measure performance.

- On Systems running Microsoft Windows, the Procyon Office Productivity Benchmark now produces two scores: a Windows-only score that is compatible with scores from previous versions of Procyon Office Productivity, and an "MP Score" for comparison between systems running Windows and macOS.

UL Procyon Office Productivity Benchmark v1.1

March 7, 2023

- Updated to target .NET 4.8 and Visual Studio C++ 2022.

- This benchmark will no longer run in an elevated state. This may reduce scores on systems using 9th generation Intel CPUs or older.

UL Procyon Office Productivity Benchmark v1.0

October 4, 2021

- Launch version

How to run the Procyon Office Productivity Benchmark on macOS

Installing required software

Make sure you are connected to the Internet.

Updating macOS

1. Ensure you are running the latest version of macOS. You can check the latest versions of macOS on the Apple website.

Installing Microsoft Office software

1. Install Microsoft Office 365 or Microsoft Office 2019 (or newer).

2. Open any Microsoft Office application and activate the license by either logging in with a suitable account or by entering a license key.

3. Open the Microsoft Excel, Word and PowerPoint apps at least once, then clear any popups or activation dialogs to prevent them from interfering with the Procyon office productivity Benchmark.

Installing the UL Procyon Office Productivity Benchmark

1. Install Procyon:

Procyon-macos-installer-x64-OfficeProductivity-<version>.pkg

2. You may be prompted to install Rosetta to continue the installation unless Rosetta is already installed in the system. It can be installed with the command:

softwareupdate --install-rosetta

3. Follow the prompts to complete the installation.

Note:
UL Procyon is installed in the '/Library/UL/Procyon/OfficeProductivity' folder.

Registering your Procyon license

1. Open Terminal.

2. In Terminal, navigate to the installation folder with:

cd /Library/UL/Procyon/OfficeProductivity

3. Register your license:

./UL_Procyon --register <license key>

First time Procyon setup

We recommend that in order to correctly set up the required macOS security permissions, you first run the "Office Productivity first time setup" process, then accept the requests for security permissions that appear in the first few minutes of the process.

Usually on a system that has not any special permissions configured the Office Productivity first time setup process goes as follows:

1. Using Terminal, run the configuration tool in the Procyon install directory:

<./UL_Procyon -d office_productivity_first_time_setup.def

2. Accept the macOS permission requests that appear during the first-time process.

3. The last prompt will take you to Security & Permissions in Settings app.

4. Check the box next to "java" (on macOS Monterey) or "Terminal" (on macOS Ventura)

5. The first-time setup will end and show a prompt to retry the first-run setup if it did not have all necessary security permissions.

6. Click 'Retry' in the first-time setup dialog.

7. Accept any more permission requests that appear.

8. Necessary security permissions will have been set up once the first-time setup ends successfully. You may have to run the setup several times to achieve this.

Notes:

- *In case you accidentally deny a permission instead of accepting it, you can go to Security & Permissions in Settings app to check boxes in Accessibility and Automation tabs*

- *If it all fails, you can start over by resetting all permissions by issuing the following command in Terminal:*

tccutil reset All

- *Some enterprise security systems may require you to first add Terminal app to have Full disk access in Security & Permissions*

Required Permissions

MacOS 12 Monterey

On macOS 12 Monterey, the required permissions are:

Accessibility:

- /Library/UL/Procyon/jdk8u292-b10-jre/Contents/Home/bin/java

Automation:

- /Library/UL/Procyon/ jdk8u292-b10-jre/Contents/Home/bin/java

- Microsoft Word

- Microsoft PowerPoint

- Microsoft Excel

- System Events

MacOS 13 Ventura

On macOS 13 Ventura, the required permissions are:

Accessibility:

- Terminal

Automation:

- Terminal

- Microsoft Word

- Microsoft PowerPoint

- Microsoft Excel

- System Events

Run the office productivity benchmark

Once the benchmark is installed and permissions configured properly, it can be run as follows:

1. Open Terminal.

2. In Terminal, navigate to the installation folder with:

cd /Library/UL/Procyon/OfficeProductivity

3. To run the office productivity benchmark:

./UL_Procyon -d office_productivity.def -o "<output path>/<output file>.procyon-result"

Example:
./UL_Procyon -d office_productivity.def -o
"/Users/ProcyonTestUser/Procyonresults/OfficeProductivityResult.procyon-result"

Viewing your results

The best method to process benchmark result data is to use the Office Productivity benchmark with Testdriver Cloud.

If you chose to not use Testdriver Cloud, you can extract the information from the results file using either of the following processes.

Exporting with command line switch

Option 1:

1. Use -export-csv or -export-xml command line switch to export results as an XML or CSV file:

./UL_Procyon -d office_productivity.def -o <Export File Name>.zip --export-csv ~/<Result File Name>.csv

Example:
./UL_Procyon -d office_productivity.def -o ZipOfficeProductivityResult --export-csv
OfficeProductivityResult.csv

Option 2:

1. Use the -export-simple-CSV command line switch to export results as a single CSV file:

./UL_Procyon -d office_productivity.def -o <Export File Name>.zip -l 2 --export-simple-csv <CSV File Name>.csv

Example:
./UL_Procyon -d office_productivity.def -o ZipOfficeProductivityResult.zip -l 2 --export-simple-csv OfficeProductivityResult.csv

Extracting Result.xml from the .procyon-result file.

(This is essentially the same as using -export-xml command)

1. Unzip the .procyon-result file to extract the contents. Your benchmark results are available in the 'Result.xml' file.

Once you have the CSV or XML file, you can process the data with your preferred tools.

Uninstalling UL Procyon Office Productivity

The benchmark can be uninstalled as follows:

1. Open Terminal.

2. In Terminal, navigate to the installation folder with:

cd /Library/UL/Procyon/OfficeProductivity

3. Run the uninstallation script:

sudo ./uninstall.sh

Note:

It is not recommended to uninstall just by removing the installation folder, as it will leave the Procyon app installed in the operating system registers. This can cause issues when installing Procyon again later.

Procyon® Scores

The following interactive graph shows a distribution of PCs tested by UL Solutions as part of our 'Benchmarks Data for Retailers' service for Elkjop – A major European consumer electronics retailer. Along the X-axis are ranges of scores for tested devices, while along the y-axis represents is the percentage of devices that fall within that score range. Computers are further grouped into five colored performance tiers for each benchmark based on their suitability for the use-case being tested.

