QSP
Quality Slide Program

Version 2.1

User Manual

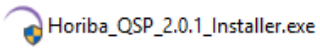
HORIBA

Fraunhofer IIS

Contents

1. Installation

For installing *QSP* use the provided *QSP* installer:



Accept the license agreement and chose an installation directory.

It is not possible to have different versions installed side-by-side.

Before uninstalling *QSP* make sure all *QSP* applications are closed.

Installing *QSP* requires admin rights on the computer

2. User Account Concept

QSP is a desktop software that uses the concept of user accounts. They are different from the Microsoft Windows user accounts.

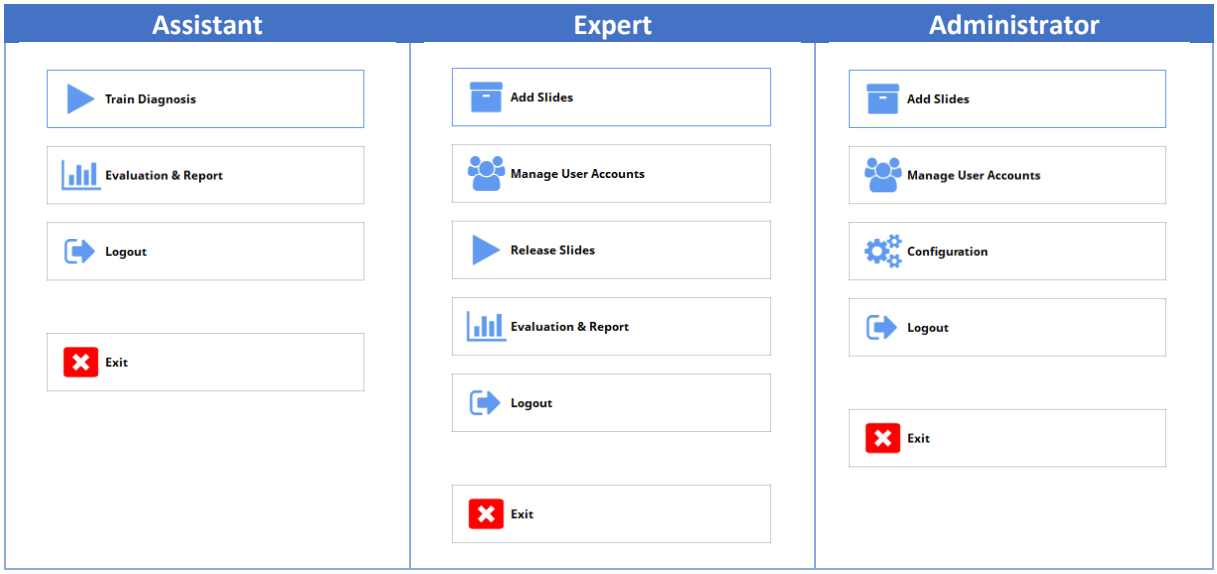
An account can have one of three Roles

- Assistant
- Expert
- Administrator

Typically, each installation of *QSP* will have a single Expert and a single Administrator account and one or more Assistant accounts.

Across the life cycle of *QSP*, the *Expert* user will add new *Slide Packages* frequently and double-check the pre-provided diagnosis. Then the new slides will be available to all *Assistant* users who can train by entering their own diagnosis, including classifying each individual cell. Assistants can evaluate themselves by comparing their diagnosis with the ground truth and store the evaluation in a PDF report or an Excel sheet.

The options available to the three user types are:



2.1. Role Assistant

An assistant can open a previously loaded *Slide Package* and diagnose the slides one by one. For slides that have been entirely diagnosed, the assistant can create the evaluation as well as an *Evaluation Report*.

An assistant cannot import new *Slide Packages* into *QSP* as the process of importing a new *Slide Package* involves double-checking the pre-provided diagnose, which is reserved for an *Expert* user.

2.2. Role Expert

An expert user can load new Slide Packages into *QSP*. Packages are provided by Horiba Medical. They contain a diagnose that includes a classification for every single cell. Nevertheless, upon importing the Slide Package, the expert is asked to sign-off on or, if necessary, correct the slides' cell classifications.

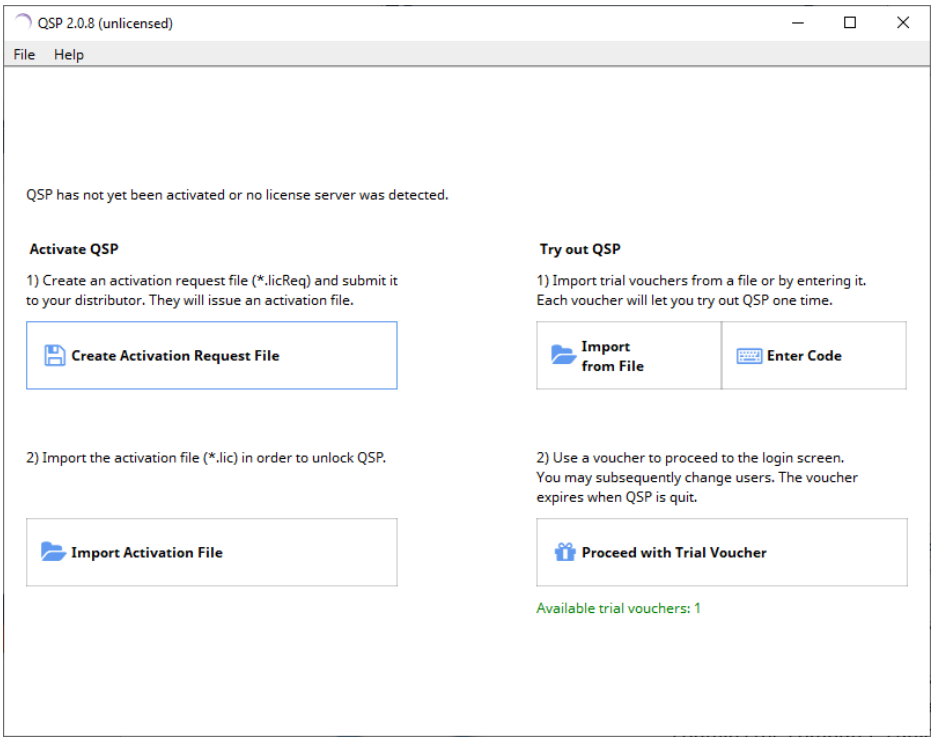
An expert can also create an *Evaluation Report* individually for each assistant user as well as an *Expert Evaluation Report* that contains statistics on all assistant users.

2.3. Role Administrator

Only the administrator account can access the program settings, where for instance the paths where imported slides are stored, can be configured.

3. First Start

QSP will check at every program start for a valid software license. When no such license is detected, *QSP* will not display the usual user login, but instead show the following screen:



Two options are possible to proceed

Activate QSP

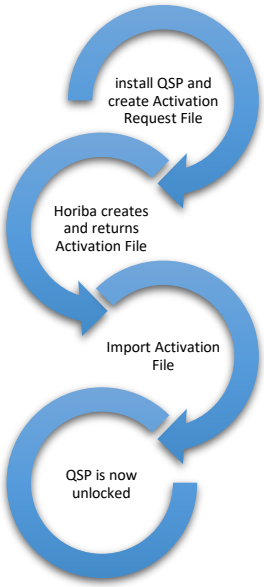
(left column) QSP can be **permanently activated** by requesting and subsequently importing an activation file (aka license file, *.lic). This process is explained in chapter 3.1.

Try out QSP

(right column) QSP can be operated in trial mode by importing one (or multiple) trial vouchers. Each start of QSP will consume one code. This process is explained in chapter 3.2.

3.1. Activating *QSP*

The activation procedure works as follows:



1. User installs *QSP* on their local computer where they plan to use it subsequently
2. User opens *QSP* and creates an *Activation Request File* (Button "Create Activation Request file"). This file contains the computer's unique fingerprint.
   User sends the file via email to their local *QSP* distributor, who forwards it to Fraunhofer IIS
3. Based on the activation request file, Fraunhofer IIS will create an *Activation File* (contains software license) and return it, via the *QSP* distributor, to the user
4. User will import the *Activation File* (Button "Import Activation File"). Now the software is activated. The license file will only work on the same computer where the *Activation Request File* has been created.

3.1.1. Single License

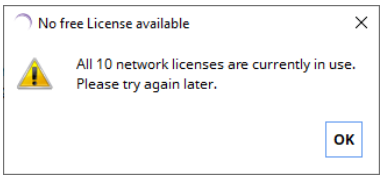
The QSP single-license is a "node-locked" license, i.e. it is tied to a single computer based on the computer's unique "fingerprint". The single QSP installation can be shared by multiple Windows user accounts, though.

3.1.2. Network/Site License

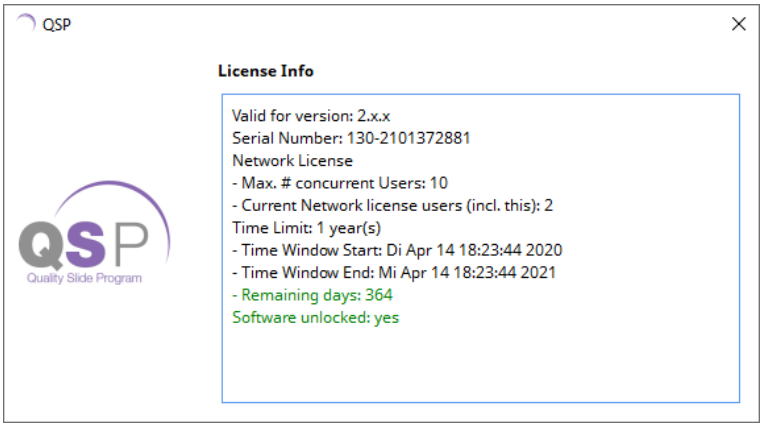
Alternatively, a "Network license" (analogously also referred to as "site license") is available. A single computer will serve as a "License Server" and be activated with a QSP network license, e.g. for 10 concurrent users. The computer that serves as a license server is required to be always on (though QSP does not have to run). Typically, this will be a stationary computer located in the office building or company headquarter.

Subsequently, QSP can be installed on any computer in the network or on remote computers or notebooks connected via VPN. At program start, QSP will automatically search for a "License Server" in the network and if one is found, use one of the 10 available slots. The local QSP installation does not have to be activated with a license file.

The first ten concurrent users can use QSP in this way. When the 11th parallel user starts QSP, they will see this message at program start:



Information on the current license can be accessed by pressing in the main menu “Help” | “License Information”.



3.1.3. Network/Site License – License Server Installation

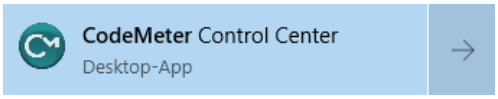
The process of importing the network/site license activation file is identical to the activation of a single license as described above.

1) Install QSP
2) Start QSP
3) Create activation request file
4) Import activation file. In contrast to a “single license”, this file contains the information that it is a network/site license as well as the maximum number of concurrent users (e.g. 10)

The computer has to remain switched on. Otherwise other computers in the local network will not be able to detect the site license. QSP itself does not have to be started. It is only used to import the activation file. Typically, this will be a stationary computer located in the office building or company headquarter.

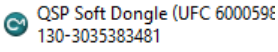
However, before the network/site license is found by other computers, the server has to be made “visible”:

5) In the Windows Start-Menu type “CodeMeter” and open the “CodeMeter Control Center”

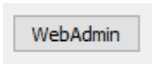


CodeMeter (by Wibu Systems) is the copy protection system built into QSP. It has been automatically installed as part of the QSP installation.

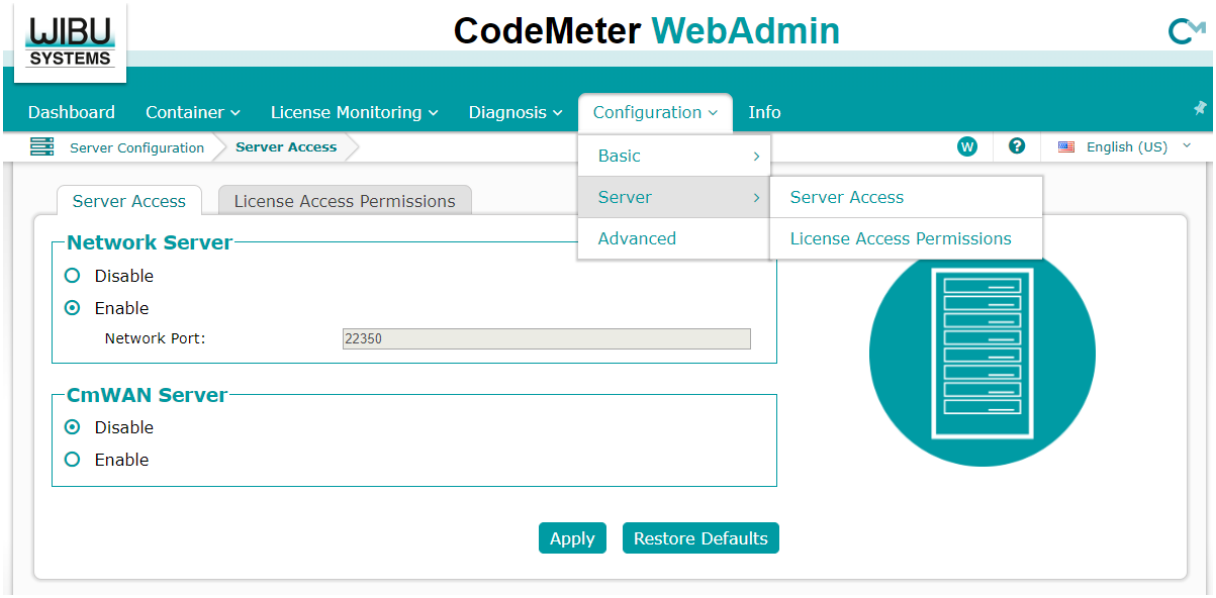
6) *CodeMeter Control Center* lists at least one entry related to QSP. The green icon indicates that a valid license has already been imported



Press the “WebAdmin” button in the bottom-right corner:



7) The *CodeMeter WebAdmin* website will be opened in the default web browser. Here, go to "Configuration"|"Server" and click "Enable" in the "Network Server" section.

