Part 3 Questions & Answers

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Erika Podest (erika.podest@jpl.nasa.gov) or Sean McCartney (sean.mccartney@nasa.gov).

Question 1: How do you integrate the Sen2Cor plugin offline in SNAP?
Answer 1: There are instructions on ESA's website to integrate Sen2COR offline for SNAP at Sen2Cor – STEP (esa.int). Further questions can be directed to the Latest snap topics - STEP Forum (esa.int). There are ways to run Sen2Cor integrated in SNAP or using the command line; but all details on doing this are available at these links.

Question 2: How does one estimate sown area or cultivated area of crops using SAR data?
Answer 2: AAFC has developed a robust method to integrate SAR and optical data to operationally map crops across Canada. This webinar and the next ARSET webinar (Part 4) will walk participants through this entire process (from field data collection, to SAR pre-processing, classification, post-processing, and map publication). If questions remain, please contact the AAFC team.

Question 3: How does one utilize ascending pass and descending pass from Sentinel-1 images?
Answer 3: In an operational crop inventory, either pass can be utilized. In some cases, there is an attempt to avoid using the pass that may be acquired when dew is present. However, in general, it is not necessary to exclude those images or stick to either descending passes or ascending passes. Nor is it necessary in a crop classification to stick to a single incidence angle. For further details on incidence angle, water and moisture, and SAR, please refer to Part 1 in this series.

Question 4: What is SLC - Single Look Complex and GRD? What is the difference between them and when do we use one over the other?
Answer 4: SLC data are in slant range (the natural viewing geometry of SAR) and phase is preserved. GRD data have been projected into ground range. If phase information is not required for your analysis, GRD is a good choice for operations as these products

are easier to stack, integrate with other geospatial data (like in situ field observations), and ingest into classifiers.

Question 5: Using Sen2Cor, can I do terrain correction of an L1C granule using a DEM that covers it partially (spatial extent of the granule is bigger than that of the DEM)?
Answer 5: Typically we ensure that the DEM covers the entire area of the granule. You can download DEMs to cover the entire granules. Otherwise there will be errors in the portion not covered by the DEM. For details on using SEN2COR though, and using only a partial DEM, you may want to refer to the links I mentioned above.

Question 6: I never looked for this, but do Sentinel-1 and -2 satellites pass on the same day? Are they in some kind of train where both optical and SAR data is captured on the same day?
Answer 6: This would depend on where the images are being acquired. For example, we have been providing satellite calendars over Southern Ontario, Canada. Sentinel-1 & -2 are being acquired on sequential days. In Europe, I imagine there is some overlap, however, this is probably a question for ESA.

Question 7: Do the Sentinel-1 images from the ASF and the Copernicus HUB have the same name (ID)?
Answer 7: Yes, the naming convention is an ESA standard.

Question 8: A question about Sentinel dataset products. What does a corrected file refer to? What does the correction process produce?
Answer 8: Correction of SAR includes many steps - geometric and radiometric correction. Geometric correction is applied to relate the SAR image to a position on the Earth. Radiometric correction is necessary to correct for system errors and to provide accurate measures of backscatter response per unit area.

Question 9: Is it correct to process images from Sentinel-1A and Sentinel-1B at the same time? What happens with the "ascending" and "descending" orbit? Does it cause interference in the results?
Answer 9: We have never experienced issues with using ascending or descending together; however, as we mentioned, we sometimes try to use those data that avoid dew. In an operational context, it is imperative to acquire a time series of SAR imagery that captures the entire growing season. As such, the AAFC crop classification

operations include both. This is a trade-off between the potential effects of dew, difference in incidence angles and slightly different viewing directions, and a good temporal coverage. However, as we discussed during the SAR basics refresher, if your objective is to use the SAR backscatter for change detection, it is important that orbit and incidence angle are the same.

Question 10: Page 25: Did you mention where the blue marked filters are implemented?
Answer 10: Typically we use a GAMMA Map filter with a 7x7 or greater window, however, it is recommended that tests are made on the filter type and filter size. In some cases a specific filter (or one of those blue listed filters) may be more appropriate for your particular area of interest. It is best to test these over several sites in your area of interest.

Question 11: How do you determine the threshold of limited cloud cover in Sentinel-2?
Answer 11: We will generally not have a minimum threshold because we attempt to utilize all portions of images that are not covered in clouds. We do have a manual process by which we review our optical imagery to ensure we can use all portions of viable images possible. By using a threshold you may exclude an image that has portions that are useful (cloud-free) and may be the only available optical imagery for a particular period of time.

