HBP
Technology Readiness Level
Assessment guide

A checklist to evaluate the maturity of Hardware, Software, Service, Datasets

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1. Introduction

The aim of this TRL assessment guide is to support HBP members in evaluating the maturity of their developing results (hardware, software, services or datasets) and help them to realise how far these results are from their ´final´ form. A ´final´ form is a fully operational version or release of the developed solution, and subsequent versions should capture further scientific or technological advances.

In fact, while acknowledging that scientific and technological progress are endless processes, and that the researchers´ essential motivation is to move beyond the state-of-the-art on his/her scientific area of work, we have also to accept that a technology solution, to be useful, has to achieve at some point that ´final´ or mature form.

The Technology Readiness Level (TRL), therefore, tries to measure the maturity or readiness of results to be effectively utilised, i.e. commercially or non-commercially exploited, in the users´ markets.

Results to be assessed include those hardware, software, services and datasets, developed totally or partially within HBP, that serve to address one or several users´ needs.

When using this checklist please have also into account the following observations:

- It is recommended to read all the points required in each level before properly starting the evaluation. This will help to have an idea of the aspects associated to each specific TRL.
- Choose the category (Hardware, Software, Service or Dataset) that corresponds to the result whose TRL or RL is going to be evaluated.
- Every exploitable (commercially and/or non-commercially) result need to be evaluated separately. You can copy/paste the specific checklist and make the evaluation in a separate document.
- Some check-list statements, within the same TRL level, could look to be describing similar requirements with different wording. This just helps to clarify the actual meaning of the requirement and to corroborate (double-check) some important aspects of the assessment.
- Some solutions may include a variety of tools and services (e.g. platforms), each of them presenting different levels of maturity. When more than one level of maturity is present within a solution, we should consider the lowest one as the technology level of the whole.
- A specific TRL is achieved when all the conditions required for that level are met. Otherwise, the TRL of the technology would be the highest one on which all conditions are fulfilled.
- As mentioned above, mature technologies are supposed to be ready to be utilised (exploited) to its full extent by (commercial or non-commercial) end-users, which also imply the availability of sustaining engineering support for users.
- Note that offering sequential product releases (e.g. developing new software versions with new functionalities) and scaling up in the maturity process (TRL) are two different processes. It may happen the coexistence of several versions of a technology solution (distributed and utilised by several users) each of them presenting different levels of maturity. When this happens, assessing the maturity of the solution (e.g. a software project where different sequential versions cohabit) implies to assess and acknowledge the maturity of each active version.
- A summary of the main TRL requirements for each result category can be seen in table 1.

2. Hardware

2.1 TRL1 Project initiation

- ☐ Basic technology processes and scientific knowledge underpinning hardware applications are known.
- ☐ Technology principles and high-level objectives are defined.
- ☐ Supporting Information includes published research or other references that identify the principles.
- ☐ Ethical aspects for hardware production and operation are addressed and compliant with EU policies
- ☐ Use case definitions (includes target users and activities)

2.2 TRL2 Conceptualisation

- ☐ Practical applications are identified. However, applications are speculative, and there may be no proof or detailed analysis to support the assumptions.
- ☐ Most of the work is analytical or paper studies with the emphasis on understanding the science better.
- ☐ Experimental work is designed to corroborate scientific principles, including validation criteria for critical components.
- ☐ PoC (proof-of-concept) is being planned.

2.3 TRL3 Proof of concept implementation

- ☐ Analytical studies and laboratory-scale studies to validate the analytical predictions of separate elements of the technology have been performed (modelling and simulation may be used to complement experiments).
- ☐ Critical components of the technology are validated, but there is no attempt to integrate the components into a complete system.

2.4 TRL4 Prototype component

- ☐ Basic technological components are integrated to establish a load testing of elements or components.
- ☐ This is a "low fidelity" system to demonstrate basic functionality and critical test environments.
- ☐ Supporting information includes the experimental components and experimental test results differing from the expected system performance goals.

2.5 TRL5 Prototype integration

- ☐ The technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects.
- ☐ Supporting information includes results from the laboratory scale testing, analysis of the differences between the laboratory and eventual operating system/environment and analysis of what the experimental results mean for the eventual operating system/environment.
- ☐ Increased fidelity of the system and environment to the actual application.