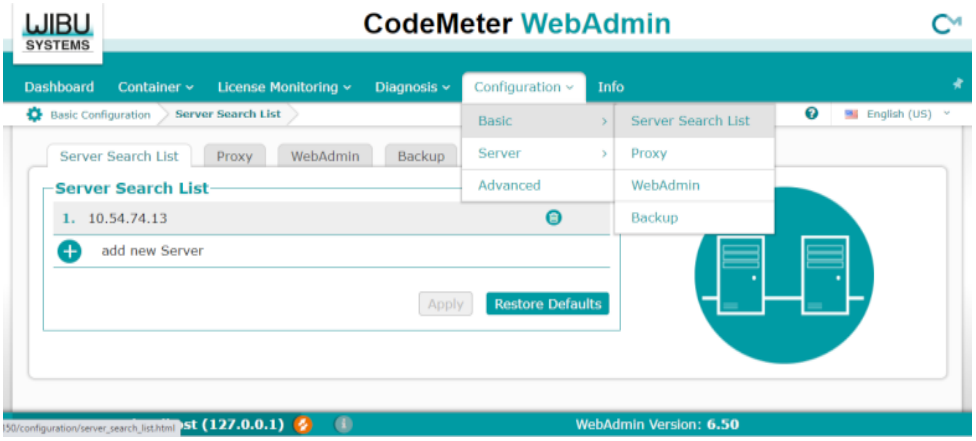


8) Congratulations. Now QSPs running on other computers in the network will detect the site license.

3.1.4. Network/Site License – QSP via VPN (home office)

If the QSP "license server" installation is in the same local network, no additional steps are required. If, however, a QSP client is run on a remote computer that is connected via a virtual private network (VPN) connection, e.g. in a home office situation, the QSP client might not automatically find the QSP license server. In this case, the license server's computer name or IP address must be configured:

1) Open the *CodeMeter WebAdmin* Console as explained in the chapter above in steps 5-7
2) In the *Configuration* menu entry, go to *Basic* and click *Server Search List:*



3) Click the “add new Server” button and enter the name or IP address, in the example above “10.54.74.13”, of the always-on computer where the QSP license server is installed. Then click “Apply”
4) Now restart the QSP client and it will find the license server

The network license discovery service requires that the port 22350 is open.

If the network server is not discovered, please contact your IT and have them check that the license server is reachable under the given name or IP address and that port 22350 is not blocked.

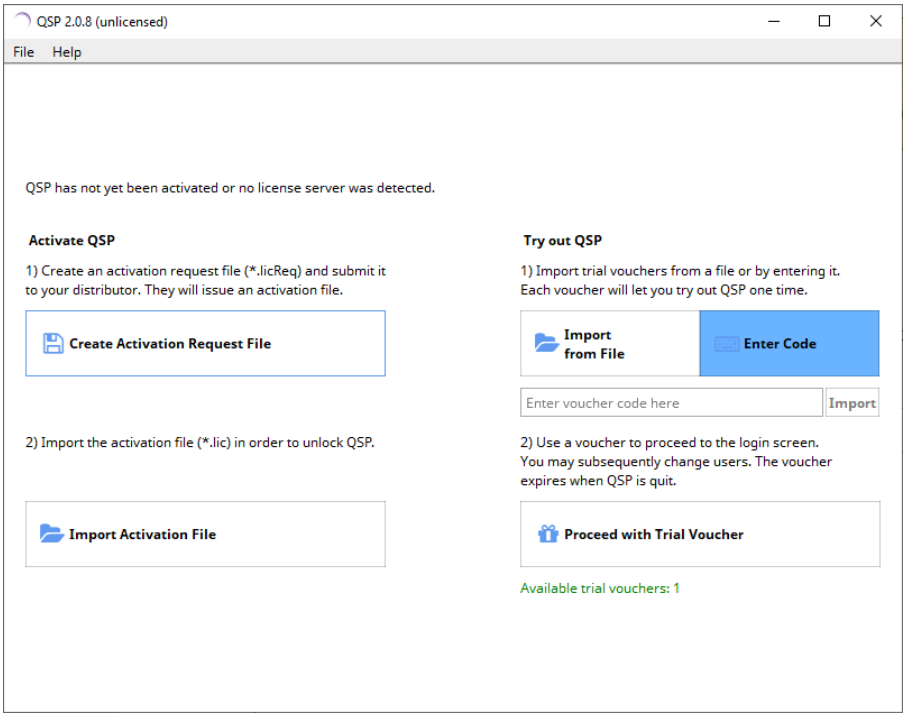
3.2. Starting QSP with trial voucher

Before QSP has been permanently activated by purchasing an activation file (aka license file), it can be tested in trial mode. This requires that a trial voucher code or file is available. Please inquire with your local sales representative.

Trial voucher codes can be imported in one of two ways:

1. From a file which may contain one or multiple codes. The file has the file extension *.voucher. Click the “Import from File” button and then select the file.
2. If you have received a printed code, please enter it manually. Click on the “Enter Code” button to turn the field visible where you can type the code in. Once you have entered it, click the “Import” button next to it.

In either case, once the file or code has been imported, a dialog will appear stating how many codes have been imported. In the screenshot below, a single code been imported. The “Proceed with Trial Voucher” button is enabled when at least one code remains available. The text below the button informs how many codes are available.



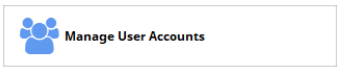
When the “Proceed with Trial Voucher” button is pressed, a single code will be consumed. QSP will then proceed to the login screen. Log in with any of the available users.

Switching user accounts subsequently by logging out and logging in with another user is possible and will not consume another voucher code.

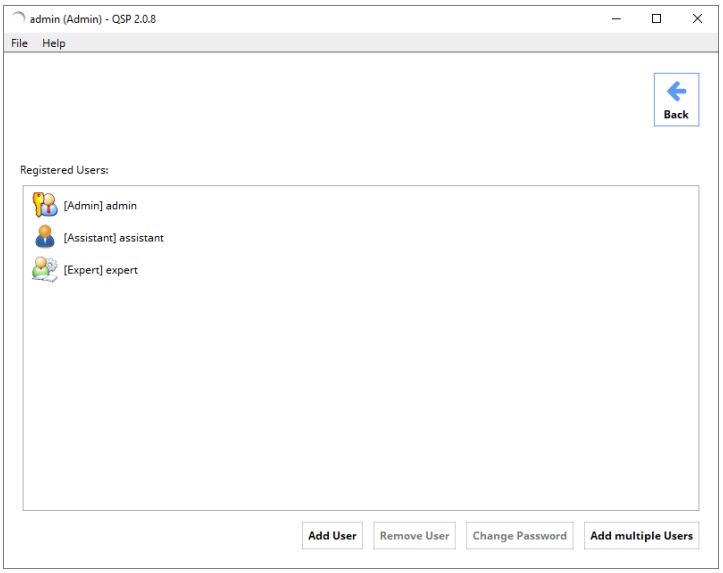
QSP will authenticate the entered codes with a server operated by Fraunhofer IIS. This procedure requires an active Internet connection.

3.3. Setting up User Accounts

The Expert and Admin users can manage user accounts via the “Manage User Account” button in the main menu.



The “Manage User Account” view shows a list of all currently registered accounts.



By default, *QSP* has three pre-configured accounts, one for each role: *Assistant*, *Expert* and *Admin*:

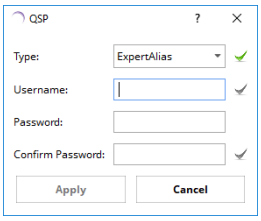
Username	Role	Password
“assistant”	Assistant	“12”
“expert”	Expert	“12”
“admin”	Administrator	“12”

The default passwords should be changed by selecting an account and clicking the “Change Password” button. You will be prompted to enter the current password: type “12”. Afterwards you are asked to enter the new password twice.

The passwords cannot be reset in case they are forgotten, so make sure to store them safely.

3.3.1. Adding a single new account

New user accounts are created by clicking “Add User”. A dialog will pop up:

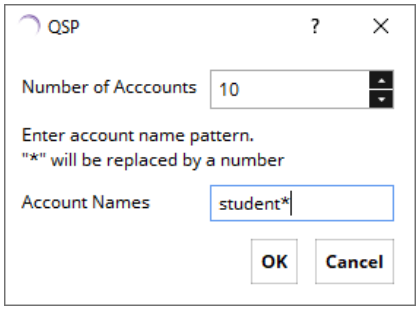


Select whether the new user is an *Expert* (select “ExpertAlias”) or an *Assistant*. Additional Administrator accounts cannot be created.

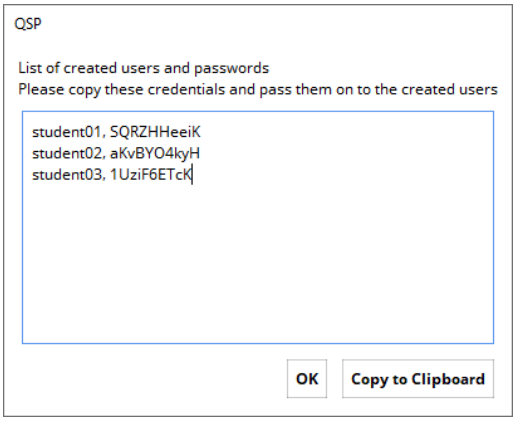
3.3.2. Adding multiple new accounts

Since creating many “assistant” accounts one by one would be very tedious, a convenience option for the creation of a batch of new accounts is included.

Click the “Add multiple Users” button. A dialog will appear where the number of new accounts can be configured and a name pattern can be entered. E.g. creating three accounts with the pattern “student*” will create the accounts “student01”, “student02” and “student03”.

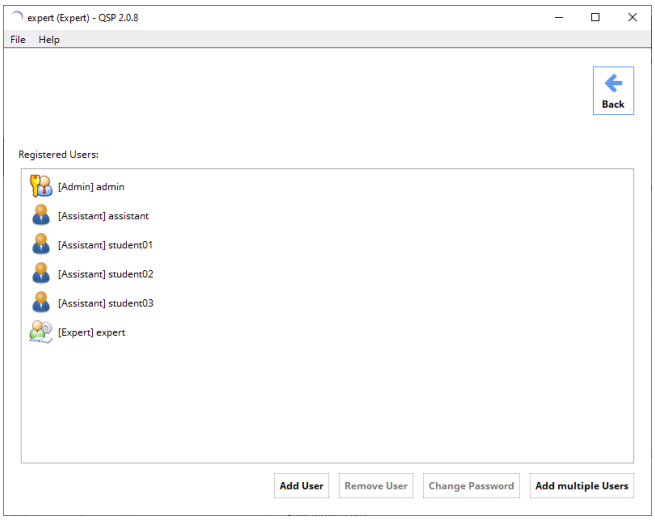


Random passwords will be automatically generated. Upon clicking “OK”, the created user names and passwords will be displayed.



Please copy and paste the account details. The passwords will not be accessible anymore afterwards. However, it is perfectly possible to manually change the password of each individual account later by clicking the “Change Password” button. Eventually, the user names and passwords must be individually provided to each single assistant/student.

Now, the three new accounts “student01”, “student02”, “student03” have been created:



Remember to change the default passwords for the built-in accounts “admin” and “expert”, so that assistants/students cannot access these accounts.

3.4. Adding a new Slide Package [Expert/Admin-only]

Loading a new *Slide Package* into *QSP* is only possible to users with the role *Expert*.

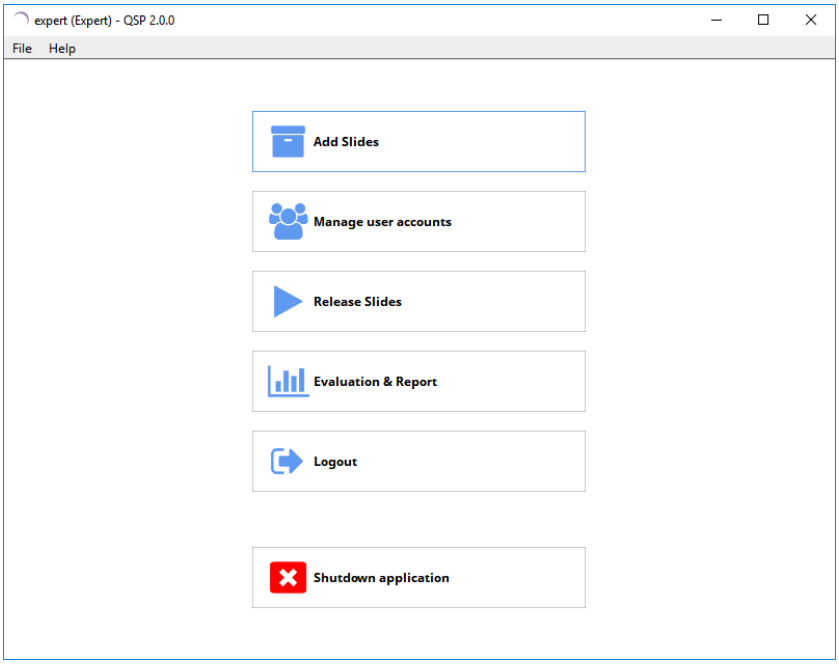
Packages are provided by Horiba Medical. They contain a diagnose that includes a classification for every single cell. Nevertheless, upon importing the *Slide Package*, the expert is asked to sign-off on or, if necessary, correct the slides’ cell classifications.