You can interact with the graph to view the representative hardware and usage scenario for each level.

Score Range & Distribution of PC's Tested by UL Solutions

Choose a benchmark type

○ Office productivity
● **Office productivity (MP)**
○ Photo Editing
○ Video Editing

Year

● **2023**

Computers performance scores with **Office Productivity Benchmark MP scores** in 2023

Level 1 ■ Level 2 ■ Level 3 ■ Level 4 ■ Level 5
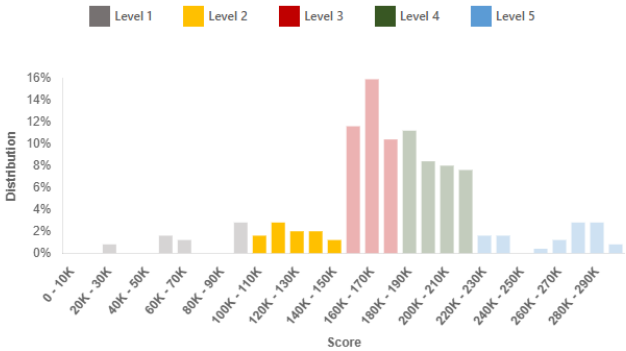
Level 2 | Range 100001 - 150000

Example level 2 system

CPU: AMD Ryzen™ 3 7520U
iGPU: AMD Radeon™ 610M
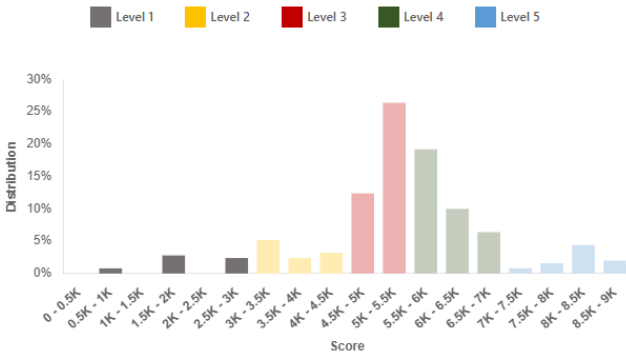**Typical usage:** Light office productivity, comfortable web experience

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Choose a benchmark type

● **Office productivity**
○ Office productivity (MP)
○ Photo Editing
○ Video Editing

Year

● **2023**

Computers performance scores with **Office Productivity Benchmark GEN scores** in 2023

Level 1 ■ Level 2 ■ Level 3 ■ Level 4 ■ Level 5

Level 1 | Range < 3000

Example level 1 system

CPU: Intel® Celeron® Processor N4500
iGPU: Intel® UHD Graphics
Typical usage: Light document editing and web browsing

Choose a benchmark type
- ○ Office productivity
- ○ Office productivity (MP)
- ● **Photo Editing**
- ○ Video Editing

Year
- ● **2023**

Computers performance scores with **Photo Editing Benchmark scores** in 2023

Legend: Level 1 (gray), Level 2 (yellow), Level 3 (red), Level 4 (dark green), Level 5 (blue)
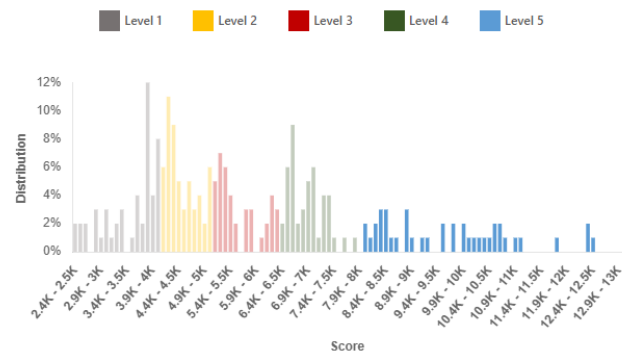
Level 5 | Range > 8000

Example level 5 system

CPU: AMD Ryzen™ 7 7700X
iGPU: AMD Radeon™ Graphics
dGPU: AMD Radeon™ RX 7900 XT
Typical usage: Next-generation hardware

Procyon benchmarks measure performance in real-world tasks using industry standard software, helping achieve up-to-date understanding of a system's performance.

This distribution is based on a sample of approximately 250 devices should not be considered a representative sample of PCs and laptops sold by Elkjop, nor is it a representative sample of PCs and laptops sold globally.

Procyon AI Benchmarks offering

Procyon AI Image Generation

Benchmark GPU AI Image Generation Performance

The Procyon AI Image Generation Benchmark provides a consistent, accurate, and understandable workload for measuring the inference performance of on-device AI accelerators. This benchmark was developed in partnership with multiple key industry members to ensure it produces fair and comparable results across all supported hardware.

The benchmark includes three tests for measuring the performance from low power NPUs to high-end discrete graphics cards. The Stable Diffusion XL (FP16) test is our most demanding AI inference workload, and only the latest high-end GPUs meet the minimum requirements to run it. For moderately powerful discrete GPUs, we recommend the Stable Diffusion 1.5 (FP16) test. Finally, we designed the Stable Diffusion 1.5 (INT8) test for low power devices using NPUs for AI workloads.

The Procyon AI Image Generation Benchmark can be configured to use a selection of different inference engines, and by default uses the recommended optimal inference engine for the system's hardware.

Features

- A range of tests built around an image generation workload, using state-of-the-art neural networks.

- Designed to measure the inference performance of a wide range of AI accelerators.

- Benchmark with NVIDIA® TensorRT™, Intel® OpenVINO™, and ONNX with DirectML.

- Verify inference engine implementation and compatibility.

- Simple to set up and use via the Procyon application or via command-line.

- Test with multiple versions of the Stable Diffusion AI model.

- Compare up to 4 results side-by-side in the app.

Benchmark details

- Stable diffusion, released in 2022, made using AI for text-to-image generation on their own hardware accessible for the everyday consumer. Given its ease of access, wide usage, and creative aspect, text-to-image generation quickly became one of the most memorable AI use cases for the public.
- The AI Image Generation Benchmark uses a set of standardized text prompts for a reliable and consistent AI image generation workload. Results provide an overall score for easy comparison, as well as further detailed scores and the generated images for closer inspections of performance and quality.