2.6 TRL6 Pilot-scale prototype to real-world integration

- ☐ Integrated systems or engineering-scale prototypes are tested in a relevant environment.
- ☐ The operating environment for the testing should closely represent the actual operating environment
- ☐ This includes initial system documentation and initial user documentation.

2.7 TRL7 Operational integration

- ☐ Validation of a full-scale, integrated system in a relevant real-world environment.
- ☐ Supporting information includes results from the full-scale testing and analysis of the differences between the test environment.
- ☐ Final design is virtually complete.

2.8 TRL8 Deployment

- ☐ Integrated system has been proven to work in its final form and under expected conditions.
- ☐ The final product in its final configuration is successfully demonstrated through test and analysis for its intended operational environment.
- ☐ all user documentation, training documentation and maintenance documentation completed.

2.9 TRL9 Production

- ☐ System is in its final form and operated under the full range of operating conditions.
- ☐ Final product operates over the full range of expected conditions.

3. Software

3.1 TRL1 Project initiation

- ☐ Basic technology processes and scientific knowledge underpinning software applications (architecture, formulation) are known.
- ☐ Technology principles and high-level objectives are defined.
- ☐ Supporting Information includes published research or other references that identify the principles.
- ☐ Ethical aspects for software production and operation are addressed and compliant with EU policies
- ☐ Use case definitions, including target users and activities.

3.2 TRL2 Conceptualisation

- ☐ Practical applications are identified. However, applications may be still speculative, and there may be not yet a detailed analysis to support the assumptions.
- ☐ Most of the work is analytical or paper studies with the emphasis on understanding the concept better.
- ☐ Experimental work is designed to corroborate scientific principles, including validation criteria for critical components and basic properties of algorithms.
- ☐ PoC (proof-of-concept) being planned, starting with preliminary simulations with synthetic data.

3.3 TRL3 Proof of concept implementation

- ☐ Analytical studies and small-scale studies to validate the analytical predictions of separate components of the software have been performed (modelling and simulation may be used to complement experiments).
- ☐ Software components are validated, but there is no attempt yet to integrate the components into a complete system.

3.4 TRL4 Prototype component

- ☐ Key software modules are integrated, functionally validated, and tested with a range of data sets, to establish interoperability and begin architecture development.
- ☐ It is an alpha prototype integrated locally and containing key components to demonstrate basic functionality and critical test environments against expected system performance goals.
- ☐ Supporting information includes the experimental components and experimental test results differing from the expected system performance goals.
- ☐ Initial architecture documentation available

3.5 TRL5 Prototype integration

- ☐ End-to-end software elements integrated with key components, as well as implemented and interfaced with existing systems/simulations conforming to target environment.

- ☐ Supporting information includes results from the laboratory scale testing, analysis of the differences between the laboratory and eventual operating system/environment, and analysis of what the experimental results mean for the eventual operating system/environment.
- ☐ All required data formats have been specified.
- ☐ Increased fidelity of the system and environment to the actual application.
- ☐ The medium-fidelity prototype has been tested at laboratory scale system to demonstrate overall performance in a relevant environment.

3.6 TRL6 Pilot-scale prototype to real-world integration

- ☐ Integrated systems or high-fidelity prototype implementations of the software are tested in a relevant environment under expected load, being demonstrated on full-scale realistic problems.
- ☐ The operating environment for the testing closely represents the actual operating environment.
- ☐ Initial system documentation, user documentation and final architecture documentation are available.

3.7 TRL7 Operational integration

- ☐ Validation of a prototype software with all key functionality available in a relevant real-world environment.
- ☐ Well integrated with operational hardware/software systems demonstrating operational feasibility.
- ☐ Most software bugs removed.
- ☐ No expected data format or application programming interfaces changes.
- ☐ Supporting information includes results from the full-scale testing and analysis of the differences between the test environment.
- ☐ Final design is virtually complete.

3.8 TRL8 Deployment

- ☐ Full software system has been proven to work in its final form and under expected conditions, i.e. the end-to-end system has been already created with all components
- ☐ All functionality successfully demonstrated in simulated operational scenarios.
- ☐ End-to-end system tested and integrated in a real-world environment with a small number of real users.
- ☐ Software has been thoroughly tested (user-acceptance and performance) and debugged.
- ☐ Software has been fully integrated with all operational hardware and software systems.
- ☐ All user documentation, training documentation and maintenance documentation completed, including software/system requirements and architecture/design related descriptions.

