Guide for advanced technology application in seed testing: Computer Vision

Consultation Version

Drs. Ruojing Wang, Bert van Duijn

2024-06-29

Background: the needs

Advanced technology applications are in demand to be recognized in seed testing.

Lack of practical guidance for technology developers and end users.

Require acceptable standards or processes for tool evaluation.

Background: a working group

ISTA formed a working group 2023

ISTA Technical committees:

(ATC, PUR, GER, VIG)

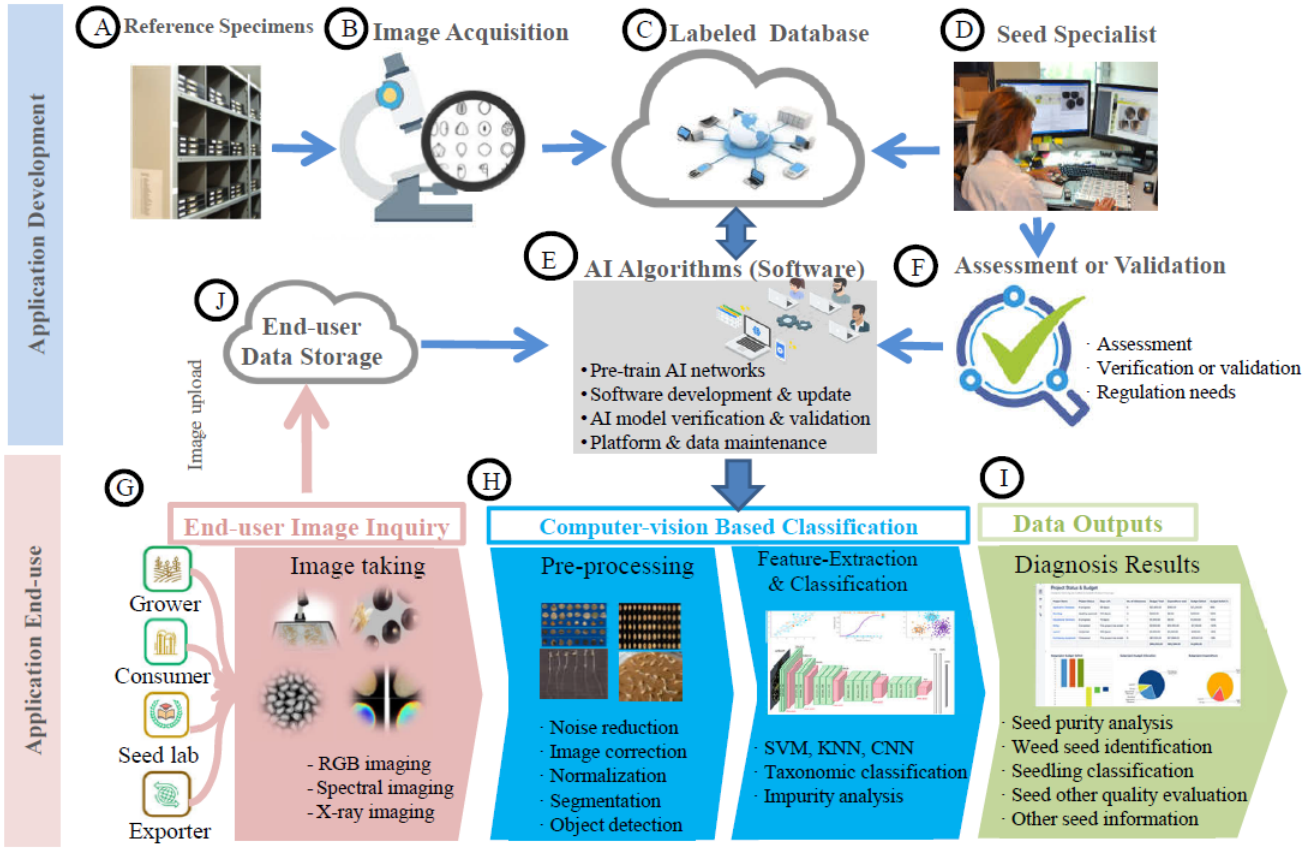
Consultation groups: STA, PT, and ISTA Accreditation department