Test	Workload	Image resolution	Batch size	Steps
Stable Diffusion XL (FP16)	Heavy	1024 x 1024	1	100
Stable Diffusion 1.5 (FP16)	Medium	512 x 512	4	100
Stable Diffusion 1.5 (INT8)	Light	512 x 512	1	50

Results and insights

Benchmark scores

Compare AI Inference performance with two different versions of the Stable Diffusion model.
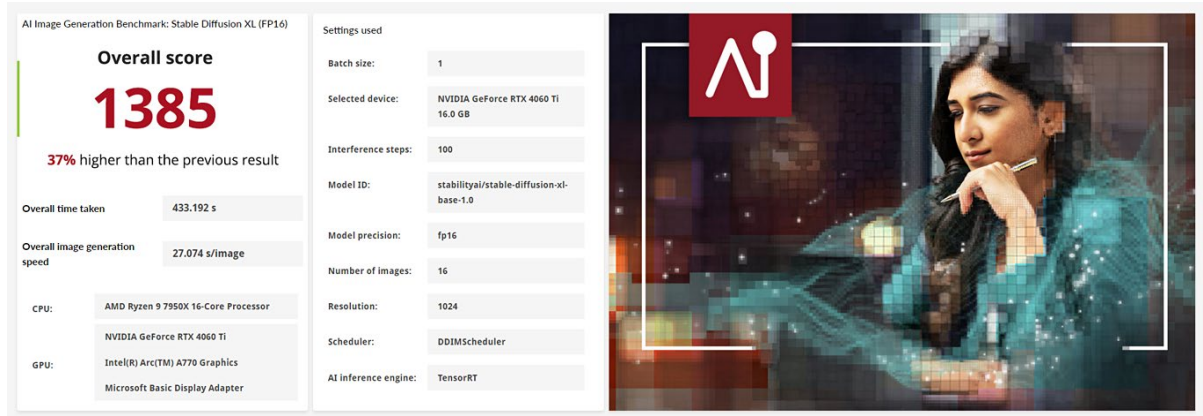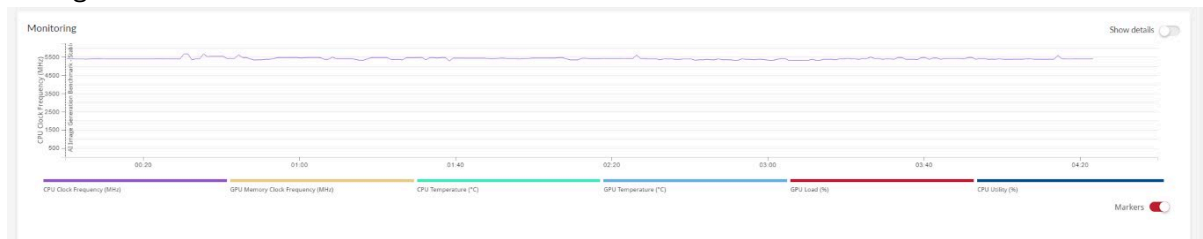

Detailed scores

Inspect generated images, and get detailed scores for each image generation batch.
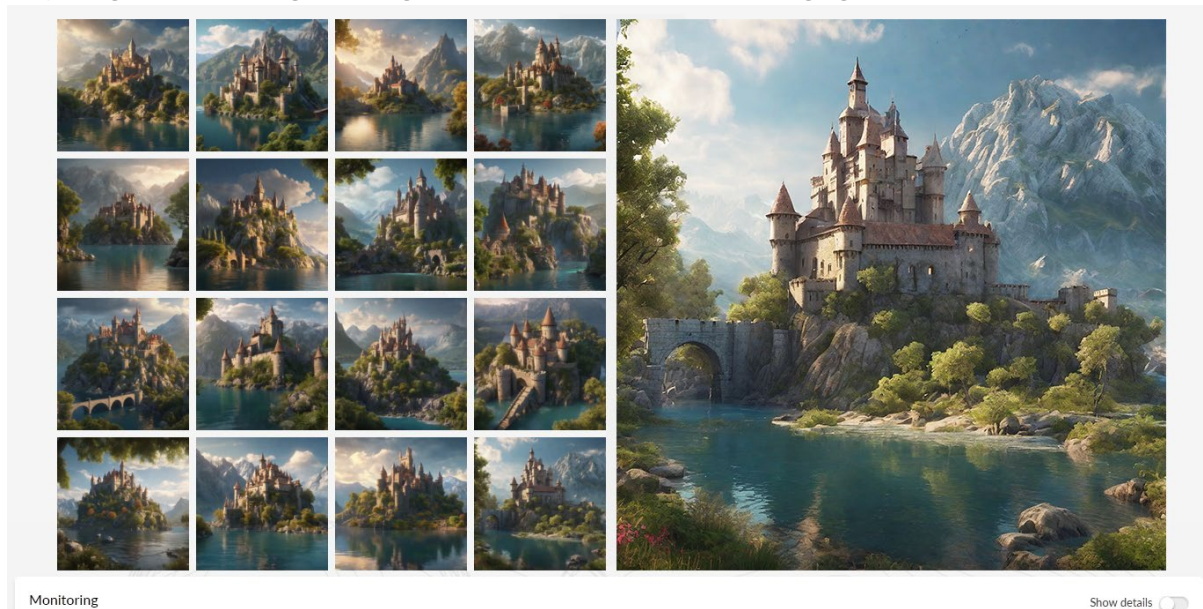
Hardware monitoring

Get detailed metrics on how CPU and GPU temperatures, clock speeds and usage change during the benchmark run.

Developed with Industry expertise

Procyon benchmarks are designed for industry, enterprise, and press use, with tests and features created specifically for professional users. The Procyon AI Image Generation Benchmark was designed and developed with industry partners through the UL Benchmark

Development Program (BDP). The BDP is an initiative from UL Solutions that aims to create relevant and impartial benchmarks by working in close cooperation with program members.

Inference Engine Performance

With the Procyon AI Image Generation Benchmark, you can measure the performance of dedicated AI processing hardware and verify inference engine implementation quality with tests based on a heavy AI image generation workload.