3.9 TRL9 Production

- ☐ System is in its final form and operated under the full range of operating conditions.
- ☐ Tested in a real-world environment with a target number of real users.
- ☐ Sustaining software engineering support is in place (e.g. forum, issue tracking, help desk, bug reporting email, etc.)
- ☐ Final product operates over the full range of expected conditions.

4. Service

4.1 RL1 Project initiation

- ☐ Basic principles of the service are known.
- ☐ High-level objectives defined.
- ☐ Supporting information includes published research or other references that identify the principles.
- ☐ Ethical aspects for service operation are addressed and compliant with EU policies
- ☐ Use case definitions (includes target users and activities)

4.2 RL2 Conceptualisation

- ☐ Practical applications of the service are identified. However, applications are speculative, and there may be no proof or detailed analysis to support the assumptions.
- ☐ Most of the work is analytical with the emphasis on understanding the service better.
- ☐ Validation work is designed to corroborate principles.
- ☐ PoC (proof-of-concept) is being planned, starting with preliminary service simulations.

4.3 RL3 Proof of concept implementation

- ☐ It includes analytical studies to validate the performance of separate elements of the service.
- ☐ These elements are validated (modelling and simulation may be used to complement the validation) but there is no attempt to integrate them into a complete service system.

4.4 RL4 Prototype component

- ☐ Key service elements are integrated, and functionally validated, to establish interoperability.
- ☐ Supporting information includes validation of elements and those results that differ from the expected service performance goals.
- ☐ Initial version of the service to demonstrate basic functionality and testing critical environments ready.

4.5 RL5 Prototype integration

- ☐ End-to-end service elements integrated, as well as implemented and interfaced with existing systems conforming to target environment.
- ☐ Supporting information includes results from the testing, analysis of the differences between the test and eventual operating system/environment and analysis of what the tested results mean for the eventual operating system/environment.

4.6 RL6 Pilot-scale prototype to real-world integration

- ☐ Integrated service is tested in a relevant environment being demonstrated on full-scale realistic problems.

- This is a step up from tests to operational real-world scale and the determination of scaling factors that will enable design of the service system.
- The operating environment for the testing should closely represent the actual operating environment.
- System monitoring points identified.
- Initial service documentation and initial user documentation are available.

4.7 RL7 Operational integration

- Validation of the service with all key functionality available in a relevant real-world environment.
- Well integrated with other systems and services demonstrating operational feasibility.
- Supporting information includes results from the full-scale testing and analysis of the differences between the test environment.
- System monitoring points implemented.
- SLA monitored.
- No expected service changes.
- Final design is virtually complete.

4.8 RL8 Deployment

- Full service has been proven to work in its final form and under expected conditions.
- All functionality successfully demonstrated in simulated operational scenarios.
- Tested in a real-world environment with a small number of real users.
- SLA enforced.
- The service has been fully integrated with all operational systems.
- all user documentation, training documentation and following-up documentation is completed.

4.9 RL9 Production

- Service is in its final form and running under the full range of operating conditions.
- It has been thoroughly depurated and fully integrated with all operational systems.
- Tested in a real-world environment with a target number of real users.
- All documentation has been completed.
- Service engineering and following-up support is in place.
- Final service operates over the full range of expected conditions

5. Dataset

This RL assesment applies to datasets produced by the data providers within HBP and partnering projects.

See data related definitions in table 2

5.1 RL1: Project initiation

☐ High-level objectives of the data are defined, including SMART requirements (Specific, Measurable, Achievable, Relevant, Time-bound)

☐ Acquisition methods are identified

☐ Processing methods are identified

☐ Ethical procedures for data production and handling are addressed and compliant with EU policies

☐ Component created in the project management tool (PLUS, in the Human brain project)

5.2 RL2: (Meta)data management concept

☐ File formats of (meta) data community standards (see table 3 below) were followed

☐ Repository concept is designed (standardised repository solutions are considered)

☐ Local storage concept is designed (guaranty of long-term preservation and integrity of data)