3.4.1. Download Slide Package from Horiba Medical website

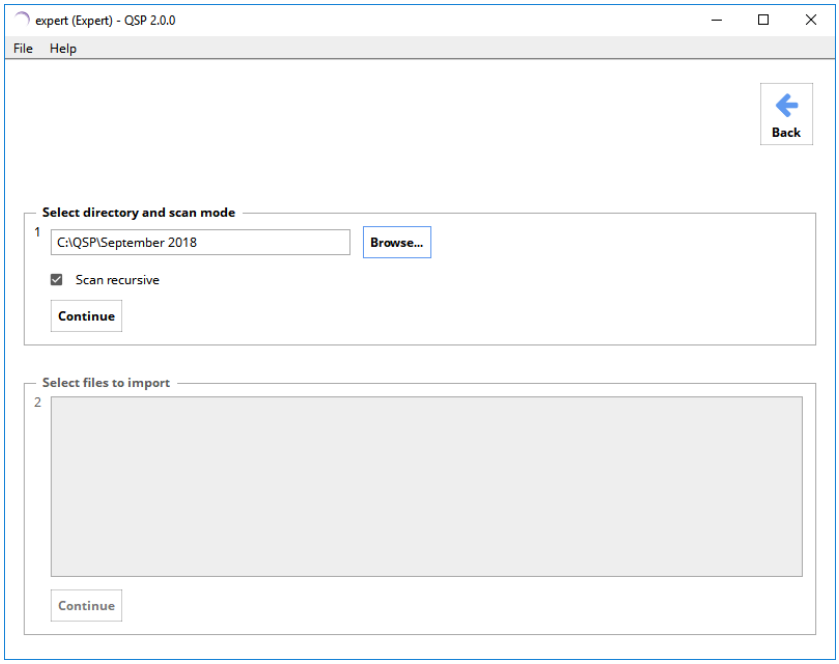
Slide Packages are provided monthly directly by Horiba Medical. An expert creates new Virtual Slides and pre-classifies all cells.

3.4.2. Import Slide into *QSP*

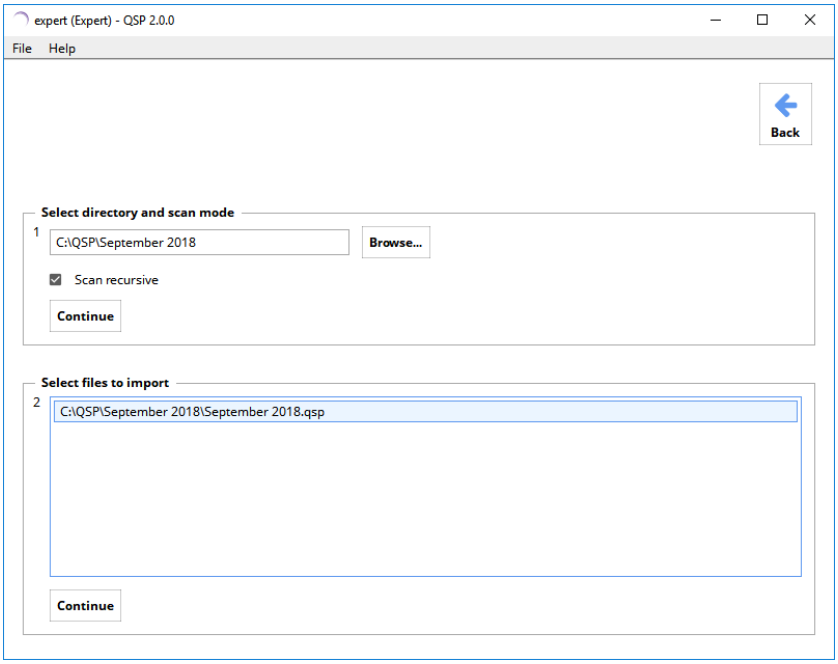
1) Click the “Add Slides” button.



2) Click the “Browse” button and select the folder where the Slide Package is stored. Check the “Scan recursive” option. Then click “Continue”.

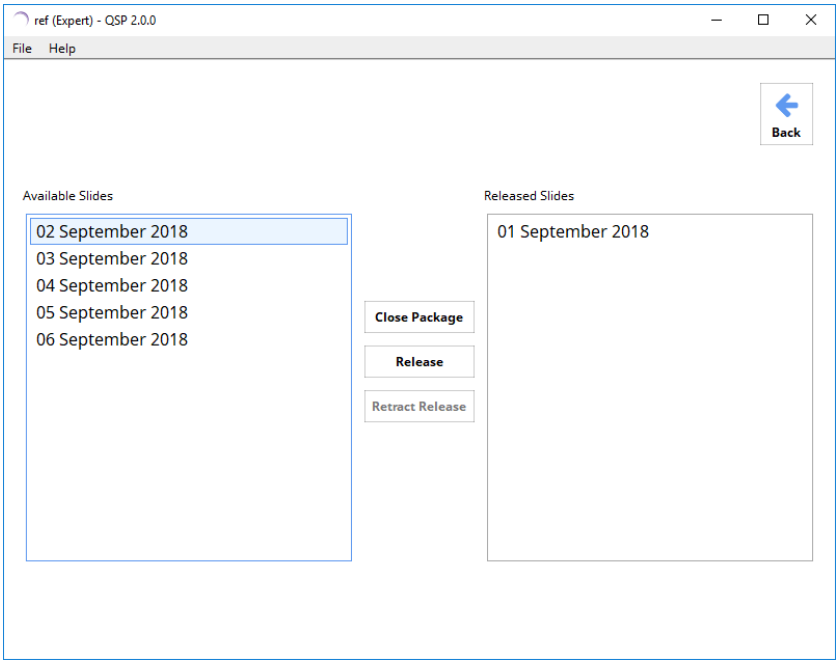


3) Now, select the detected *.*QSP* file and click “Continue”.



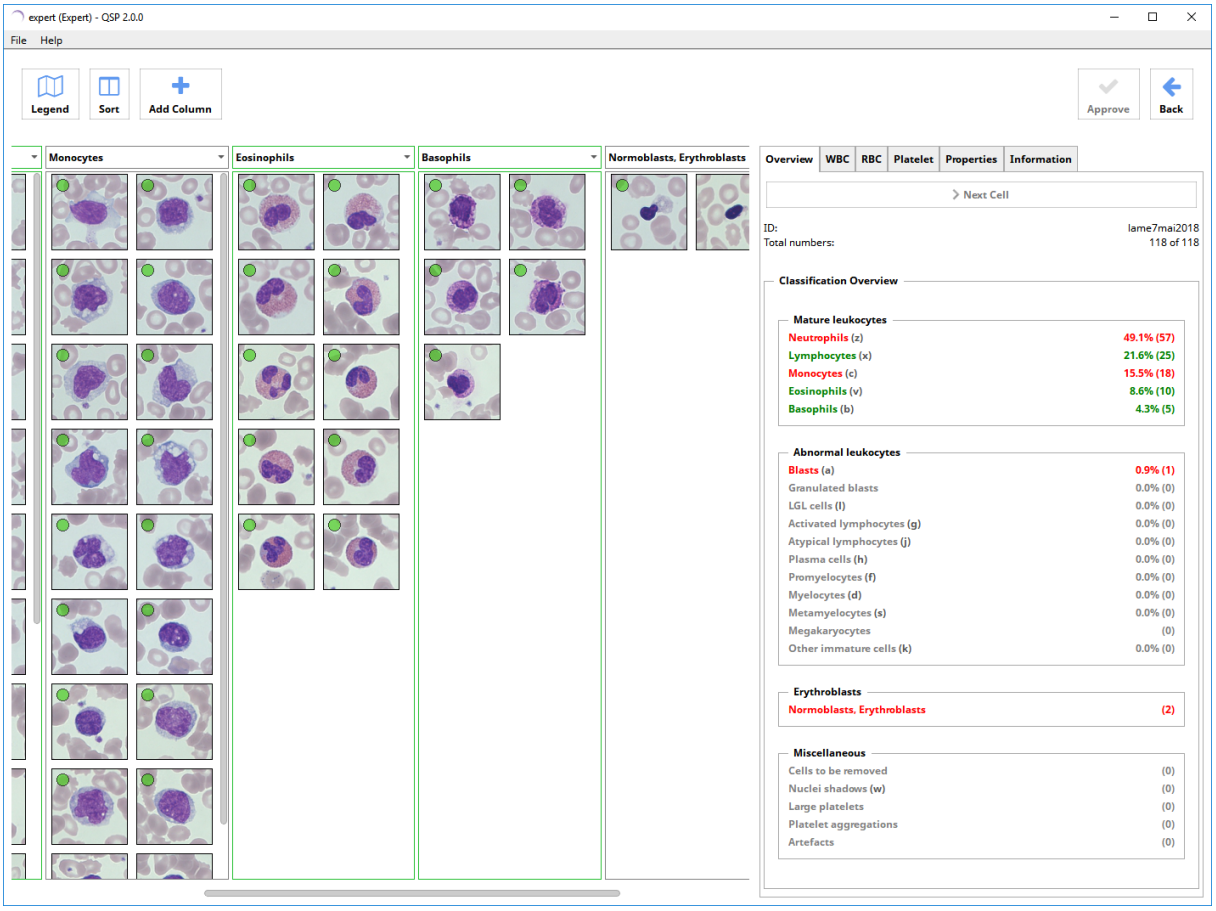
3.4.3. Release Virtual Slides within a Slide Package one by one

The left half lists all the virtual slides contained within the *Slide Package*. For each virtual slide, select the slide and click the "Release" button. Previously released slides are displayed in the right list. All released slides are then visible to *Assistant* users.



3.4.4. Sign-off on / Double-check provided Diagnosis

The left side displays all the cells in the virtual slide, grouped into columns by their cell class. The right side contains, grouped into six tabs, further slide-level information.



The *Virtual Slide* is released by clicking the “Approve” button in the top right corner. As a precautionary measure, the button remains greyed out until all cells have been examined. This ensures that the local resident expert agrees 100% with the diagnosis provided by Horiba Medical.

Each cell that has been visible for at least two seconds, will be marked with a green dot in its top left corner. Once all cells within a cell class column have been examined, the column’s border becomes green. Similarly, in the *Overview* tab’s *Classification Overview*, examined classes are highlighted green, remaining classes in red and empty classes in grey.

Corrections can be applied, simply by dragging a falsely classified cell into another column or onto the correct class name in the *Classification Overview* list.

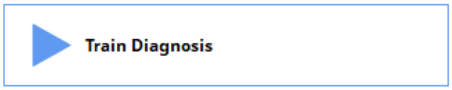
The local expert should check the following properties

1. Classification of each individual cell
2. Leukocyte Morphology (0|+|++|+++) in the “WBC” (white blood cell) tab
3. Erythrocyte Morphology (0|+|++|+++) in the “RBC” (red blood cell) tab
4. Platelet Morphology (0|+|++|+++) in the “Platelet” tab
5. The expert’s comment can be edited in the “Properties” tab

4. Diagnosing a Virtual Slide [Assistant]

After an Expert user has imported a new *Slide Package* and released some or all of the contained *Virtual Slides*, they are available for training to the *Assistant* users.

An Assistant user enters a new training run by clicking the “Train Diagnosis” button:

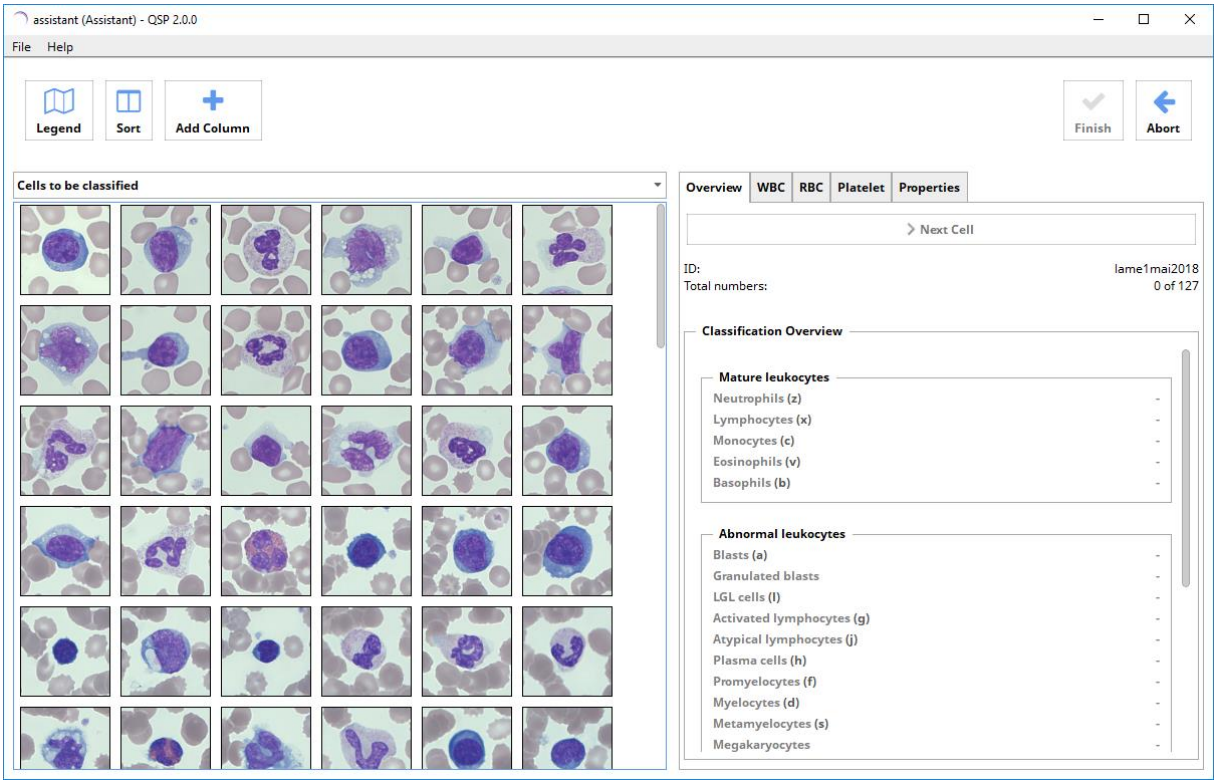


Next, select a Slide Package and then a single Virtual Slide within the package.