Designed for Professionals

We created our Procyon AI Inference Benchmarks for engineering teams who need independent, standardized tools for assessing the general AI performance of inference engine implementations and dedicated hardware.

Fast and easy to use

The benchmark is easy to install and run—no complicated configuration is required. Run the benchmark using the Procyon application or via command-line. View benchmark scores and charts or export detailed result files for further analysis.

Procyon AI Inference Benchmark for Android

Benchmark AI performance and quality using NNAPI

Machine learning is powering exciting new features in mobile apps. Many devices now have dedicated hardware to accelerate the computationally intensive operations required for on-device inferencing. The Android Neural Networks API (NNAPI) provides a base layer for machine learning frameworks to access the dedicated AI processing hardware in a device.

The Procyon AI Inference Benchmark for Android measures the AI performance of Android devices using NNAPI. The benchmark score reflects both the speed and the accuracy of on-device inferencing operations. With the Procyon AI Inference Benchmark for Android, not only can you measure the performance of dedicated AI processing hardware in Android devices, you can also verify NNAPI implementation quality.

The benchmark uses a range of popular, state-of-the-art neural networks running on the device to perform common machine-vision tasks. The benchmark runs on the device's dedicated AI-processing hardware via NNAPI. The benchmark also runs each test directly on the GPU and/or the CPU for comparison.

Features

- Tests based on common machine-vision tasks using state-of-the-art neural networks.

- Measures both inference performance and output quality.

- Compare NNAPI, CPU and GPU performance.

- Verify NNAPI implementation and compatibility.

- Optimize drivers for hardware accelerators.

- Compare float- and integer-optimized model performance.

- Simple to setup and use on a device or via ADB.

NNAPI performance and quality

With the Procyon AI Inference Benchmark for Android, you can measure the performance of dedicated AI processing hardware and verify NNAPI implementation quality with tests based on common machine-vision tasks.
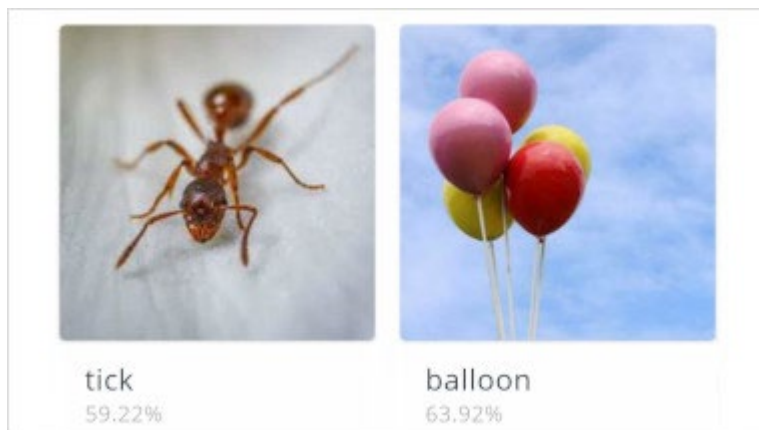
Designed for professionals

We created the Procyon AI Inference Benchmark for Android for engineering teams who need independent, standardized tools for assessing the general AI performance of NNAPI implementations and dedicated mobile hardware.

Fast and easy to use

The benchmark is easy to install and run—no complicated configuration required. Run the benchmark on the device or via ADB. View benchmark scores, charts and rankings in the app or export detailed result files for further analysis.

Neural network models

MobileNet V3

MobileNet V3 is a compact visual recognition model that was created specifically for mobile devices. The benchmark uses MobileNet V3 to identify the subject of an image, taking an image as the input and outputting a list of probabilities for the content in the image. The benchmark uses the large minimalistic variant of MobileNet V3.

Inception V4

wallet
85.88%

zebra
98.43%

Inception V4 is a state-of-the-art model for image classification tasks. Designed for accuracy, it is a much wider and deeper model than MobileNet. The benchmark uses Inception V4 to identify the subject of an image, taking an image as the input and outputting a list of probabilities for the content identified in the image.

SSDLite MobileNet V3

chair
71.09%

chair
67.97%

potted plant
64.84%

dining table
64.84%

vase
55.08%
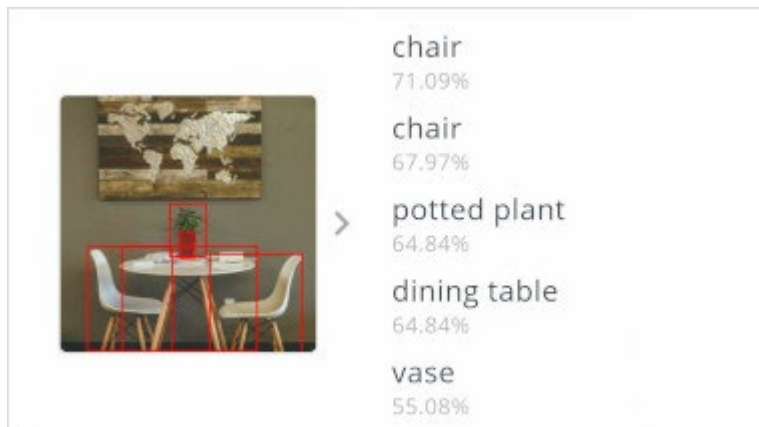
SSDLite is an object detection model that aims to produce bounding boxes around objects in an image. SSDLite uses MobileNet for feature extraction to enable real-time object detection on mobile devices. In the benchmark, the float version of SSDLite uses the small minimalistic MobileNet V3 variant. The integer version uses the EdgeTPU variant of MobileNet V3.

DeepLab V3
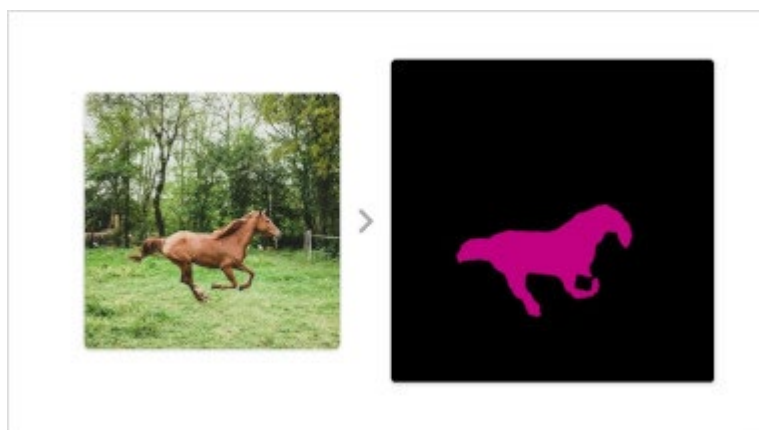
DeepLab is an image segmentation model that aims to cluster the pixels of an image that belong to the same object class. Semantic image segmentation labels each region of the image with a class of object. The benchmark uses MobileNet V2 for feature extraction enabling fast inference with little difference in quality compared with larger models.