Question 12: What are LUTs? Where can I find them and how do I use them?
Answer 12: LUTs (look up tables) are provided in a satellites' metadata. They are incorporated in various processing tasks such as radiometric conversion to sigma naught, etc.

Question 13: Can we access the AAFC training system documentation?
Answer 13: The AAFC training system documentation is not currently available to the public to download, but contact Leander Campbell (Leander.Campbell@agr.gc.ca) and he will pass along the training materials and answer any additional questions you may have.

Question 14: What is the other information you gather from the ground aside from the crop type and how often do you go to the field?

Answer 14: Besides crop types, data collectors can also add points for additional agricultural information (fallow, harvested, too wet to seed, standing water in the field) and they can add various land cover types (wetlands, forest, water, etc). In addition to this, collectors have the ability to add additional notes to their points that may be of interest (i.e., lots of weeds, crops looking dry/stressed, etc.).

Question 15: Is there a similar free/open-source software also available for data collection?

Answer 15: Any georeferenceable collection tool can be used as a data collection tool. The AAFC GPS-enabled tablets use an old ESRI collection software called ArcPad. Recently we developed a phone-based app using ESRI Survey123. We have also experimented with the NGA's MAGE data collection tool (you can find this in the app store), which is used by the USDA-FAS.

Question 16: For crop classification using training data, what is the data sample size and what should be the average farm size? In India we have avg. farm sizes of 1/2 Ha, so is that farm size ok? And should we use at least 100 such farm data for training datasets? What is meant by well dispersed data? How do we differentiate between grain crops such as paddy, wheat, or what kind of training data sets should be considered? What specific method could be used to distinguish crop type?

Answer 16: The AAFC operations provides a roadmap, but understanding that adaptation will be required to apply to your region depending on cropping systems, growing seasons, and field sizes. Canada has a relatively simple cropping season and relatively large field sizes. For small fields, consider higher resolution SAR modes and remember that the noise associated with SAR will require noise reduction. As such, typically some type of averaging (spatially, multi-looking) will be needed. In terms of dispersion of training data, it will be important to collect field observations across the area you wish to classify, as seeding dates and meteorological conditions may create differences in crop development. We differentiate between many many different crop types including grains and vegetables and oil seeds. You will require samples of all crops types you are trying to classify. There is no simple answer to the number of field observations needed, as this depends on the mixture of crop types and how different the SAR and optical signatures are amongst the crop types. AAFC's operations began with research and we are continually adapting our methods to achieve the best results.

Question 17: Do you stratify the training sample collection to ensure sufficient training samples and are you confident in capturing rare land cover classes? Do you calculate accuracies for land cover classes individually or overall?
Answer 17: Sample collection is not stratified but based on our knowledge of the areas; areas with rare fields are usually sampled with a higher density. We are publishing overall crop accuracies per province. Individual crop accuracies are also computed but not published (available upon request).

Question 18: I wanted to ask if you have published the crop maps and training data repository?
Answer 18: Yes, all is published on OpenCanada.ca.
The Annual Crop Inventory Maps can be found here:
https://open.canada.ca/data/en/dataset/ba2645d5-4458-414d-b196-6303ac06c1c9
Our ground truth points that we have collected (not the data provided by provincial crop insurance companies) can be found here:
https://open.canada.ca/data/en/dataset/503a3113-e435-49f4-850c-d70056788632

Question 19: As Landsat and Sentinel-2 imagery have different resolutions and bandwidths, how can they be combined and used in the same study to, for example, prolong a time series?
Answer 19: You can combine them by resampling one to the other for spatial resolution. Similarly, both Sen2AGRI, which is available from ESA, and HLS (Harmonized Landsat Sentinel-2) version 2 dataset data from the USGS attempt to normalize the bandwidth between the two imagery types. I believe you will be hearing more about Sen2AGRI in lecture 5. Or you can check it out at Sentinel-2 for Agriculture (esa-sen2agri.org)
https://lpdaac.usgs.gov/news/release-of-harmonized-landsat-and-sentinel-2-hls-version-20/

Question 20: Thank you for the informative presentation. I wanted to ask if you have published the crop maps and training data repository?
Answer 20: Yes. It is available at Open Canada.ca Open Government | Open Government, Government of Canada. Specific links can be found in Q18.