5.3 RL3: Validation of project execution

☐ Acquisition methods are validated and refined

☐ (Meta)data formats are validated and refined

☐ Storage/repository concepts are validated and refined

☐ Processing methods are validated and refined

☐ Quality check on test raw and/or derived data are developed and optimised

5.4 RL4: Data production

☐ Raw (meta)data are produced

☐ Quality check of raw data is applied according to: completeness, accessibility, consistency, accurateness, comprehensiveness, quantity, credibility, readability, relevance, timeliness, uniqueness, usefulness, validation possible, standard based processed, reproducibility, privacy and security observed (applicable to derived data, e.g. patient data)

☐ Derived data and corresponding metadata are produced

☐ Quality check of derived data is applied

☐ (Meta)data production is documented

5.5 RL5: Data findability / Curation initiation

☐ Data repository is (re)located onto a long-term storage system

☐ DataDescriptor is completed and accompanies the data

☐ Email with curation request is sent to curation team (curation-support@humanbrainproject.eu)

☐ Basic metadata (MINDS: Minimum Information for Neuroscience Data Sets) are collected and reviewed

☐ Metadata are clearly and explicitly linked to corresponding data it describes (via a unique identifier (URL)

☐ Metadata are registered into a searchable resource (KnowledgeGraph) and assigned with a unique and persistent identifier (DOI)

☐ Metadata are released

5.6 RL6: Data interoperability

☐ (Meta)data are enriched with references to other (registered) (meta)data

☐ Metadata entries follow community standards (terminologies or ontologies) if applicable

5.7 RL7: Data publishing (via HBP Knowledge Graph)

☐ Data license is defined in compliance with the HBP open data policy

☐ (Derived)Data are released and assigned with a persistent DOI (on request of the data provider)

☐ Basic (meta)data are retrievable by their identifier from a searchable resource (KnowledgeGraph)

☐ Software for accessing data is provided

5.8 RL8: Data (re)usability

☐ Approach to integrate data into the HBP atlas viewers is identified

☐ Data and KnowledgeGraph are enriched with spatial metadata and guiding materials

☐ Data representation in atlas viewer is confirmed

☐ Data and KnowledgeGraph are enriched with in-depth metadata

☐ In-depth metadata are tested to be sufficient for software applications

☐ Data are integrated into the HBP atlas viewers (release of spatial metadata if possible)

☐ Data are accessible via software applications (release of in-depth metadata if possible)

5.9 RL9: Real-world application of Data

☐ Data are cited and used by 3rd parties

☐ Data achieve a high FAIRness score/ data are proven to be FAIR

Table 1: Summary of the main TRL requirements for each result category

TRL/RL	Hardware	Software	Service	Dataset
1	Project initiation	Project initiation	Project initiation	Project initiation
2	Conceptualisation	Conceptualisation	Conceptualisation	(Meta)data management concept
3	Proof of concept implementation	Proof of concept implementation	Proof of concept implementation	Validation of project execution
4	Prototype component	Prototype component	Prototype component	Data production
5	Prototype integration	Prototype integration	Prototype integration	Data findability /Curation initiation
6	Pilot-scale prototype to real-world integration	Pilot-scale prototype to real-world integration	Pilot-scale prototype to real-world integration	Data interoperability
7	Operational integration	Operational integration	Operational integration	Data publishing
8	Deployment	Deployment	Deployment	Data (re)usability
9	Production	Production	Production	Real-world application of Data

TRL/RL	Hardware	Software	Service	Dataset
1	Basic technology processes and scientific knowledge underpinning hardware applications are known. Technology principles, ethical aspects and high-level objectives are defined.	Basic technology processes and scientific knowledge underpinning software applications (architecture, formulation) are known. Technology principles, ethical aspects and high-level objectives are defined.	Basic principles of the service are known, ethical aspects discussed and high-level objectives defined.	High-level objectives of the data are defined, including ethical aspects and SMART requirements (Specific, Measurable, Achievable, Relevant, Time-bound). Data acquisition and processing methods are identified.
2	Practical applications are identified. However, applications are still speculative, and there may be no proof or detailed analysis to support the assumptions. Most of the work is analytical or paper studies with the emphasis on understanding the science better.	Practical applications are identified. However, applications are still speculative, and there may be no proof or detailed analysis to support the assumptions. Most of the work is analytical or paper studies with the emphasis on understanding the science better.	Practical applications of the service are identified. However, applications are still speculative, and there may be no proof or detailed analysis to support the assumptions. Most of the work is analytical with the emphasis on understanding the service better.	File formats of (meta) data community standards are defined and followed. A repository concept and a local storage are designed.