Custom CNN

The benchmark includes a custom Convolutional Neural Network (CNN) based on the AlexNet architecture. It is designed to test the performance of basic CNN operations and is trained on randomly generated training data. It contains two Convolutional layers, which are followed by Max Pooling and Dropout layers, and one fully connected layer.

Integer and float models

The benchmark includes both float- and integer-optimized versions of each model. Each model runs in turn on all compatible hardware in the device. With NNAPI, the benchmark will use the device's dedicated AI-processing hardware, if supported. Float models use NNAPI or run directly on the CPU or GPU. Integer models use NNAPI or run directly on the CPU.

Procyon AI Computer Vision Benchmark

Benchmark AI performance using various inference engines

Machine learning applications are rapidly growing as it becomes more accessible to integrate and deploy AI solutions into everyday applications. With the demand for faster machine learning performance, major hardware vendors have been optimizing their inference engines to provide the best possible performance on their hardware.

The Procyon AI Computer Vision Benchmark gives insights into how AI inference engines perform on your Windows PC or Apple Mac, helping you decide which engines to support to achieve the best performance. The benchmark features several AI inference engines from different vendors, with benchmark scores reflecting the performance of on-device inferencing operations.

In the benchmark, common machine-vision tasks are executed using a range of popular, state-of-the-art neural networks. Measure AI accelerator performance by comparing it with the same operations run on the CPU or GPU.

Features

- Tests based on common machine-vision tasks using state-of-the-art neural networks.

- Measure inference performance using the CPU, GPU or dedicated AI accelerators.

- Benchmark with NVIDIA® TensorRT™, Intel® OpenVINO™, Qualcomm® SNPE, Microsoft® Windows ML, and Apple® Core ML™.

- Verify inference engine implementation and compatibility.

- Optimize drivers for hardware accelerators.

- Compare float and integer-optimized model performance.

- Simple to set up and use via the Procyon application or via command-line.

Inference engine performance

- With the Procyon AI Computer Vision Benchmark, you can measure the performance of dedicated AI processing hardware and verify inference engine implementation quality with tests based on common machine-vision tasks.

Designed for professionals

- We created the Procyon AI Computer Vision Benchmark for engineering teams who need independent, standardized tools for assessing the general AI performance of inference engine implementations and dedicated hardware.

Fast and easy to use

- The benchmark is easy to install and run—no complicated configuration is required. Run the benchmark using the Procyon application or via command-line. View benchmark scores and charts or export detailed result files for further analysis.

Neural network models

MobileNet V3

- MobileNet V3 is a compact visual recognition model that was created specifically for mobile devices. The benchmark uses MobileNet V3 to identify the subject of an image, taking an image as the input and outputting a list of probabilities for the content in the image. The benchmark uses the large minimalistic variant of MobileNet V3.

Inception V4

- Inception V4 is a state-of-the-art model for image classification tasks. Designed for accuracy, it is a much wider and deeper model than MobileNet. The benchmark uses Inception V4 to identify the subject of an image, taking an image as the input and outputting a list of probabilities for the content identified in the image.

YOLO V3

- YOLO, which stands for You Only Look Once, is an object detection model that aims to identify the location of objects in an image. The benchmark uses YOLO V3 to produce bounding boxes around objects with probabilities on the confidence of each detection.

DeepLab V3

- DeepLab is an image segmentation model that aims to cluster the pixels of an image that belong to the same object class. Semantic image segmentation labels each region of the image with a class of object. The benchmark uses MobileNet V2 for feature extraction enabling fast inference with little difference in quality compared with larger models.

Real-ESRGAN

- Real-ESRGAN is a super-resolution model trained on synthetic data for increasing the resolution of an image, reconstructing a higher resolution image from a lower resolution counterpart. The model used in the benchmark is the general image variant of Real-ERSGAN, and upscales a 250x250 image to an 1000x1000 image.

ResNet 50

- ResNet 50 is an image classification model that provides a novel way of adding more convolutional layers with the use of residual blocks. Its release enabled the training of deep neural networks previously not possible. The benchmark uses ResNet 50 to identify image subjects, outputting a list of probabilities for the content identified in the image.

Integer and float models

- The benchmark includes both float- and integer-optimized versions of each model. Each model runs in turn on all compatible hardware in the device. Select the device and inference precision for each runtime to compare performance between integer and float models.

Results and insights
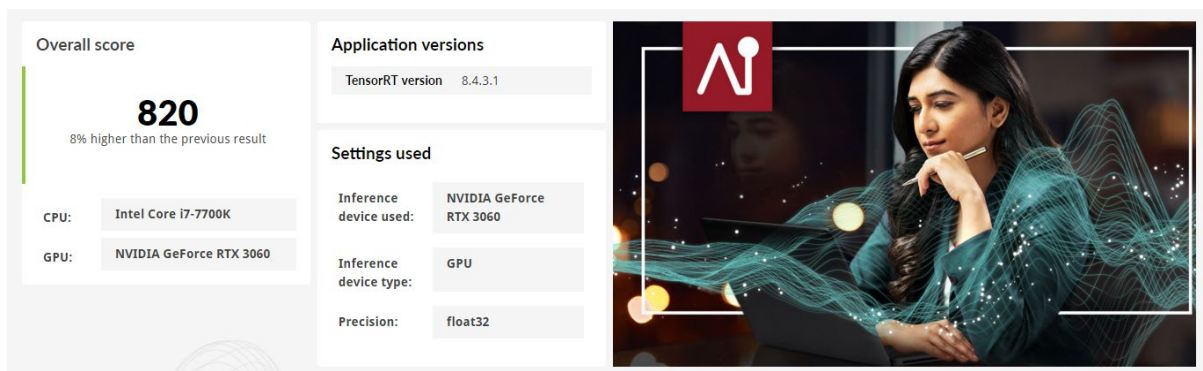
Benchmark scores

Compare AI Inference performance with integer and float models using a CPU, GPU or dedicated AI accelerator.