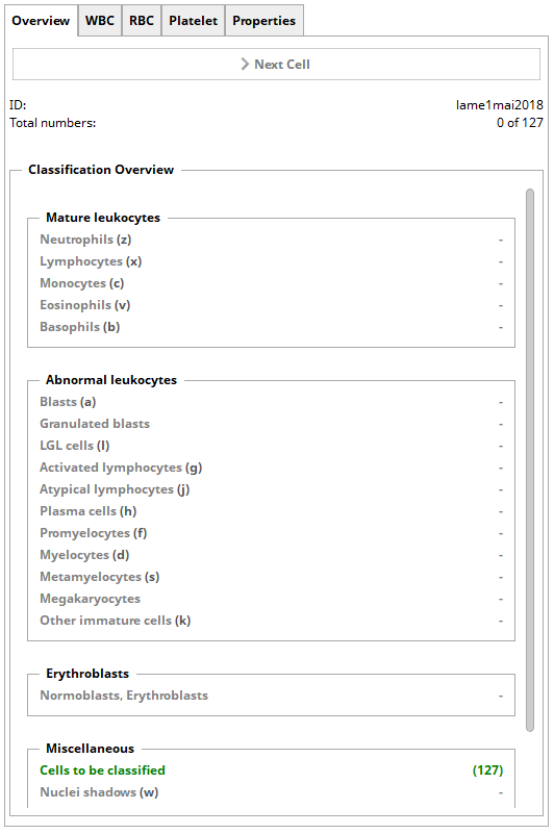
If no Slide Package is listed, a likely reason is that the Expert or Admin users have not yet imported and released a Slide Package.

The following user interface shows a single undiagnosed *Virtual Slide*. It is the user’s task to create a complete diagnose:

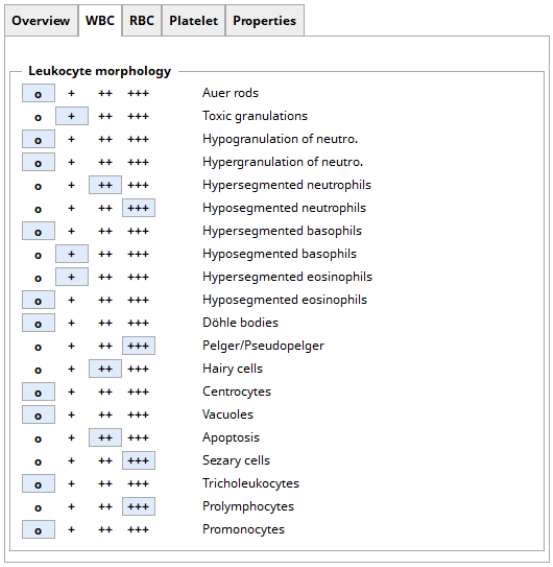
1. Assign each single cell to a class
2. Score the Leukocyte Morphology (0|+|++|+++) in the “WBC” (white blood cell) tab
3. Score the Erythrocyte Morphology (0|+|++|+++) in the “RBC” (red blood cell) tab
4. Score the Platelet Morphology (0|+|++|+++) in the “Platelet” tab



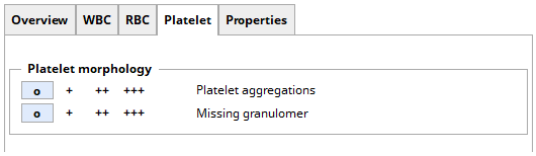
Overview with Cell Classes



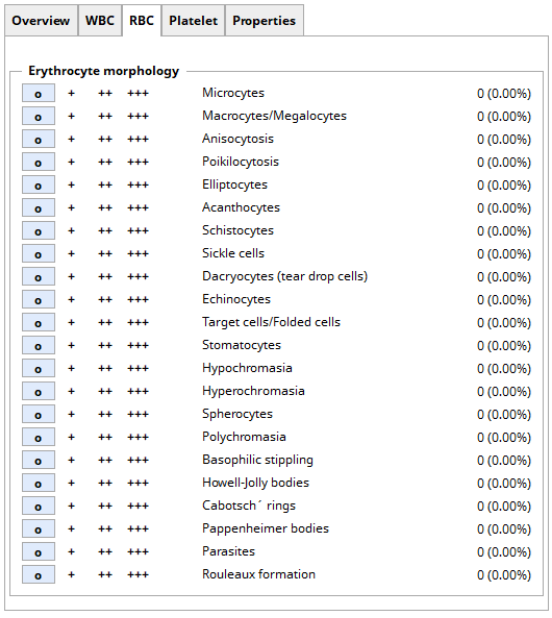
WBC – White Blood Cell Morphology



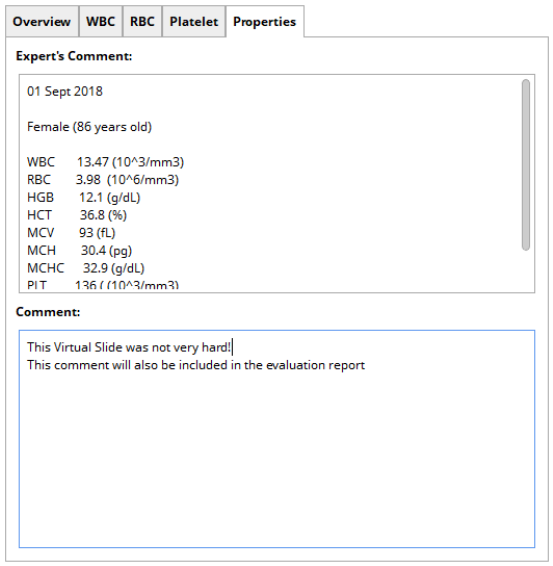
Platelet Morphology



RBC – Red Blood Cell Morphology



Properties



The „Overview“ tab lists all possible cell classes. The character right next to the cell class is the keyboard shortcut, e.g. press “x” to re-assign all currently selected cells to the “Lymphocyte” class.

The rightmost figure gives the absolute number of cells that is currently assigned this class.

The tabs “WBC”, “RBC” and “platelets” each list a multitude of cell classes and cell properties that each need to be scored with one of the four classes “0”, “+”, “++” or “+++”.

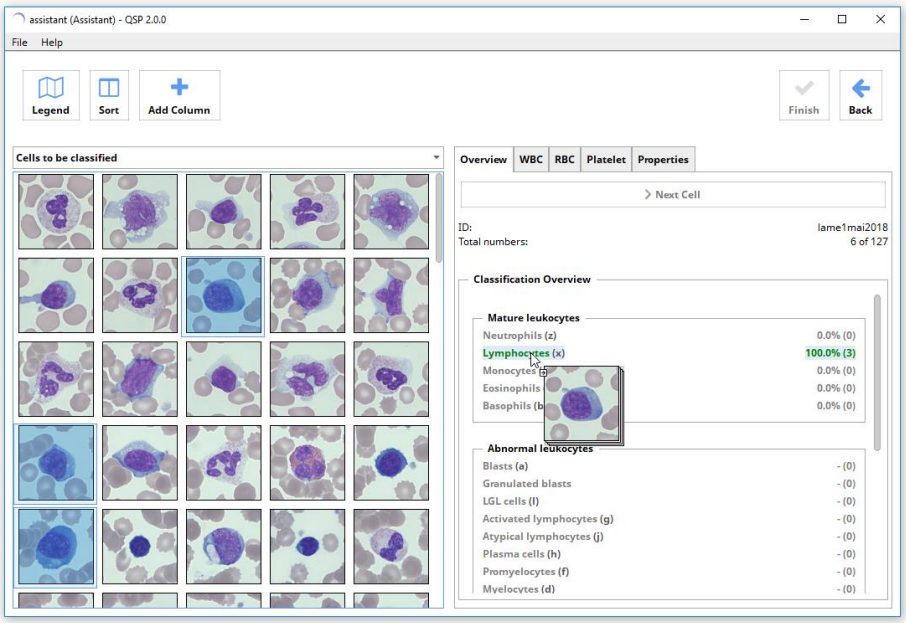
4.1. Patient Information

Relevant background information on the patient is available in the “Properties” tab.

4.2. Classify Cells

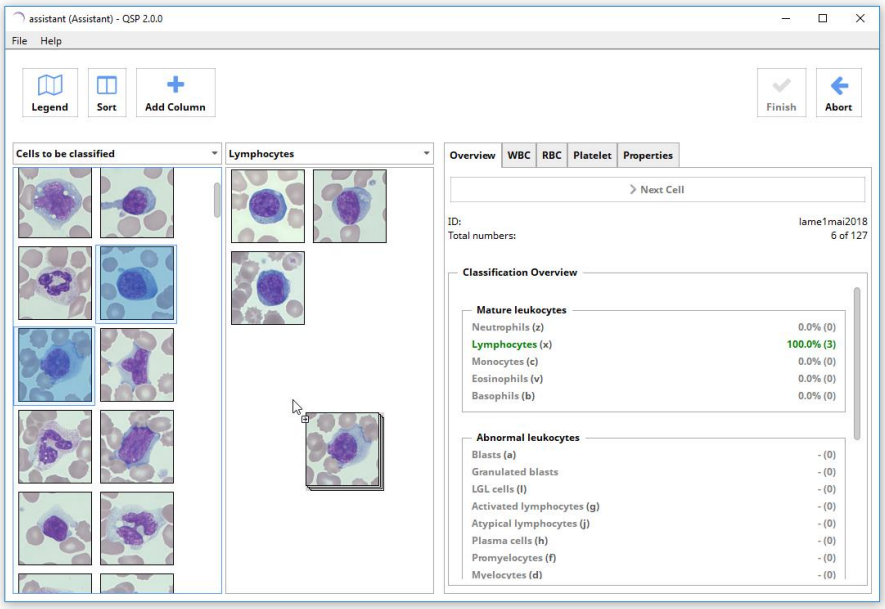
The user interface offers multiple options to classify cells.

1) Select one or more cells and drag & drop them onto a class in the “Overview” tab

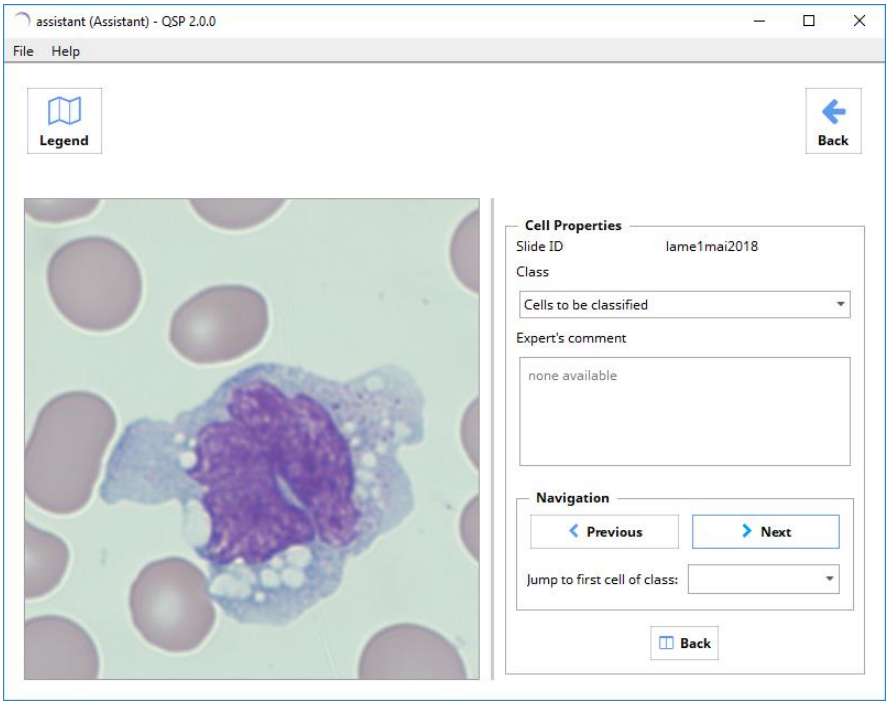


Select multiple cells by pressing the CTRL or SHIFT key.

2) Add a new column by clicking the “Add Column” button, select the desired class in the drop down box above the new column and finally drag&drop cells from any column into the new column.



3) Highlight one or more cells and press the class'es keyboard shortcut indicated in round brackets right next to the class name, e.g. "x" for "Lymphocytes"
4) Enter the Single-Cell-View by double-clicking on a cell. Here, the class for the displayed cell can be selected in the "Class" drop-down-box on the top-right.
   One by one, iterate through all cells using the "Previous" or "Next" buttons.



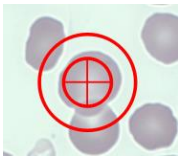
4.3. Morphology

The "WBC" (white blood cells), "RBC" (red blood cells) and "platelet" tabs each list a multitude of cell classes and cell properties that each need to be scored with one of the four categories "0", "+", "++"

or “+++”. The left-hand side shows in the WBC-tab the white blood cell single images and in the RBC and platelet tabs a Virtual Slide with red blood cells.