AOSA-SCST Advanced Technology Committee is the observer

Guide Focus: Computer Vision (AI)

AI Components:

- Imaging equipment
- AI modeling (Software)
- System output
  - Tool Scope
  - Performance
  - Monitoring
  - Scope expansion
  - Maintenance
  - Quality control records



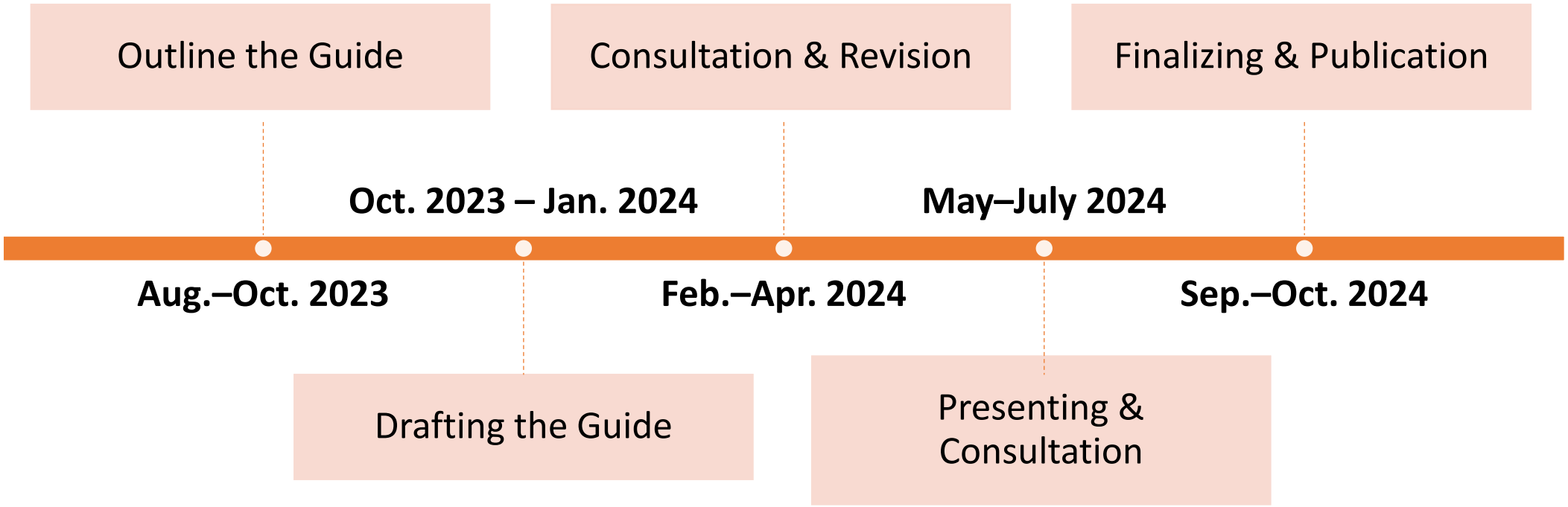
Zhao, et al., 2022

Seed Science & Technology https://doi.org/10.15258/sst.2022.50.1.s.05

Working Group Objectives

- Develop an operational guide for applying computer vision (AI tools) (equivalent to humans) in seed testing.
- Provide verification expectations of end-user labs and support the audit team for the validity of tool outcomes.
- Specify the minimum quality control expectation
- Facilitate the speedy or prioritized applications of computer vision (equivalent to human) in seed testing
- Share common/best practice in computer vision application

Working Group Milestones



Outline of the Guide: Definitions

Computer Vision: Computer vision is a field of artificial intelligence (AI) that uses machine (deep) learning and neural networks to teach computers and systems to derive meaningful information from digital images, videos and other visual inputs. The AI powered computer system enables to think, to see, to analyse, and to make recommendations (ibm.com).

Tool development: In this guide, tool development refers to the process of creating AI software tools or applications that assist in various aspects of software development, testing, and maintenance. Tool development aims to address specific needs and challenges faced by developers through processes such as data collecting, coding, debugging, testing, documentation, and deployment, i.e., research and development stage of an AI application.