Detailed scores

See inference times for each neural network test when using your selected inference engine and processing unit.

MobileNet V3		ResNet 50		Inception V4	
Average inference time	0.67 ms	Average inference time	2.26 ms	Average inference time	6.81 ms
Median inference time	0.67 ms	Median inference time	2.26 ms	Median inference time	6.81 ms
Total inferences count	187 627	Total inferences count	70 643	Total inferences count	22 813
DeepLab V3		SSD MobileNet V2		Real-ESRGAN	
Average inference time	12.27 ms	Average inference time	1.39 ms	Average inference time	291.19 ms
Median inference time	12.38 ms	Median inference time	1.39 ms	Median inference time	291.36 ms
Total inferences count	10 529	Total inferences count	72 130	Total inferences count	616
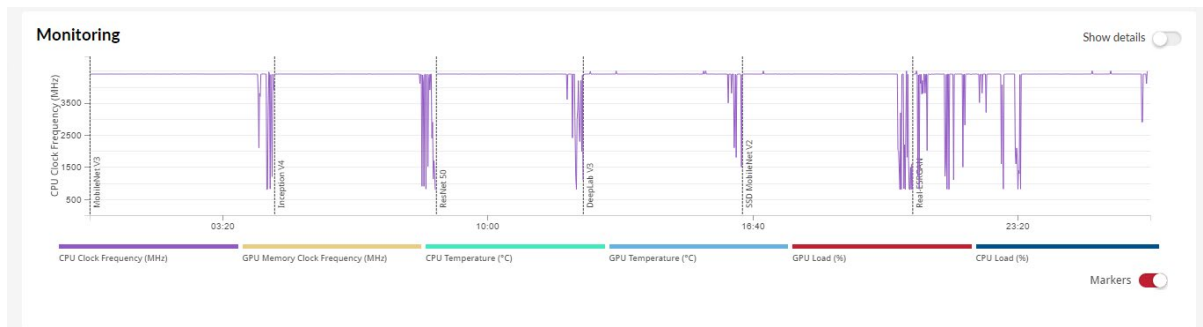
Hardware monitoring

Get detailed metrics on how CPU and GPU temperatures, clock speeds and usage changes during the benchmark run.

UL Benchmarks for retailers

PC performance data for retailers

When shopping for a Windows PC or Mac computer, consumers can get overwhelmed by the multitude of available choices. Complex specifications indicate each computer's strengths and capabilities, but such technical information can prove difficult to understand, especially when comparing multiple computers. The challenge is to demonstrate a computer's actual performance in an instantly meaningful way.

At UL Solutions, we offer industry-leading benchmarks that make it easier for everyone to understand the performance of a PC or Mac computer. A benchmark tests how well a product performs a function and how that performance compares across similar products. UL Solutions custom benchmarks test computers and reduce a computer's specification sheet to an easily understood numbered score. The higher the score, the better the performance. It's that simple.

Simplifying complex specifications into user-friendly statistics

UL Solutions began developing industry-standard computer benchmarks in the 1990s. Since then, our benchmarks have evolved to perform accurate assessments of PCs and Macs as well as notebooks, tablets and smartphones. Millions of people around the world trust our benchmarks; they are accurate and user-friendly and they come from UL Solutions, a trusted industry partner with more than 120 years of experience in product testing, certification and verification services.

UL Solutions benchmarks cover a variety of performance capabilities for computers and smart devices used at the office and in the home, for work and for play. Customers can easily understand our benchmark data because sales associates can easily explain it. Even nontechnical customers can feel empowered to understand how a computer will perform the tasks specific to their needs. Will it run smoothly while multitasking or handling large files? Will a laptop battery last throughout the day? Consumers who understand computer performance make better purchasing decisions.

How can UL Solutions benchmarks help your business?

For retail businesses, our easily understood benchmarks can help increase sales, reduce returns and improve customer satisfaction. We already work with many international consumer electronics retailers, helping them achieve their goals and maximize customer experience. Our Benchmark team can create custom benchmarks to fit your business needs. We can thoroughly test and assess your products under controlled conditions in dedicated laboratories, or we can help you set up and run your own testing facilities with processes that deliver accurate, repeatable test results.

Our benchmark data comes in tailored packages, making it much easier for your customers to confidently choose and buy a new PC, Mac, tablet or smartphone and allowing your sales staff to recommend and sell devices with greater information and insight into each product on the shelf. Your customers can also download our complimentary benchmarking software to test an existing device or computer at home before coming into a store, which can highlight the value of an upgrade or replacement.

What benchmark services do we offer?

As electronics retailers already know, gamers are a huge part of the consumer computer market, and game performance depends heavily on computer and processor capabilities. Our most popular benchmark measures and tests video game performance.
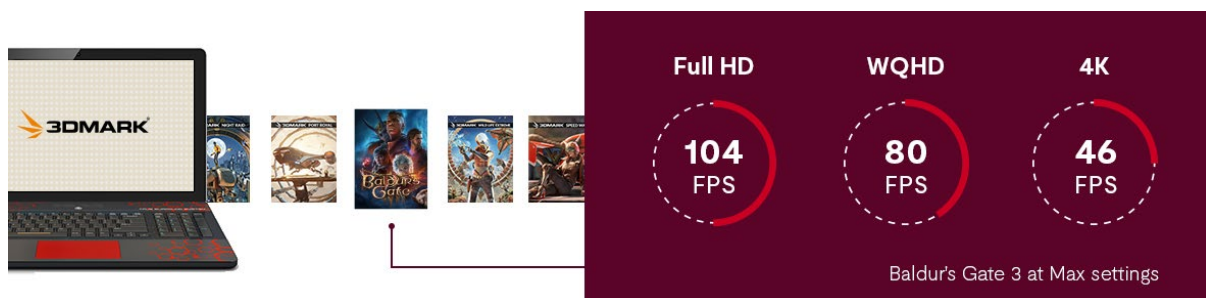
PC performance is incredibly important for gamers, and new games constantly raise the bar for visually rich, immersive experiences. We conduct game performance testing on a broad selection of hardware that covers the range of popular CPUs and GPUs found in modern gaming computers.