Quantity	Cell Anomalies	Score
< 3 %	almost none	0
3-10%	Subtle, discrete, few	+
10-20%	noticeable, many	++
20-50%	Very distinct, a lot	+++

The red crosshair helps in judging the cells’ sizes:

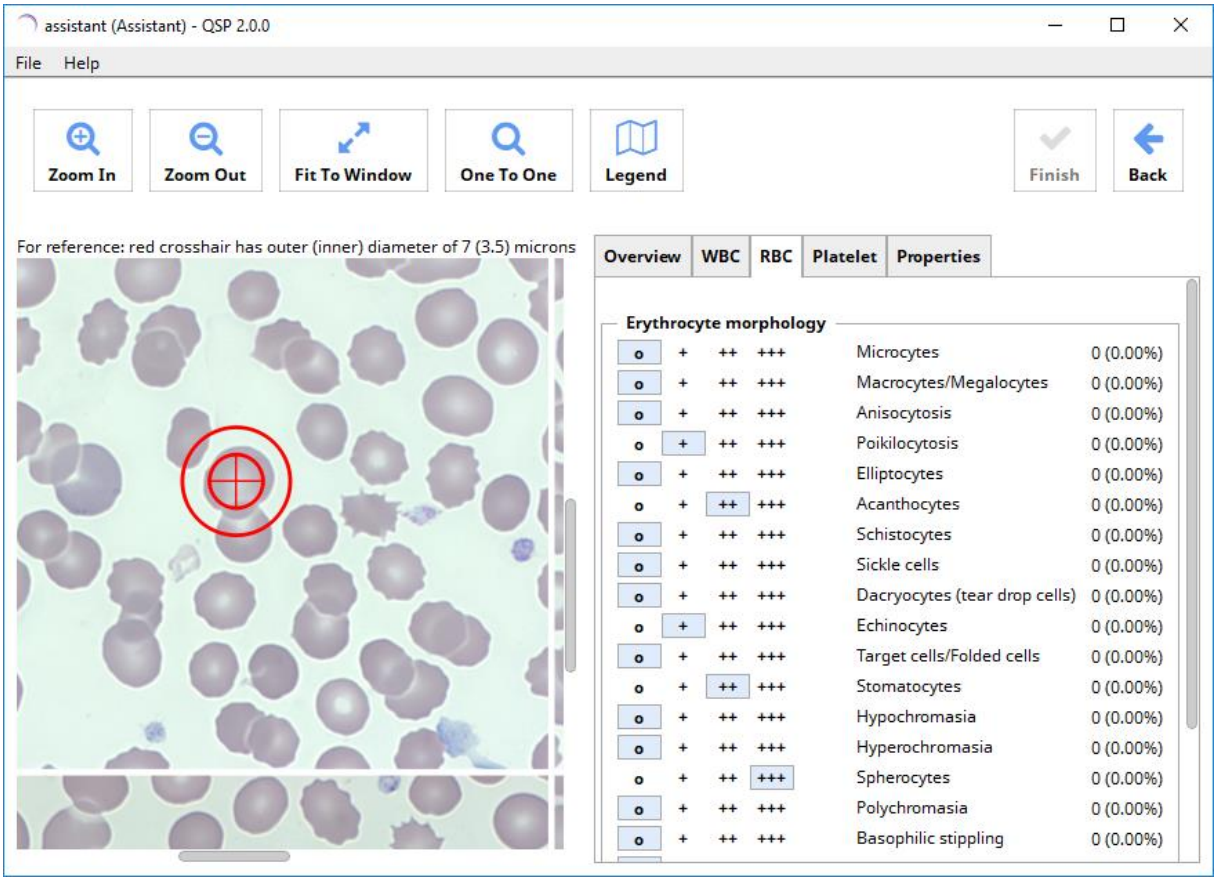


Crosshair	Size
outer diameter	14 microns
Inner diameter	7 microns

The *Virtual Slide* can be zoomed in and out using either the “Zoom In” and “Zoom Out” Buttons in the toolbar or by using the mouse wheel.

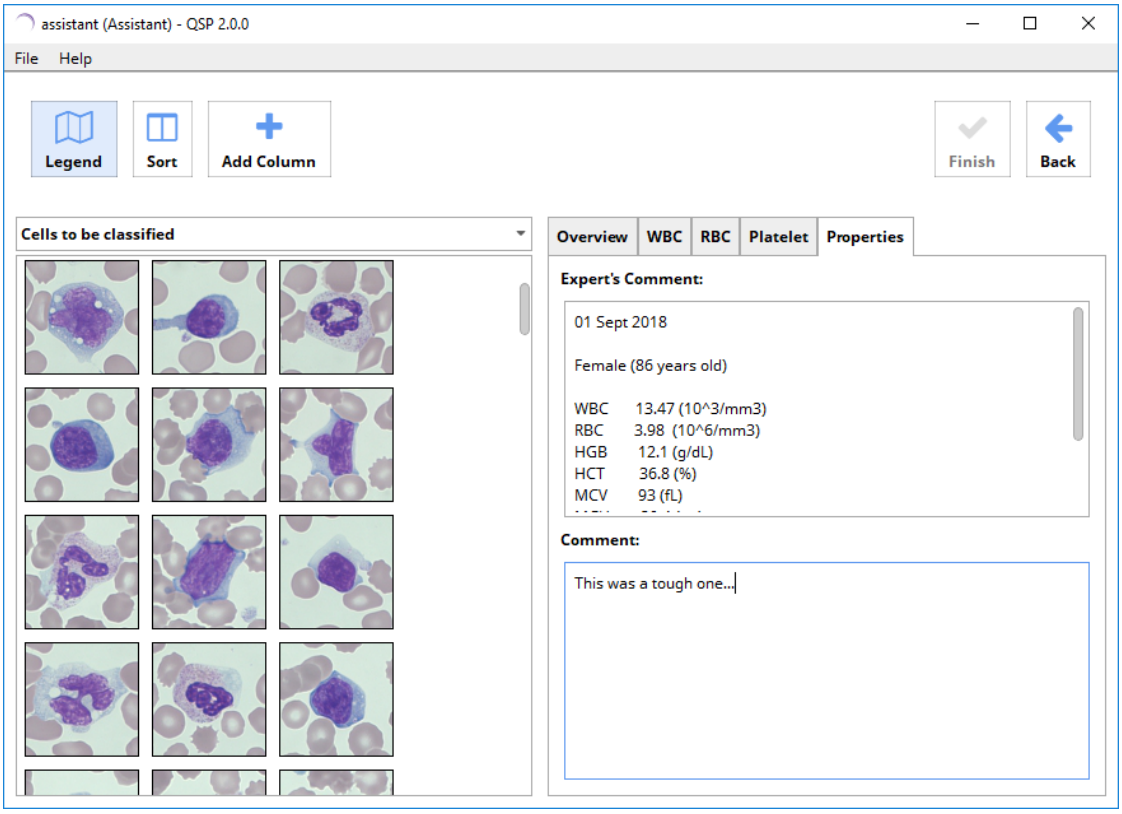
“Fit to Window” scales the *Virtual Slide* so that the entire slide is visible and all available window space is used.

“One to One” scales the *Virtual Slide* to the native resolution where one image pixel equals one window pixel.



4.4. Properties and Comment

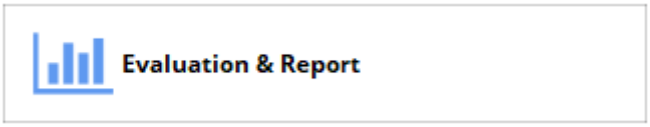
The tab “Properties” shows the expert’s comments on this case. The text is read-only. Additionally, the user may enter own comments. They will be included in the evaluation report.



5. Evaluation & Report

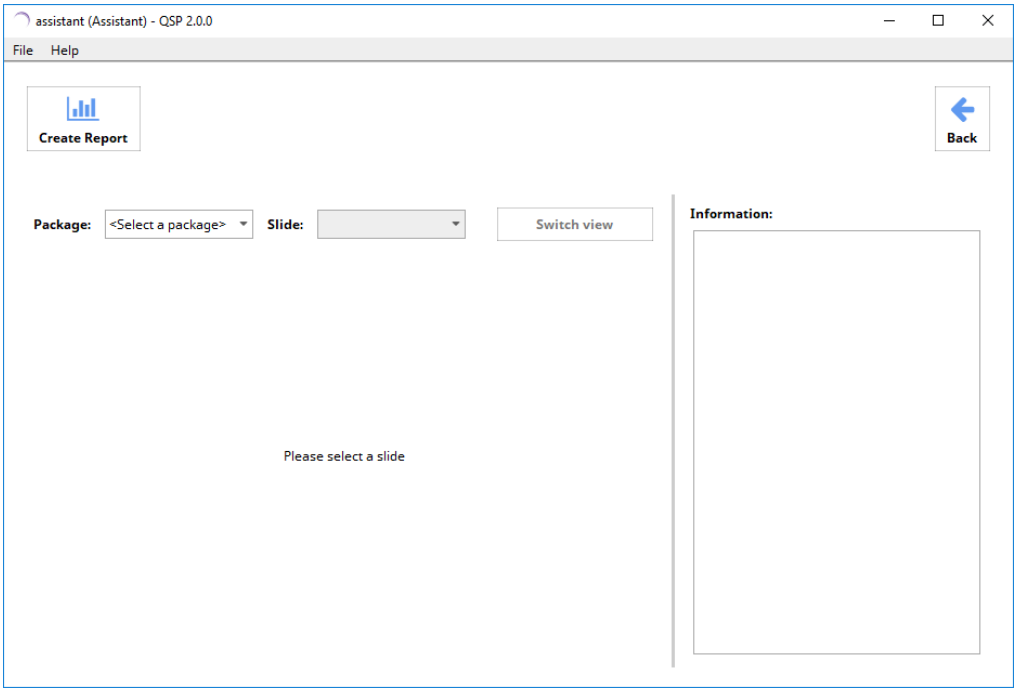
Click the “Evaluation & Report” button in the main menu to compare results from any previously diagnosis training with the ground truth provided by the expert.

Additionally, a PDF report of the comparison can be created as well as a table in CSV-Format, that can be opened e.g. with Microsoft Excel.



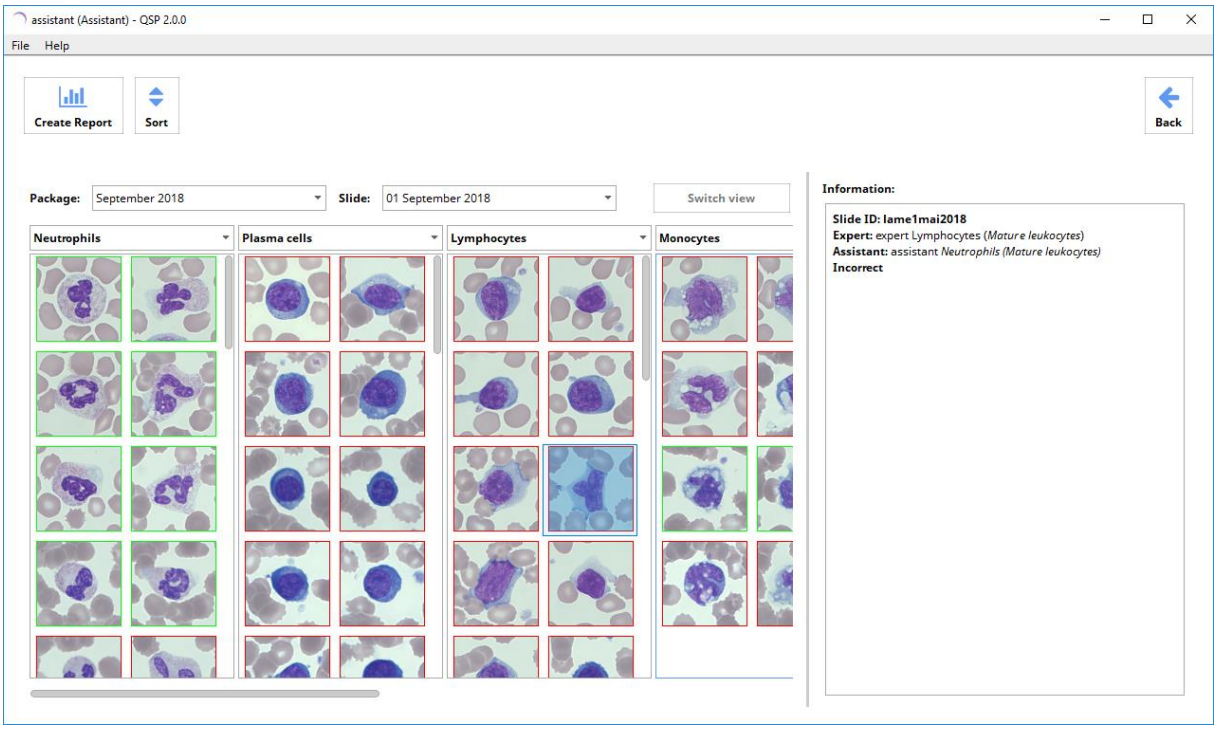
5.1. Evaluation

In the next view, first select a package and then select a single Slide from that package.



If no packages or no slides are available in the drop-down list, the likely reason is that no slides have been diagnosed yet.

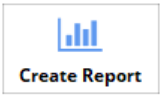
After a slide has been selected, all cells are marked with a green border, if they have been classified correctly, or with a red border otherwise.