Question 21: Is there a minimum area size that a training sample can be qualified for sampling? Also, in areas having a multi-cropping system, how can this be mapped using SAR?

Answer 21: Please see the answer to Question 16.

Question 22: In my understanding, fields are classified according to the view from the roads driven during AAFC field surveys. This would assume that the "road-view-crop" is representative of the entire field. Could you provide an estimate of the error entailed in this assumption?
Answer 22: Data collectors are instructed to place their observation point only in the area they can see. We try not to assume a whole field is growing a uniform crop type. When we run the segmented process over the imagery, the observation point will then be linked to the proper polygon. But of course nothing is perfect and in our discussions with our USDA counterparts, the decision-tree methodology can handle up to 20% training data error and still produce an acceptable map. Of course we never want to be anywhere near that percentage! :) It is a trade off in the development of your field training data.

Question 23: Do you do the survey every year?
Answer 23: Yes. We survey for every growing season (July-August) and we sample areas where information is not available otherwise (such as from crop insurance agencies).

Question 24: Did you consider using bikes instead of or in conjunction with cars, which would eventually allow access to more fields? How about drones?
Answer 24: Considering the very large areas to sample in Canada, it would be an impossible task to do it by bike, even in conjunction with cars. Logistics with drones (permissions, weather, etc.) is currently too complicated to use it operationally.

Question 25: I have a question about the data collection of AAFC. Maybe I missed it, but is it possible to ask all the farmers in a specific region to indicate on a map what the crop type is on each of their farmland? I can imagine that this is difficult for large areas. However, in the Netherlands farmers have to register their plots each year, though we are a very small country, the farmlands/plots are small and scattered.
Answer 25: This sounds like it could be an excellent source of in situ data. In Canada, farmers are not required to do this registration. We mentioned that we are able to acquire crop insurance data for some provinces. However, there are strict rules and agreements between us and those provinces to use those data. In provinces where we cannot obtain this type of data, we do our field surveying ourselves.

Question 26: How do you ensure that your training set is representative of the study area? How can I determine the sampling density before even starting? Is there any known formula, ratio, expression, or tips in addition to being familiar with the region of interest (obviously I need to be a local expert in order to achieve acceptable accuracy)? Is the choice of sampling sites only related to the landscape heterogeneity level in terms of lithology, geographic formations, soil types, land cover/land use class, and so on? Thanks in advance!
Answer 26: We are not using any quantitative rules to determine our sampling density in Canada. In areas with lots of field diversity, we sample “as much as possible” along the driving routes. Samples should be well distributed across the mapped area. This will help collect data in areas that might experience micro-climatic differences (wet/drought, pest or disease infestation). Plus, as we saw in the first lesson from Dr. McNairn, sampling across the entire area of interest will help with near and far range issues with SAR data. We also focus more sampling in areas with rarer crop types. The more samples, the better for these crops as the Decision-tree will start to bias to the more common crop types given there is a more robust sampling of those crops.

Question 27: When applying the terrain correction, can you use a higher resolution DEM? What would be the effects?
Answer 27: You can use a higher resolution DEM to apply the terrain correction, but you would lose any additional benefits from this as you are limited by the pixel resolution of the original image. In fact, a higher resolution DEM could slow down the processing time as it is more detailed and likely a larger file size.

Question 28: If we want to automate this process, can all of this be done in Earth Engine? Or does it have to be a separate script in Python?
Answer 28: All these processes can be automated using Python (as SNAP has a version of Python (SNAP PY) and all these tasks can be called by python commands. Similarly, you can run all of this within SNAP using the batch processing options.

Question 29: Is there a suggested approach to subset before corrections to reduce computational time? Or a reason not to do it?
Answer 29: In order to subset your image to your known location it must be terrain corrected and projected.

Question 30: Why didn't you do the radiometric calibration?

Answer 30: It was completed during the terrain correction. Refer back once the video is posted. In SNAP, if applying a radiometric calibration that is more precise using the DEM, you would utilize the process within the Terrain Correction module. In some cases you may not wish to do this and subsequently you can apply this radiometric correction in SNAP using RADAR - Calibrate - to Sigma naught prior to your speckle filtering.