3	This includes analytical studies and laboratory-scale studies to validate the analytical predictions of separate elements of the technology. Critical components of the technology are validated, but there is not yet attempt to integrate the components into a complete system.	This includes analytical studies and laboratory-scale studies to validate the analytical predictions of separate components of the technology. Software components are validated, but there is not yet attempt to integrate the components into a complete system.	It includes analytical studies to validate the performance of separate elements of the service. These elements are validated, but there is not yet attempt to integrate them into a complete service system.	Data acquisition, formats, storage, and processing methods are validated and refined. Quality checking on test raw and/or derived data are developed and optimised.
4	Basic technological components are integrated to establish a load testing of elements or components. This is a "low fidelity" system to demonstrate basic functionality and critical test environments. This is the first step in determining whether the individual components will work together as a system.	Key software components are integrated, and functionally validated, to establish interoperability and begin architecture development. This is an alpha prototype to demonstrate basic functionality and critical test environments. This is the first step in determining whether the individual modules will work together as a system.	Key service elements are integrated, and functionally validated, to establish interoperability. This is an initial version of the service to demonstrate basic functionality and testing critical environments.	Raw (meta)data are produced and quality is checked on completeness, accessibility, consistency, accurateness, comprehensiveness, quantity, credibility, readability, relevance, timeliness, uniqueness, usefulness, validation possible, standard based processed, reproducibility, privacy and security observed.
5	The technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects.	End-to-end software elements integrated, as well as implemented and interfaced with existing systems/simulations conforming to target environment.	End-to-end service elements integrated, as well as implemented and interfaced with existing systems conforming to target environment.	Data repository is (re)located onto a long-term storage system. Data Descriptor is completed and accompanies the data. Basic metadata (MINDS: Minimum Information for Neuroscience Data Sets) are collected and reviewed. Metadata are registered into a searchable resource and assigned with a unique and persistent identifier (DOI).
6	Integrated systems or engineering-scale prototypes are tested in a relevant environment. This is a step up from laboratory scale to operational real-world scale and the determination of scaling factors that will enable design of the operating system. The operating environment for the testing should closely represent the actual operating environment. It includes initial system documentation and initial user documentation.	Integrated systems or prototype implementations of the software are tested in a relevant environment being demonstrated on full-scale realistic problems. This is a step up from laboratory scale to operational real-world scale and the determination of scaling factors that will enable design of the operating system. The operating environment for the testing should closely represent the actual operating environment. This includes initial system documentation and initial user documentation.	Integrated service is tested in a relevant environment being demonstrated on full-scale realistic problems. This is a step up from tests to operational real-world scale and the determination of scaling factors that will enable design of the service system. The operating environment for the testing should closely represent the actual operating environment. This includes initial service documentation and initial user documentation.	(Meta)data are enriched with references to other (registered) (meta)data. Metadata entries follow community standards (terminologies or ontologies) if applicable.

7	Validation of a full-scale, integrated system in a relevant real-world environment. Examples include testing a high-fidelity full-scale prototype in the field in order to address all critical scaling issues. Final design is virtually complete.	Validation of a prototype software with all key functionality available in a relevant real-world environment. Well integrated with operational hardware/software systems demonstrating operational feasibility. Most software bugs removed. No expected data format or application programming interfaces changes. Final design is virtually complete.	Validation of the service with all key functionality available in a relevant real-world environment. Well integrated with other systems and services demonstrating operational feasibility. No expected service changes. Final design is virtually complete.	Data license is defined in compliance with the data policy. (Derived) data are released and assigned with a persistent DOI (on request of the data provider). Basic (meta)data are retrievable by their identifier from a searchable resource. Software for accessing data is provided.
8	Integrated system has been proven to work in its final form and under expected conditions. The final product in its final configuration is successfully demonstrated through test and analysis for its intended operational environment.	Full software system has been proven to work in its final form and under expected conditions. All functionality successfully demonstrated in simulated operational scenarios. Tested in a real-world environment with a small number of real users. Software has been thoroughly debugged and fully integrated with all operational hardware and software systems.	Full service has been proven to work in its final form and under expected conditions. All functionality successfully demonstrated in simulated operational scenarios. Tested in a real-world environment with a small number of real users. The service has been fully integrated with all operational systems.	Approach to integrate data into the atlas viewers is identified. Data and the search resource are enriched with spatial metadata and guiding materials. Data representation in atlas viewer is confirmed. Data are accessible via software applications.
9	System is in its final form and operated under the full range of operating conditions. Examples include testing in a real-world environment with a target number of real users. Final product operates over the full range of expected conditions.	System is in its final form and operated under the full range of operating conditions. All software has been thoroughly debugged and fully integrated with all operational hardware/software systems. Tested in a real-world environment with a target number of real users. All documentation has been completed. Sustaining software engineering support is in place. Final product operates over the full range of expected conditions.	Service is in its final form and running under the full range of operating conditions. It has been thoroughly depurated and fully integrated with all operational systems. Tested in a real-world environment with a target number of real users. All documentation has been completed. Service engineering and following up support is in place. Final service operates over the full range of expected conditions.	Data are cited and used by third parties. Data have achieved a high FAIRness score and are proven to be FAIR.