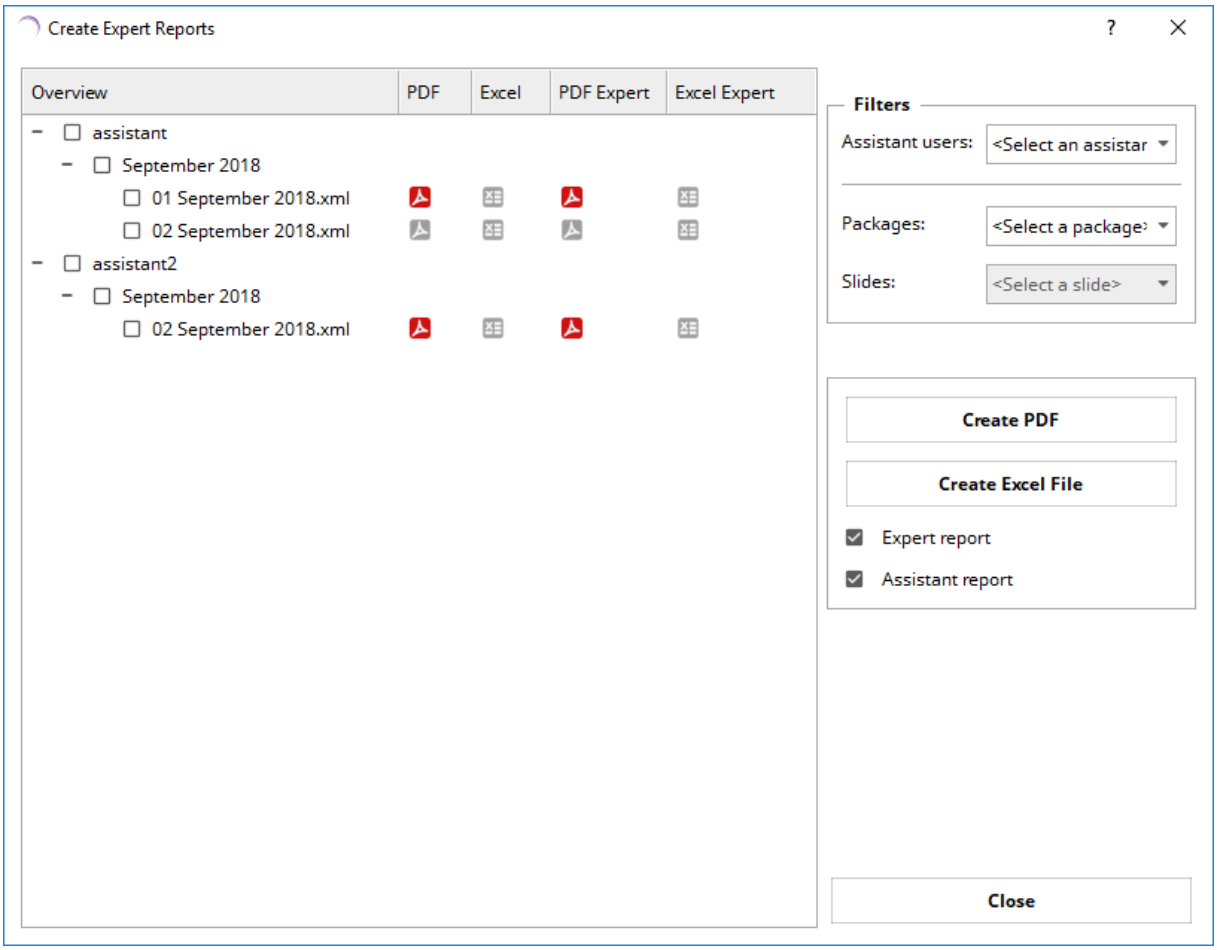
By clicking on a cell, the correct classification is displayed in the right-hand information panel.

5.1. Creating Report

By clicking the “Create Report” button, the current evaluation can be saved as a PDF file or a CSV-file that can be opened e.g. with Microsoft Excel.



A dialog pops up that lists in a tree structure (1st level: user name; 2nd level: package; 3rd level: slide) all packages and slides that can be saved. Mark the checkbox of all slides that shall be saved. After using *QSP* for a while, many slides will be listed here. The “Filters” option on the right-hand side can be used to conveniently filter the visible slides.



The columns “PDF” and “Excel” indicate whether a particular report had previously already been saved in this format. If this is not the case or the exported report files have been moved afterwards, the buttons remain greyed out. Colored buttons can be clicked to open the respective file in the default PDF or CSV viewer.

The “PDF Expert” and “Excel Expert” columns are only available to *Expert* users, not to *Assistant* users.

Once one or more slides have been selected, the “Create PDF” or “Create Excel File” buttons can be clicked to create the report file in the respective formats.

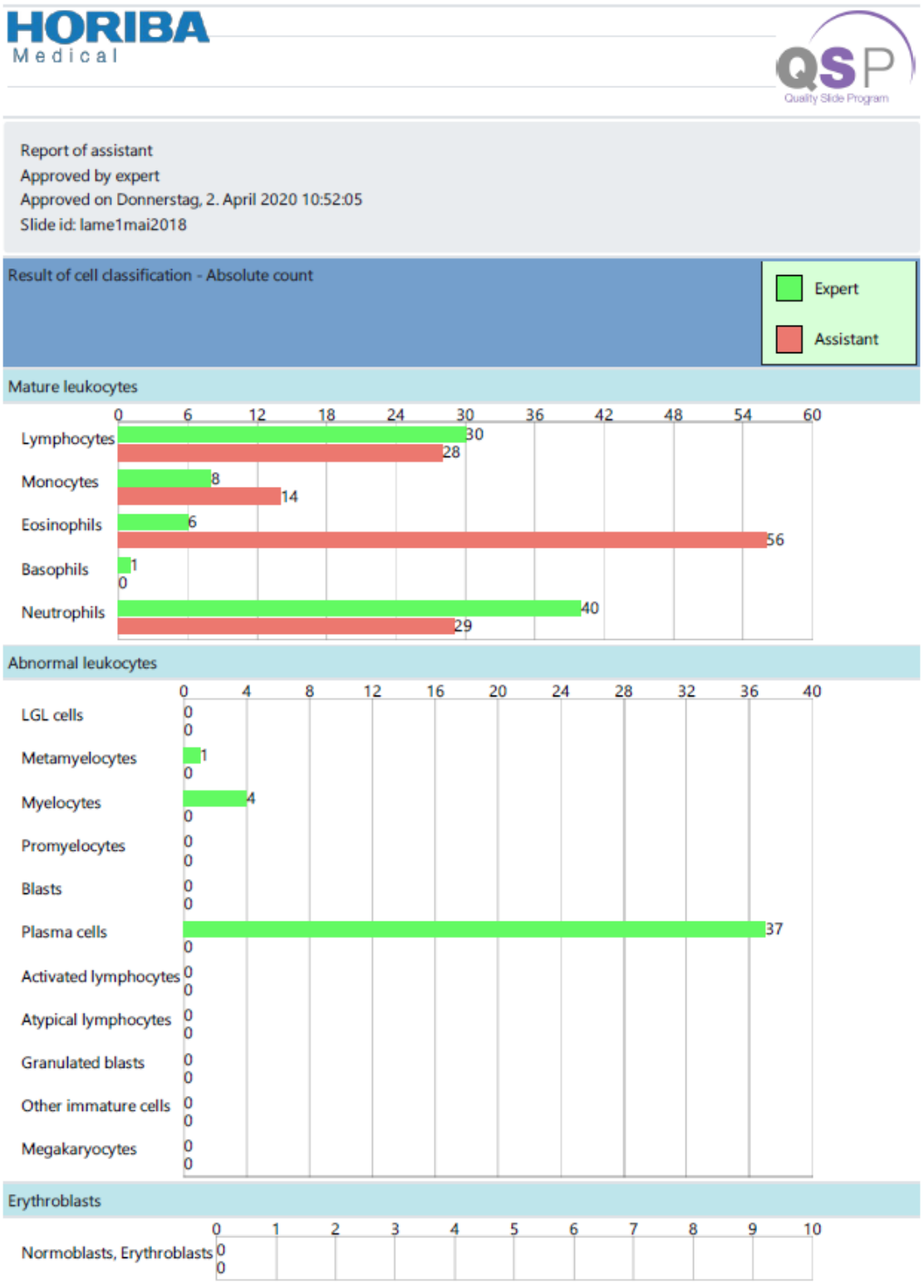
5.2. Reports

5.2.1. Assistant PDF Report

Every page in the report has a header that contains

- User name
- Date
- Slide name

The first section after the main header is the white blood cell classification result summary. It states for every cell class the quantity detected by the expert (green bar) and by the *Assistant* user (red bar).



HORIBA Medical

QSP Quality Slide Program

Report of assistant
Approved by expert
Approved on Donnerstag, 2. April 2020 10:52:05
Slide id: lame1mai2018

Result of cell classification - Absolute and relative frequencies				
Name of cells	Assistant #	Assistant %	Expert #	Expert %
Mature leukocytes				
Lymphocytes	28	22.05	30	23.62
Monocytes	14	11.02	8	6.30
Eosinophils	56	44.09	6	4.72
Basophils	0	0.00	1	0.79
Neutrophils	29	22.83	40	31.50
Abnormal leukocytes				
LGL cells	0	0.00	0	0.00
Metamyelocytes	0	0.00	1	0.79
Myelocytes	0	0.00	4	3.15
Promyelocytes	0	0.00	0	0.00
Blasts	0	0.00	0	0.00
Plasma cells	0	0.00	37	29.13
Activated lymphocytes	0	0.00	0	0.00
Atypical lymphocytes	0	0.00	0	0.00
Granulated blasts	0	0.00	0	0.00
Other immature cells	0	0.00	0	0.00
Megakaryocytes	0	0.00	0	0.00
Erythroblasts				
Normoblasts, Erythroblasts	0	0.00	0	0.00
Miscellaneous				
Platelet aggregations	0	0.00	0	0.00
Large platelets	0	0.00	0	0.00
Nuclei shadows	0	0.00	0	0.00
Artefacts	0	0.00	0	0.00

The second section lists the absolute and relative quantities of white blood cell classes detected by both the Assistant user and the expert.

HORIBA Medical

QSP Quality Slide Program

Report of assistant
Approved by expert
Approved on Donnerstag, 2. April 2020 10:52:05
Slide id: lame1mai2018

Result of cell classification - Sensitivity, Precision						
Name of cells	TP	FP	TN	FN	Sensitivity	Precision
Mature leukocytes						
Lymphocytes	6	22	75	24	0.2	0.21
Monocytes	2	12	107	6	0.25	0.14
Eosinophils	2	54	67	4	0.33	0.04
Basophils	0	0	126	1	0	-
Neutrophils	8	21	66	32	0.2	0.28
Abnormal leukocytes						
LGL cells	0	0	127	0	-	-
Metamyelocytes	0	0	126	1	0	-
Myelocytes	0	0	123	4	0	-
Promyelocytes	0	0	127	0	-	-
Blasts	0	0	127	0	-	-
Plasma cells	0	0	90	37	0	-
Activated lymphocytes	0	0	127	0	-	-
Atypical lymphocytes	0	0	127	0	-	-
Granulated blasts	0	0	127	0	-	-
Other immature cells	0	0	127	0	-	-
Megakaryocytes	0	0	127	0	-	-
Erythroblasts						
Normoblasts, Erythroblasts	0	0	127	0	-	-
Miscellaneous						
Platelet aggregations	0	0	127	0	-	-
Large platelets	0	0	127	0	-	-
Nuclei shadows	0	0	127	0	-	-
Artefacts	0	0	127	0	-	-

The third section lists the sensitivity and precision of the white blood cell classification.

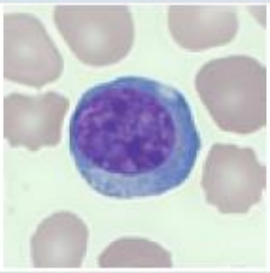
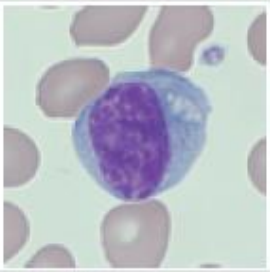
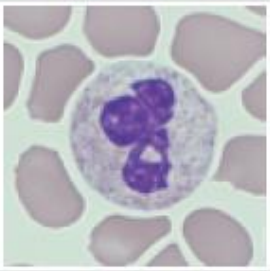
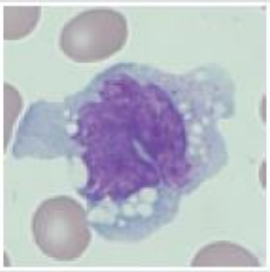
Term	Explanation
True Positive (TP) class A	Cell is class A and user classified A
False Positive (FP) class A	Cell is class other than A and user classified A
True Negative (TN) class A	Cell is class other than A and user classified other than A
False Negative (FN) class A	Cell is class A and user classified other than A
Sensitivity	TP / (TP + FN)
Precision	TP / (TP + FP)

HORIBA Medical

QSP Quality Slide Program

Report of assistant
Approved by expert
Approved on Donnerstag, 2. April 2020 10:52:05
Slide id: lame1mai2018

Result of cell classification - Misclassified cells

classified in Neutrophils	belongs to Plasma cells	
classified in Neutrophils	belongs to Lymphocytes	
classified in Neutrophils	belongs to Monocytes	
classified in Neutrophils	belongs to Lymphocytes	

The next section lists all misclassified white blood cells and states the false and correct class.

HORIBA Medical

QSP Quality Slide Program

Report of assistant
Approved by expert
Approved on Donnerstag, 2. April 2020 10:52:05
Slide id: lame1mai2018

Morphology		
Experts observation	Assistants observation	Morphology
Erythrocyte morphology		
o	o	Microcytes
o	o	Macrocytes/Megalocytes
o	o	Anisocytosis
o	+	Poikilocytosis
o	o	Elliptocytes
o	++	Acanthocytes
o	o	Schistocytes
o	o	Sickle cells
o	o	Dacryocytes (tear drop cells)
o	+	Echinocytes
o	o	Target cells/Folded cells
o	++	Stomatocytes
o	o	Hypochromasia
o	o	Hyperochromasia
o	+++	Spherocytes
o	o	Polychromasia
o	o	Basophilic stippling
o	o	Howell-Jolly bodies
o	o	Cabotsch´ rings
o	o	Pappenheimer bodies
o	o	Parasites
o	o	Rouleaux formation

This following sections list the true and observed morphology classification for the red blood cells, white blood cells and platelets.

HORIBA Medical

QSP Quality Slide Program

Report of assistant
Approved by expert
Approved on Donnerstag, 2. April 2020 10:52:05
Slide id: lame1mai2018

Assistants comments and observations:

This was a tough one...

Experts comments and observations:

01 Sept 2018

Female (86 years old)

WBC 13.47 (10^3/mm3)
RBC 3.98 (10^6/mm3)
HGB 12.1 (g/dL)
HCT 36.8 (%)
MCV 93 (fL)
MCH 30.4 (pg)
MCHC 32.9 (g/dL)
PLT 136 ((10^3/mm3)

History of myeloma.

Corrective actions:

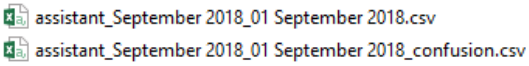
Assistants signature

Experts signature

The final section contains both the expert's and assistant's comments as well as fields to sign the report, if desired.