To date, our dedicated laboratories have assessed more than 50 of the world's newest, most popular games on a variety of computers. We test each game at different resolution settings, from 1080p medium and 1080p ultra to 1440p ultra, 4K UHD medium and 4K UHD ultra, pushing each game and computer system to its technical limits. In your retail store, you can explain this performance data and demonstrate the expected frame rates for each gaming computer.

Gaming categorization

Gamers fear that a new PC won't be able to play the latest games or deliver the experiences they want, but how do they know for sure? Even expert consumers may struggle to understand complex technical specifications, confusing naming schemes and manufacturer jargon. Measuring and grading computer and game specifications according to specific categories can help clear the air. Product categories can help your customers find the gaming computers that best meet their needs and budgets.

Gaming computer benchmarks slot performance into different categories, from abilities adequate to basic computing needs or full-blown artistic creation to meeting the needs of a casual or elite gamer. Color-coded categories and numbered scores give consumers and sales associates a good idea of which platforms work best for specific games, enabling improved in-store presentation by grouping products with similar performance. You can guide consumers to what they really need and want rather than what is simply technically possible.

Beyond the gaming world

We designed our benchmarks to be accurate, neutral and relevant, and they extend beyond gaming to the many uses of both home and office computers. Our benchmarking capabilities include real-world scenario testing on professional applications like Microsoft 365 and Adobe. Our multiplatform Procyon® benchmark suite, for example, runs benchmark tests focusing on office productivity, photo and video editing, battery life, AI inference and more.

We designed our benchmarks and performance around common activities and real-world applications. We can provide data on everyday device usage as well as gaming-specific statistics. Our performance data combined with categorization gives your customers a more accessible way to choose a PC or Apple Mac computer. Instead of trying to compare complicated specifications, consumers can choose a device based on the activities that are most important to them, and it's all summed up in a simple score.

Office Productivity Score Guide

Office Productivity Score Level 1 | Range < 3000

Representative hardware: Low end Celerons and Ryzens

Intel® Celeron® Processor N4500, Intel® UHD Graphics

Typical usage: Light document editing and web browsing

Office Productivity Score Level 2 | Range 3000 - 4500

Representative hardware: U and G-CPUs with iGPU

AMD Ryzen™ 3 7320U, AMD Radeon™ 610M

Typical usage: Light office productivity, comfortable web experience

Office Productivity Score Level 3 | Range 4500 - 5500

Representative hardware: P-CPUs with lower end dGPUs

Intel® Core™ i7-1355U Processor, Intel® Iris® Xe Graphics

Typical usage: Suits most Office productivity needs

Office Productivity Score Level 4 | Range 5500 - 7000

Representative hardware: desktop and H-CPUs; dGPUs;

AMD Ryzen™ 7 7840HS, AMD Radeon™ 780M, NVDIA GeForce RTX™ 4060 Laptop GPU
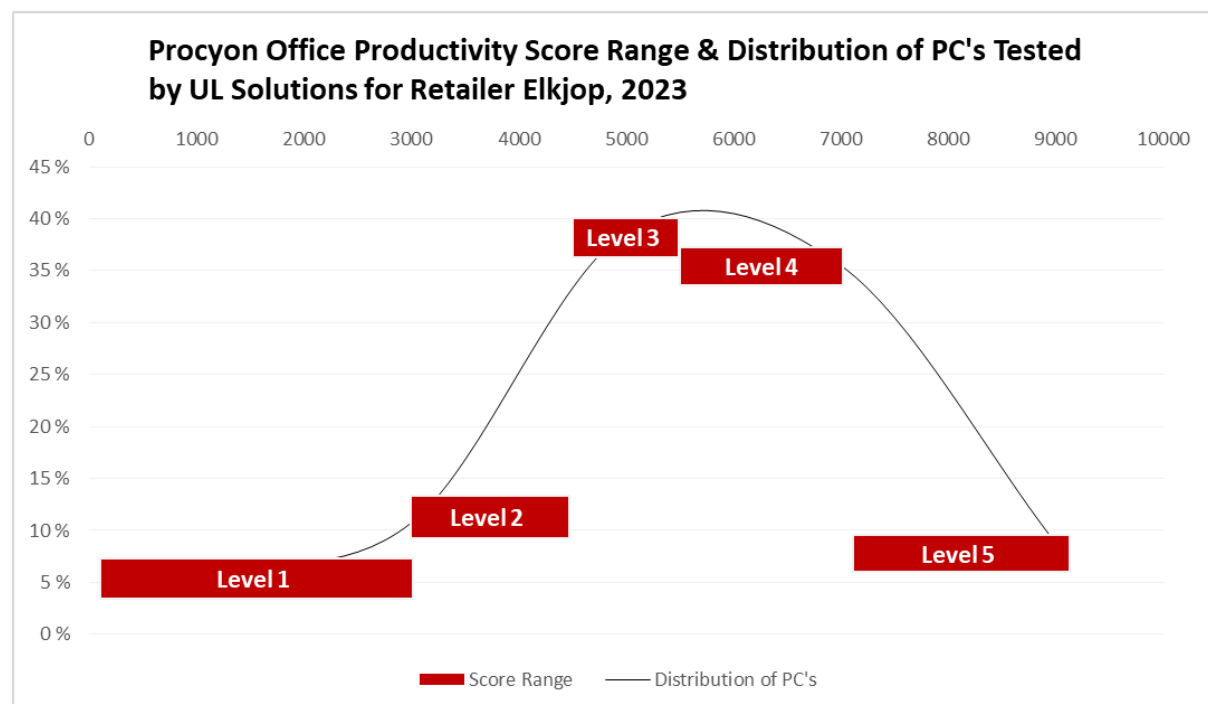
Typical usage: Heavy Excel computations and solvers

Office Productivity Score Level 5 | Range 7000 >
Representative hardware: High-end CPU + high-end GPU