Tool Verification: Tool Verification is a crucial process used to ensure that a product, service, or system meets specific requirements and specifications, as well as fulfils its intended purpose. It plays a vital role in quality management systems, such as ISTA Accreditation standard

Process Documentation

Customized software requires verification to meet required accuracy

(See ISO/IEC 17025:2017, section 7.11.2).

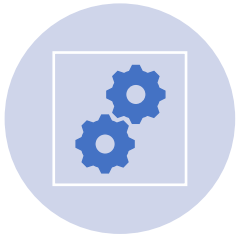
Overview of tool application scope and performance indicators (Annex 1)

Original observations of tool development on performance indicators (Annex 2)

Tool performance equivalency verification with single or multiple laboratories (Annex 3)

General Principles of the Guide

TOOL OBJECTIVE AND SCOPE INTENDED



EQUIPMENT AND METHODS

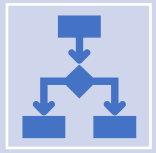
VARIATION OF MATERIALS

EXPECTED OUTCOMES

MAINTENANCE

Tool Verification*
(performace indicator in development)

Single lab verification for known value, such as seed identification?



Multiple labs for unknown value, such as % values?

Standard or peer reviewed data set, e.g., seedling classification?

Illustration on the Process of an AI Tool Development

Tool Development

- Set up the system (Hardware)
- Determine the tool scope
- Collect data and build computer model (Software)
- Determine tool performance indicators

Tool Verification

- Determine verification method & design
- Obtain verification samples or data sets
- Evaluate performance
- Decide the acceptance

Tool Deployment

- Maintain development and verification records
- Set up operation and maintenance procedures
- Monitor and feedback on the performance

Standard Forms (Annexes) for Tool Records

Annex 1: Overview of tool application scope and performance indicators
***Notes**: the grey text are hypothetical examples

Category	Description	Notes
Name of the tool:		
Laboratory Name:		
Scope of the tool:	e.g., Digital RGB computer vision system for OSD in barley	OSD species: *Brassica* spp. *Cuscuta* spp. *Datura stramonium*
Sample taxon names	e.g., *Hordeum vulgare* L. subsp. *vulgare*	
Tests	e.g., OSD	
Additional specifications, please specify:	e.g., sample percentage purity range: >95%	
Performance indicators:		
Accuracy:	e.g., accuracy % >90%	Accuracy verified with ISTA PT sample
Others, please specify:	e.g., precision	
Releasing/deployment date:		
Tool Modification, if any		
Modification Date:		
Scope changed:		
Performance indicator, if any changes	e.g., accuracy >95%	
Operational Procedures		
SOP ID #		
Responsible Person for Tool Operational		
Maintenance requirement	e.g., specified in SOP 123	
Other notes:		

Develop standard format for documentation for:

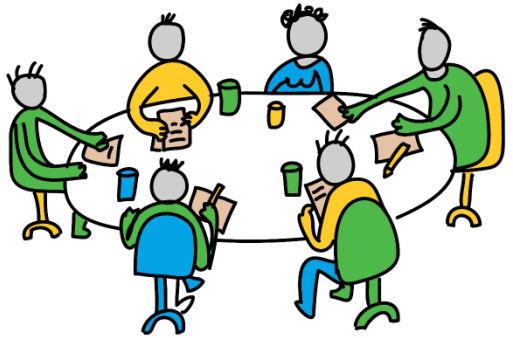
- Tool scope and performance
- QA requirement

Next steps

- Refine statistical or methodology for the verification of AI tool
- Consult other technical committees and members, especially pilot users
- Revise and publish the first version of the guide
- Draft the best practices for particular applications, e.g., germ, OSD, vigor, for a second version in 2025

Questions and Discussion

- Do you see the value of the Guide for facilitating advanced technology to be applied in seed testing?
- Other comments or questions?
- Any further comments please contact:
  - Relavent TCOMs: https://www.seedtest.org/en/technical-committees.html
  - Bert van Duijn bert.vanduijn@fytagoras.com
  - Ruojing Wang ruojing.wang@inspection.gc.ca



ISTA ANNUAL MEETING 2024
01-04 JULY
CAMBRIDGE, UNITED KINGDOM

Thank you

I have no actual or potential conflict of interest in relation to this presentation.

I have the following conflict/s of interest to declare:
Ruojing Wang, and Bert van Duijn