5.2.2. Assistant Excel Report

The CSV file is a comma separated text file that can be directly opened with Microsoft Excel. The export always creates two files:



The main file "<username>_<Slide Package name>_<Slide name>.csv" contains the white blood cell classification statistics per class:

	A	B	C	D	E	F	G
1	user_name	expert_name	test_date	approval_date	slideID	sw_version	cell_class
2	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Lymphocytes
3	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Monocytes
4	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Eosinophils
5	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Basophils
6	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	LGL cells
7	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Neutrophils
8	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Metamyelocytes
9	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Myelocytes
10	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Promyelocytes
11	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Blasts
12	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Plasma cells
13	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Activated lymphocytes
14	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Atypical lymphocytes
15	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Granulated blasts
16	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Normoblasts, Erythroblasts
17	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Platelet aggregations
18	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Large platelets
19	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Nuclei shadows
20	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Other immature cells
21	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Artefacts
22	assistant	expert	Thu Apr 2 10:52:05 2020	Tue Apr 7 19:35:16 2020	lame1mai2018	QSP 2.0.0	Megakaryocytes

	H	I	J	K	L	M	N	O	P	Q	R
1	cell_group	cell_count	cell_count_p	true_cell_co	true_cell_pe	TP	FP	TN	FN	sensitivity	precision
2	Mature leukocytes	28	0.220472	30	0.23622	6	22	75	24	0.2	0.21
3	Mature leukocytes	14	0.110236	8	0.0629921	2	12	107	6	0.25	0.14
4	Mature leukocytes	56	0.440945	6	0.0472441	2	54	67	4	0.33	0.04
5	Mature leukocytes	0	0	1	0.00787402	0	0	126	1	0	-
6	Abnormal leukocytes	0	0	0	0	0	0	127	0	-	-
7	Mature leukocytes	29	0.228346	40	0.314961	8	21	66	32	0.2	0.28
8	Abnormal leukocytes	0	0	1	0.00787402	0	0	126	1	0	-
9	Abnormal leukocytes	0	0	4	0.0314961	0	0	123	4	0	-
10	Abnormal leukocytes	0	0	0	0	0	0	127	0	-	-
11	Abnormal leukocytes	0	0	0	0	0	0	127	0	-	-
12	Abnormal leukocytes	0	0	37	0.291339	0	0	90	37	0	-
13	Abnormal leukocytes	0	0	0	0	0	0	127	0	-	-
14	Abnormal leukocytes	0	0	0	0	0	0	127	0	-	-
15	Abnormal leukocytes	0	0	0	0	0	0	127	0	-	-
16	Erythroblasts	0	0	0	0	0	0	127	0	-	-
17	Miscellaneous	0	0	0	0	0	0	127	0	-	-
18	Miscellaneous	0	0	0	0	0	0	127	0	-	-
19	Miscellaneous	0	0	0	0	0	0	127	0	-	-
20	Abnormal leukocytes	0	0	0	0	0	0	127	0	-	-
21	Miscellaneous	0	0	0	0	0	0	127	0	-	-
22	Abnormal leukocytes	0	0	0	0	0	0	127	0	-	-

The additional file "<username>_<Slide Package name>_<Slide name>_confusion.csv" contains a confusion matrix:

	A	B	C	D	E	F
1	user	expert	testdate	approvalDat	slideID	softwareversion
2	assistant	expert	Tue Apr 7 19	Thu Apr 2 10	lame1mai20	QSP 2.0.0
3						
4	ConfusionMatrix					
5	x_axis = your prediction	y_axis = reference				
6						
7		Neutrophils	Lymphocyte	Monocytes	Eosinophils	Basophils
8	Neutrophils	8	7	2	23	
9	Lymphocytes	12	6	2	10	
10	Monocytes	4	1	2	1	
11	Eosinophils	1	2	1	2	
12	Basophils				1	
13	Blasts					
14	Granulated blasts					
15	LGL cells					
16	Activated lymphocytes					
17	Atypical lymphocytes					
18	Plasma cells	4	11	6	16	
19	Promyelocytes					
20	Myelocytes		1	1	2	
21	Metamyelocytes				1	
22	Megakaryocytes					

The white blood cell classes are listed both on the x and y axis. The y-axis contains the classes selected by the user. The x-axis contains the true classes.

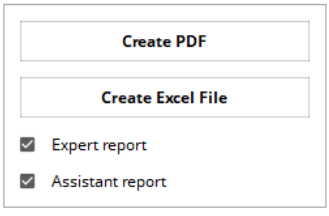
In this example above 12 (B9) cells are really Neutrophils, but the user thought them to be lymphocytes. 8 neutrophils (B8) were correctly identified.

Ideally, the majority of cells are distributed on the diagonal axis, highlighted in the above screenshot.

5.2.3. Expert PDF Report

The expert is allowed to create both individual assistant reports as well as a per-slide expert report that contains joint statistics on all assistants who diagnosed the selected slide.

By default, both kinds (assistant report and expert report) are selected:



The expert pdf report contains a peer comparison of the selected assistants. The first section lists for each white blood cell class and category each assistant's (average) sensitivity.

HORIBA Medical

QSP Quality Slide Program

Report of expert
Approved by expert
Approved on Freitag, 10. April 2020 13:49:58
Slide id: lame7mai2018

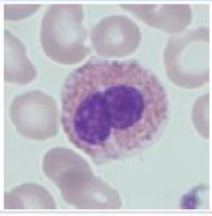
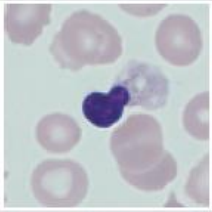
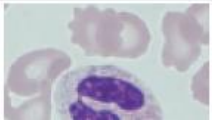
Peer Comparison

User Name	Classes	Mean Sensitivity
assistant	Neutrophils	1
assistant2	Lymphocytes	0.48
assistant2	Basophils	0.4
assistant2	Mature leukocytes, Abnormal leukocytes	0.185
assistant	Mature leukocytes, Abnormal leukocytes	0.166667
assistant2	Neutrophils	0.12
assistant2	Monocytes	0.11
assistant2	Promyelocytes	0
assistant2	Myelocytes	0
assistant2	Eosinophils	0
assistant2	Metamyelocytes	0
assistant2	LGL cells	0

The next section lists for each misclassified cell the assistant's incorrect answers.

Report of expert
Approved by expert
Approved on Freitag, 10. April 2020 13:49:58
Slide id: lame7mai2018

Misclassified cells

Cell ID	False Classes (# users)	True Class	Cell
0	Basophils (1), Neutrophils (1)	Eosinophils	
1	Basophils (1), Neutrophils (1)	Normoblasts, Erythroblasts	
2	Monocytes (1)	Neutrophils	

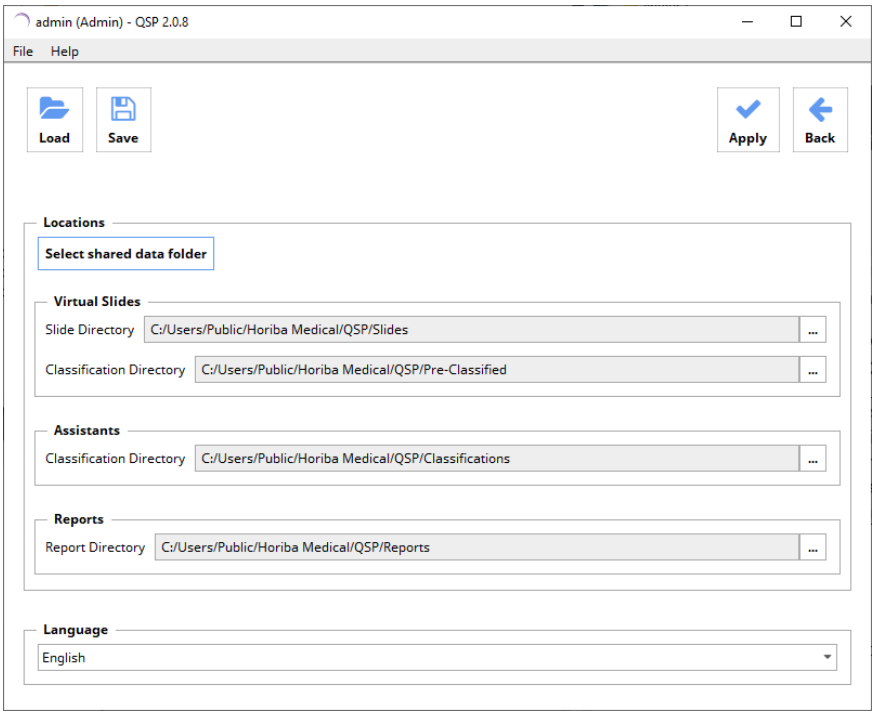
5.2.4. Expert Excel Report

The export CSV report has an identical structure to that of the assistant report. The only difference is that all selected assistants are collected within a single file (see column A). An extra file with a confusion matrix is not created.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	user_name	expert_name	test_date	approval_date	slideID	sw_version	cell_class	cell_group	cell_count	cell_c	true_cell_co	true_cell_pe	TP	FP	TN	FN	sensitivity	precision
16	assistant	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:38:21 2020	lame7mai20	QSP 2.0.0	Normoblasts	Erythroblast	0	0	2	0.0172414	0	0	116	2	0	-
17	assistant	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:38:21 2020	lame7mai20	QSP 2.0.0	Platelet aggr	Miscellaneo	0	0	0	0	0	0	118	0	-	-
18	assistant	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:38:21 2020	lame7mai20	QSP 2.0.0	Large platele	Miscellaneo	0	0	0	0	0	0	118	0	-	-
19	assistant	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:38:21 2020	lame7mai20	QSP 2.0.0	Nuclei shadc	Miscellaneo	0	0	0	0	0	0	118	0	-	-
20	assistant	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:38:21 2020	lame7mai20	QSP 2.0.0	Other immat	Abnormal le	0	0	0	0	0	0	118	0	-	-
21	assistant	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:38:21 2020	lame7mai20	QSP 2.0.0	Artefacts	Miscellaneo	0	0	0	0	0	0	118	0	-	-
22	assistant	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:38:21 2020	lame7mai20	QSP 2.0.0	Megakaryocy	Abnormal le	0	0	0	0	0	0	118	0	-	-
23	assistant2	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:11:53 2020	lame7mai20	QSP 2.0.0	Lymphocyte	Mature leuk	38	0.322	25	0.215517	12	26	67	13	0.48	0.32
24	assistant2	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:11:53 2020	lame7mai20	QSP 2.0.0	Monocytes	Mature leuk	9	0.076	18	0.155172	2	7	93	16	0.11	0.22
25	assistant2	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:11:53 2020	lame7mai20	QSP 2.0.0	Eosinophils	Mature leuk	11	0.093	10	0.0862069	0	11	97	10	0	0
26	assistant2	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:11:53 2020	lame7mai20	QSP 2.0.0	Basophils	Mature leuk	44	0.373	5	0.0431034	2	42	71	3	0.4	0.05
27	assistant2	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:11:53 2020	lame7mai20	QSP 2.0.0	LGL cells	Abnormal le	0	0	0	0	0	0	118	0	-	-
28	assistant2	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:11:53 2020	lame7mai20	QSP 2.0.0	Neutrophils	Mature leuk	16	0.136	57	0.491379	7	9	52	50	0.12	0.44
29	assistant2	expert	Fri Apr 10 13:49:58 2020	Fri Apr 10 14:11:53 2020	lame7mai20	QSP 2.0.0	Metamveloc	Abnormal le	0	0	0	0	0	0	118	0	-	-

6. Configuration [Admin only]

Only the Admin user can enter and change the configuration:



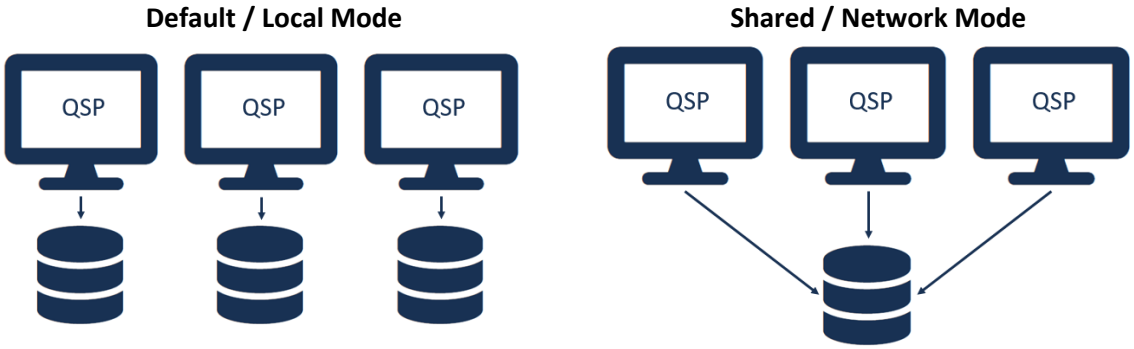
In the "**Locations**" box, the locations where data will be stored is specified.

Data Kind	Description
Slide Directory	Pre-diagnosed slide packages with image data provided by Horiba.
Classification Directory	Folder where the ground truth diagnosis entered by Expert users is stored as XML files in one subfolder folder per user and per slide.
Assistants Classification Directory	Location where assistant user's training diagnosis is stored in one subfolder per user. Additionally, the paths of previously saved reports is also stored here
Report Directory	Default folder where reports are stored. The user can override this when saving a report.
Report Template Directory	Location where report templates are stored. These templates can be customized, but only technically proficient users should attempt to do this.

The "**Select shared data folder**" will switch all locations and additionally the location of the user database and config files to another place. This option can be used to configure QSP to share data with other QSP instances in the network. For details, refer to chapter 7.

The "**Language**" box contains an option to change the language of *QSP*. To change the language, select the new language from the drop-down menu and then restart *QSP*.

7. Network Mode: sharing Database between multiple QSPs



By default, each QSP instance stores their data locally

All QSP instances can be re-configured to access data from a central network share

Default / Local Mode

By default, QSP will store its application data such as the database with the user names and password, the slides, the slide reference annotations or the diagnoses carried out during training by assistant users locally on the computer (left diagram). In other words, when installing multiple QSP instances in a network (each on one computer), they will not by default detect or be aware of each other, but rather run independently side-by-side. An account created on one computer will not automatically be available on another computer.