Table 2: HBP Data related definitions

Atlas integration	Data anchored to an appropriate anatomical location in a reference atlas, allowing data to be findable through spatial search and by search for brain structures
Basic metadata	The basic information needed to make data findable and accessible
Curation	Management of data throughout its life cycle and translating an independently created data source into a unified system
Curation support	Service that deals with questions related to metadata and data management
Data licence	Describes under which conditions data are shared
Derived data	Data that have been generated from a primary data source or data that have been created from a disseminated dataset
FAIRness score	Quantitative measurement of the FAIR (findable, accessible, interoperable and re-usable) principles
In-depth metadata	Enrichment of metadata for the purpose of data re-use
MINDS	Basic metadata schema that includes Minimum Information for Neuroscience Data Sets
Metadata	Data that describe information about other data
Provenance	A historical recording trail of the data and their origin
Quality check	A process by which entities review the quality of the data
Raw data	Primary data that has not been subjected to processing
Repository	Storage location of data
Spatial metadata	Metadata related to the spatial location of a dataset

Table 3: File formats of (meta) data community standards

FORMATS		API			REF	DOCU	(latest) VERSION	OWNER	MAINT
NAME	SUFFIX	OPEN	PROP FREE	PROP COM	(Numbers refer to references listed in next section)				
Planar and volumetric data formats: Image formats are used to save 2D and 3D image data.									
NIfTI	.nii	X	-	-	1	2	NIfTI-1/NIfTI-2	NIH, DFWG	DFWG
Analyze™7.5	.img+.hdr	?	?	?	-	3	?	Mayo Foundation	?
TIFF	.tif, .tiff	X	-	-	4	5	6.0	Adobe Systems	IETF
BigTiff	.tif, .tiff	X	-	-	4	5		Aware Systems	Aware Systems
hdf5	.h5, .hdf5	X	-	-	6	7	1.10.1	HDF Group	HDF Group
Surface geometric data formats: Image formats are used to save surface-based image data.									
GIfTI	.gii	X	-	-	8	9	1.0.9	NIH, DFWG	DFWG
Mesh	.mesh	X	-	-	10	11	4.5.0	BrainVISA	BrainVISA
Tractography data formats: Image format is used to save fibre or fibre bundle reconstructions.									
VTK	.vtk	X	-	-	12	13	8.0	kitware	kitware
MRTRIX tracks format	.tck	X	-	-	14	15		mrtrix.org	mrtrix.org
Parcellations and probability maps: Image formats are used to save 2D and 3D image data.									
Matlab (SPM)	.m, .mat	-	X	X	-	-	9.2 (R2017a)	Mathworks	SPM
NIfTI	.nii	X	-	-	1	2	NIfTI-1/NIfTI-2	NIH, DFWG	DFWG
Map terminology formats: Formats do not directly refer to images, but define parcellation labels and other parameters referring to parcellation and probability maps.									
JSON	.json	X	-	-	-	16	-	ECMA	IETF
CSV	.csv	X	-	-	-	17	-	-	-
Neuron morphology formats: Formats refer to 2D and 3D morphologies of neurons.									
ASC	.asc	X	-	-	-	18	-	-	-