Intel® Core™ i9-13900KF Processor, NVDIA GeForce RTX™ 4090

Typical usage: High end workstations

Office Productivity MP Score Guide

Office Productivity MP Score Level 1 | Range < 100000

Representative hardware: Low end Celerons and Ryzens

Intel® Celeron® Processor N4500, Intel® UHD Graphics

Typical usage: Light document editing and web browsing

Office Productivity MP Score Level 2 | Range 100000 - 150000

Representative hardware: U and G-CPUs with iGPU

AMD Ryzen™ 5 7520U, AMD Radeon™ 610M

Typical usage: Light office productivity, comfortable web experience

Office Productivity MP Score Level 3 | Range 150000 - 180000

Representative hardware: P-CPUs with lower end dGPUs

Intel® Core™ i5-12450H Processor, Intel® UHD Graphics

Typical usage: Suits most Office productivity needs

Office Productivity MP Score Level 4 | Range 180000 - 220000

Representative hardware: desktop and H-CPUs; dGPUs;

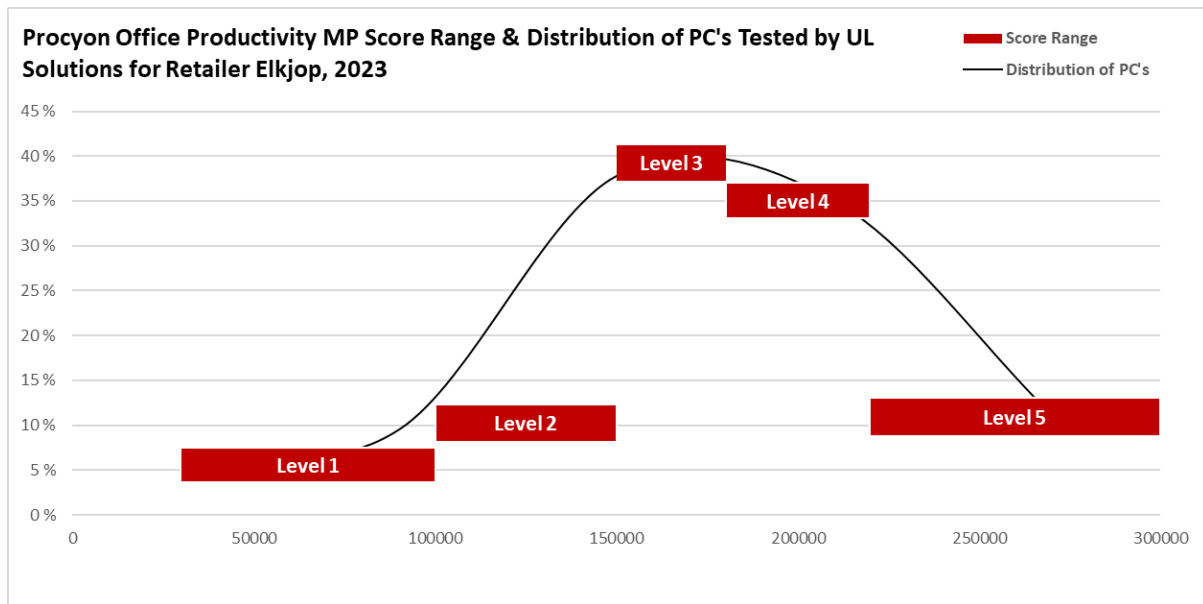AMD Ryzen™ 7 7840HS, AMD Radeon™ 780M, NVDIA GeForce RTX™ 4060 Laptop GPU

Typical usage: Heavy Excel computations and solvers

Office Productivity MP Score Level 5 | Range 220000 >
Representative hardware: High-end CPU + high-end GPU

Intel® Core™ i9-13900KF Processor, NVDIA GeForce RTX™ 4090

Typical usage: High end workstations

Procyon Office Productivity MP Score Range & Distribution of PC's Tested by UL Solutions for Retailer Elkjop, 2023

Legend: Score Range | Distribution of PC's

Please note that Procyon scores and categories are not static and will change year-on-year based on hardware and the application versions being tested.

Four categories for Photo Editing:

Level 1 | Range 2400 - 4100

Representative hardware: Intel® Core™ i7-1355U Processor, Intel® Iris® Xe Graphics

Typical usage: Simple photo editing - e.g., Image filters for social media, cropping, color adjustments.

Level 2 | Range 4101 - 5100

Representative hardware: AMD Ryzen™ 5 7530U, AMD Radeon™ Graphics

Typical usage: Casual photo editing - e.g., Light photo manipulation, small-scale batch editing of photos.

Level 3 | Range 5101 - 6400

Representative hardware: Intel® Core™ i7-13700H Processor, NVIDIA GeForce RTX™ 4050 Laptop GPU

Typical usage: Enthusiast content creation - e.g., heavy image manipulation, GPU accelerated image processing, large-scale batch editing of RAW photos.

Level 4 | Range 6401 - 8000

Representative hardware: Intel® Core™ i7-13700HX Processor, NVIDIA GeForce RTX™ 4070 Laptop GPU

Typical usage: Professional content creation

Level 5 | Range 8000 - onwards
Representative hardware: AMD Ryzen™ 7 7700X, AMD Radeon™ RX 7900 XT

Typical usage: Next-generation hardware.

Five categories for Video Editing:

Level 1 | Range 1-2200

Representative hardware: Intel® Core™ i5-1335U Processor, Intel® Iris® Xe Graphics

Typical usage: Light video editing, MP4 editing.

Level 2 | Range 2201-3500

Representative hardware: AMD Ryzen™ 7 7840U, AMD Radeon™ 780M

Typical usage: Full HD video editing H.265/HEVC editing.

Level 3 | Range 3501-5200

Representative hardware: Intel® Core™ i7-13620H Processor, NVDIA GeForce RTX™ 4050 Laptop GPU

Typical usage: Enthusiast 4K video editing H.265/HEVC editing.

Level 4 | Range 5200-6500

Representative hardware: AMD Ryzen™ 9 7940HS, NVIDIA GeForce RTX™ 4070 Laptop GPU

Typical usage: High-resolution real time video editing up to 8K resolution

Level 5 | Range 6500 - onwards
Representative hardware: Intel® Core™ i9-13900HX Processor, NVIDIA GeForce RTX™ 4090 Laptop GPU

Typical usage: Movies and professional videography projects up to 12K resolution