Shared / Network Mode

However, multiple QSPs running in the same network can easily be configured to share each other's data. This enables, for instance, a student-teacher scenario:

1. one QSP computer is used by a teacher with role "Expert". The teacher imports a new case, signs off or corrects the reference diagnoses and then releases one or more slides to the students
2. each student starts QSP on an individual computer using an individual login (e.g. "student01", "student02", …). They carry out the training diagnosis and save it.
3. When all students are done, the teacher creates a single report comparing all students' results

The following steps are required to re-configure QSP for a network scenario.

Pre-requirement: a shared network folder ("network share") where all QSP computers have read and write-access.

7.1. Installation and Setup of shared central Database

The first step is to install QSP on

- a server that will act as the QSP license server
- the teacher and/or admin computer
- all student computers

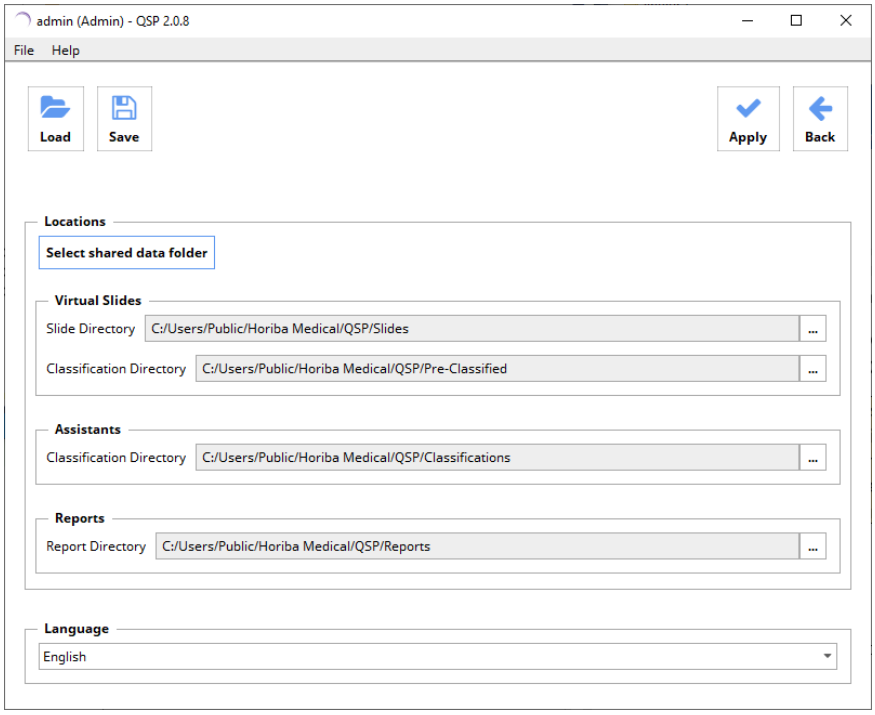
The multi-user QSP activation file (license file) is only imported on the license server. All other computers (teacher and students) must be configured to detect the license server. The activation process is explained in chapters 3.1.3 and 3.1.4.

The next step is to switch each QSP from its local database to a shared central database located on a network share where each QSP instance (or rather the Windows account it is being used from) has read and write access.

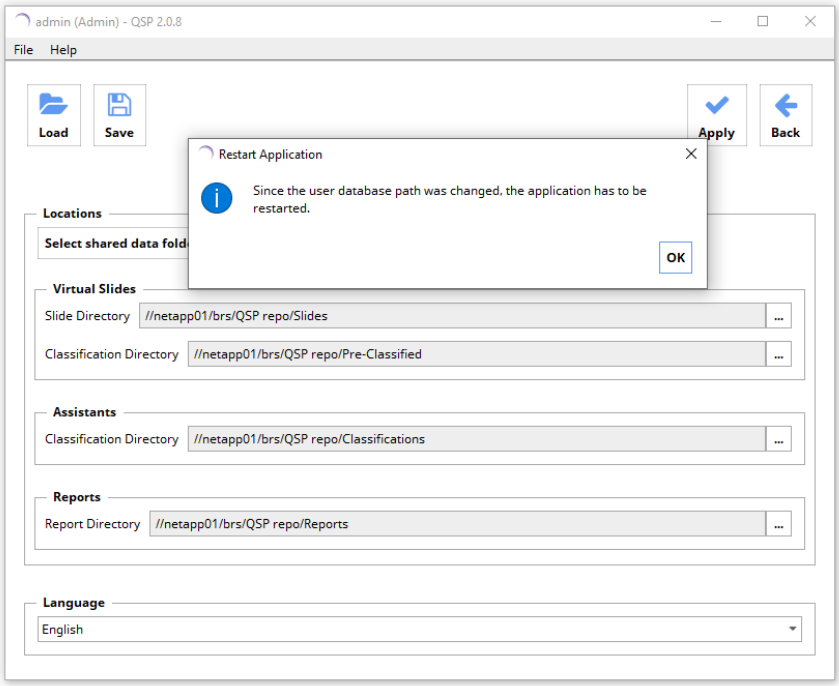
Attention: all previously created user accounts, imported slides, etc. will no longer be visible within QSP afterwards. If QSP had been used locally before, the data will remain on the local computer (e.g. at "C:\Users\Public\Horiba Medical\QSP") and can be used again later, but after pointing QSP to a network share, it will no longer load data from the local database.

The following steps are required on each QSP computer:

1. login as admin
2. click on "Configuration"



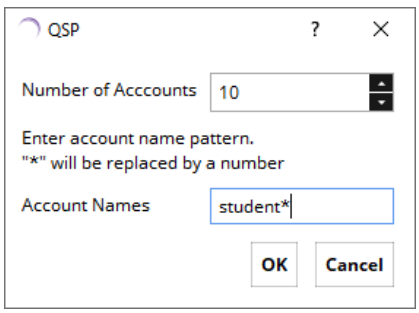
3. click the "**Select shared data folder**" button and select the shared central network folder. If none exists yet, create an empty folder.
   In the example below, a folder in the network share "\\netapp01\" has been selected. Since this step involves switching the user account database, QSP will have to be restarted immediately afterwards in order for the changes to take effect. Any previously created accounts on the local computer will then no longer be available.

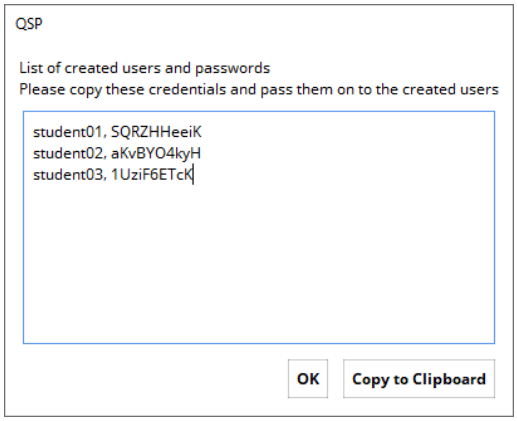


The above steps have to be repeated for every QSP client.

When QSP is installed, by default only three built-in user accounts are present: “admin”, “expert”, “assistant”. For the student-teacher scenario, new accounts for all students must be created. The accounts must be created only once from a QSP instance that has already been switched to the central database using the above steps so that the accounts will be created in the shared database and not in the local database.

New accounts can be created conveniently using the steps described in chapter 3.3.2:

1. 

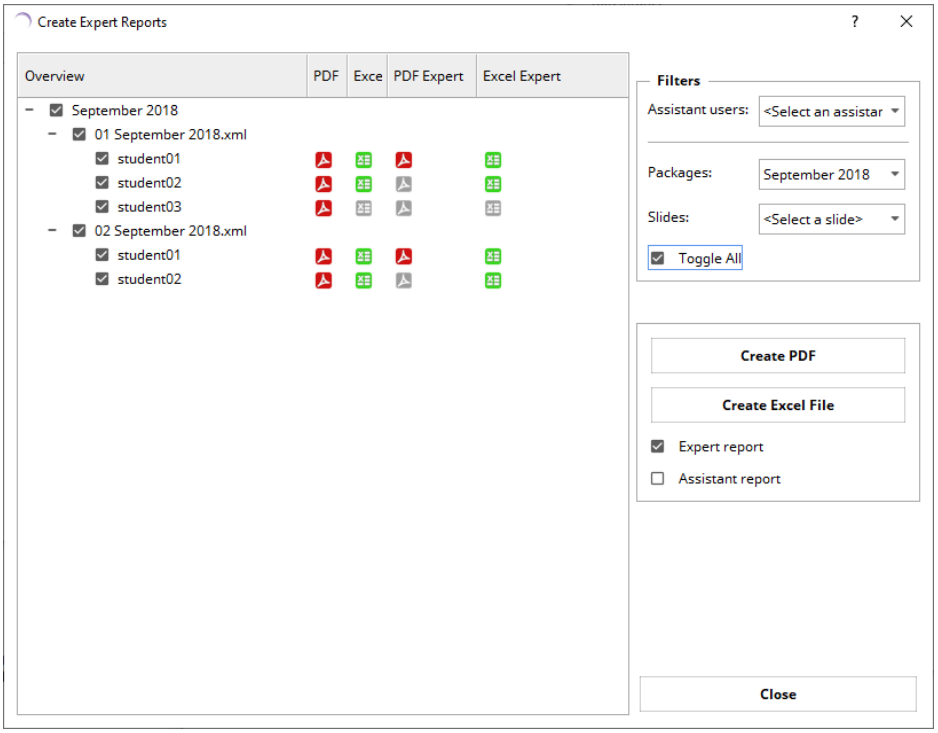
2. 

7.2. Conducting a Test

The process is similar to the regular operation of QSP in local mode.

1. In preparation for the class, the teacher logs in on any computer with the “Expert”-type teacher account.

2. The teacher imports a new case (see chapter 3.4.2)
3. The teacher double-checks and optionally corrects the reference diagnosis and releases one or multiple slides so that they will then be visible to the students (see chapters 3.4.3 and 3.4.4)
4. The students now log in and click “Train Diagnosis”. The cases released by the teacher will be visible. Each student creates a diagnosis (see chapter 4)
5. When all students are done, the teacher creates a report by clicking “Evaluation and Report”. Results for each student who finished their diagnosis will now be visible. (see chapter 5)



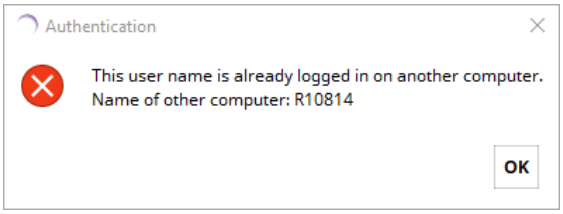
In the case that many students have participated in the test, it is recommended to use the filters in the dialog’s top right corner, to filter the tree and show only a single case. The “Toggle All” button can be used to conveniently check or uncheck all boxes. The “Assistant Report” options should be deactivated. The “Expert report” will cover a single slide and compare all students who have participated.

7.3. Safety Restrictions in Network Mode

Especially in a network scenario, but also when multiple QSP instances are for some reason started on the same computer, parallel access to the database (user accounts, slides, annotations) must be restricted to ensure a valid state of the data. For this reason, two security mechanisms are put in place:

1. **A user can only log in on one QSP instance at a time**

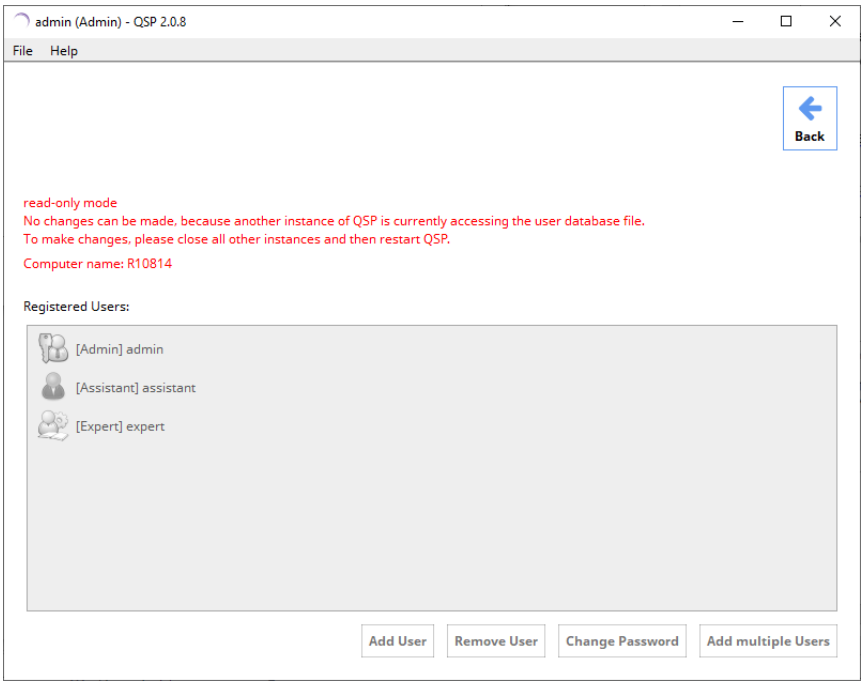
When attempting to log in with a user that is already logged in in another QSP instance, e.g. on another computer, an error message will appear:



In this case, either log in with a different account or log out on the other computer first.

2. Only one user may edit the User Accounts at a time

When an expert or admin user on another instance of QSP, e.g. on another computer, has already opened the user accounts options, the local options will open in read-only mode, in case the other instance has made changes that have not yet been saved to the database.



8. Third Party Software

This software utilizes various open source software libraries. Their licenses can be found in the “ThirdPartyLicenses” folder in the install directory.

This software is based in part on the work of the Independent JPEG Group.

9. Contact Information

With questions regarding custom developments, please get in touch with the contact listed at

https://www.iis.fraunhofer.de/microscopy