Question 31: So SAR images do not have to be corrected for atmospheric interference? Is atmospheric correction for optical images only (e.g., Sentinel-2)?
Answer 31: No atmospheric correction is needed for SAR data. This is only for optical data as they are passive systems looking at the energy reflected and emitted from the Earth. SAR satellites supply their own microwave energy source. Microwaves also have longer wavelengths than optical sensors and are not impacted by small atmospheric particles/water vapor, etc. Please review Part 1 for more on this.

Question 32: SEN2COR could be used to perform a terrain correction? or is it necessary to implement a routine analysis to do it?
Answer 32: See the question and answer to #1 above. Terrain corrected before download.

Question 33: For the slide showing the human resources in order to create the AAFC crop inventory by province, I didn't see any information on the Prairie Provinces. Is ground data for those areas provided entirely by the crop insurance companies?
Answer 33: Yes, crop insurance agencies provide crop information for the Prairies.

Question 34: Is there any disadvantage in doing thermal noise removal and radiometric calibration before terrain correction?
Answer 34: We haven’t seen any disadvantage or advantage to completing the Thermal Noise removal and it is currently not part of our processing chain. For the radiometric correction we have done some initial assessment and we have found that when using the wide swath S1 imagery it can be important to apply the radiometric normalization using the DEM and local incidence angle as the differences between values for the same class types (e.g., corn or wheat) on either side of the images can be significant.

Question 35: The Semi-Automatic Classification Plugin (v 7.9.7.1) for QGIS 3.x provides a toolkit to pre-process Sentinel-1 and Sentinel-2 imagery. Are those

tools built on the SNAPpy Python module? If not, what are the main differences between preprocessing in SNAP and with the Semi-Automatic Classification Plugin?
Answer 35: I would assume someone on the ESA forum would be familiar with this. I would post to the forum and see the reply.

Question 36: Using SNAP, how do we subset irregular shaped study areas? Can we use already prepared AOI like a shapefile or other (raster)?
Answer 36: You can pull your whole stack (S1) and subset using python. When I use SNAP I am using regular shaped polygons.

Question 37: How can I use the Mage app in my country? The app asks for a server URL.
Answer 37: For MAGE (open-source) you need to host your own server so that you can manage the MAGE database and software. MAGE link:
https://play.google.com/store/apps/details?id=mil.nga.giat.mage

Question 38: How does AAFC estimate the accuracy of the crop inventory maps?
Answer 38: Data that are being collected (by field work or from crop insurance agencies) are divided between training (70% of the data) and reference (30% of the data). That 30% is used to validate the maps.

Question 39: Crop insurance industry - I want to use Sentinel-1 data for different crops in the Indian region (small field). Please suggest how to do so.
Answer 39: The AAFC ACI provides a roadmap, but adaptation will be required for your site. If crop insurance data are not available, you will need to consider collecting in situ field observations to acquire training and validation data.

Question 40: Are you creating a new crop model each year or are you using the field data collected each year to increase the accuracy of the previous year's model? Do you also collect field data for crop yields (e.g., from farmer interviews) to ground truth your yield forecasts?
Answer 40: Yes, new models are created each year. Farmers answer surveys about their yield estimates to Statistics Canada (another Canadian government department). This is incorporated with other information such as current growth season weather

information, historical weather and yield data, plus other factors to estimate what the current yield is forecasted to be.

Question 41: How can we use Sentinel-1 data for soil moisture? Please go through the full methodology. How can one extract soil moisture using C-band (e.g., Sentinel-1 radar data)?
Answer 41: There are a number of modeling approaches (empirical, semi-empirical, and physical modeling). SNAP has a soil moisture toolkit that applies the IEM physical model, but this requires HH+VV to run the original IEM; or VV (or HH) using two different incidence angles to run the hybrid IEM. The IEM can be a challenge to apply to Sentinel-1, as typically imagery is not acquired in HH+VV (needed for original IEM) and using the hybrid IEM, there can be a time difference between the first and second Sentinel-1 image. A very promising method to retrieve soil moisture using Sentinel-1 backscatter change was just published, and has been tested over a number of sites. *Balenzano, A., Mattia, F., Satalino, G., Lovergine, F.P., Palmisano, D., Peng, J., Marzahn, P., Wegmüller, U., Cartus, O., Dabrowska-Zielińska, K., Musial, J.P., Davidson, M.W.J., Pauwels, V.R.N., Cosh, M.H., McNairn, H., Johnson, J.T., Walker, J.P., Yueh, S.H., Entekhabi, D., Kerr, Y.H., and Jackson, T.J. (2021). Sentinel-1 soil moisture at 1km resolution: a validation study, Remote Sensing of Environment, 263, doi: doi.org/10.1016/j.rse.2021.112554.*

Question 42: Can we change the file format while performing coregistration?
Answer 42: Yes. You can do this at any point that you are trying to save out SNAP.

Question 43: Please explain how to use polarimetric decomposition for crop classification techniques.
Answer 43: The AAFC ACI uses VV and VH backscatter. However, there is a significant amount of ongoing research by AAFC and by many other scientists to assess the use of polarimetric parameters for crop classification. In general, we see improved accuracy when integrating more polarimetric rich data layers, including decomposition layers. A polarimetric decomposition channel (like volume scattering) can simply be integrated into the Random Forest classifier (in the same way VV or VH backscatter layers are integrated).

Question 44: Can we use a hybrid classification (knn & kd classifier for different minor crop classifications)?

Answer 44: There are many methods to classify. Decision trees, AI, neural networks are more commonly used now and these are performing well.

Question 45: Is coregistering of S2 images the same with S1?
Answer 45: We will get into this in Part 4 of this series.

Question 46: For operational mapping purposes, is it important to consider either the ascending or descending pass of Sentinel-1 as well as incidence angles?
Answer 46: Please refer to answers 3 and 9.

Question 47: Can your in situ ground truth crop survey data be used for training and validation for different years?
Answer 47: Our current operational approach does not allow that for now. We treat every year as a new and unique classification, as the majority of farmers will rotate crops in each field annually.

Question 48: Does the order of speckle filtering in a pre-processing chain matter?
Answer 48 Typically there is no difference in classification accuracies regardless of whether noise reduction (speckle filtering) is applied before or after terrain correction. However, implementing the terrain correction as the first operation can result in a 10 to 50% increase in processing time. This is important to consider for operational systems, especially for large geographies.
Please refer to the following publication:
Dingle Roberston, L., Davidson, A., McNairn, H., Hosseini, M., Mitchell, S., de Abelleyra, D., Veron, S.R., and Cosh, M.H. (2020). Synthetic aperture radar (SAR) image processing for operational space-based agriculture mapping, International Journal of Remote Sensing, 41:7112-7144, doi: 10.1080/01431161.2020.1754494.

Question 49: Do you use PCA for reducing redundancy in the in-situ data, thereby reducing the sample size?
Answer 49: Yes. We are using it for S2 to reduce the number of bands that go in the classifier to avoid computer memory issues.

Question 50: How does one examine SAR issues such as foreshortening and layover issues before using the data in the mountains?
Answer 50: It is very difficult to remove the effects of foreshortening and layover. A good DEM will assist with geometric correction, but the SAR response is still distorted

in these landscapes. Ascending or Descending orbits may provide a different look at the terrain, and you can collect data in these different orbits to assess if this will help. Otherwise, as we covered in Part 1, you may have to mask out these terrains.

Question 51: How do you resolve ascending and descending integration due to backscatter differences due to their path?
Answer 51: By monitoring the agricultural land over a full growing season and using both ASC and DESC images, these differences are diluted and not of major concern to the AAFC crop classification system. This also emphasizes the importance of gathering field training data across the entire SAR swath from near to far range.

Question 52: Do you have any correction factor to deal with precipitation occurrence in SAR data (due to the dielectric constant effects in backscatter)?
Answer 52: No. If there is precipitation during SAR acquisitions, the microwaves are scattered by the rain droplets. As such, the SAR image is “washed out” in the sense that the differences in backscatter between fields is lost and scattering observed on the image is due to scattering by these droplets. As such, it is important to eliminate SAR data that are acquired during rain events. Twitter link that shows this: https://twitter.com/LeanderCampbell/status/1186643388352868353

Question 53: I get an error when I run 'Apply Orbit File'. It says: A problem occurred during the target production initialisation. Type: OperatorException Message: qc.sentinel1.eo.esa.int How do I resolve it? (*Several participants voiced the same error message*.)
Answer 53: The error is related to the default repository used by SNAP to automatically download the Sentinel-1 orbit data being changed. The orbits need to be downloaded manually from the STEP repository or the Copernicus Sentinels POD Data Hub (links below) and placed in the respective folders in /home/rus/.snap/auxdata/Orbits/ sorted by type, platform, year, and month. The orbits should be in individually-zipped archives - as can be downloaded from the STEP repository, if downloaded from the POD Hub they will have to be zipped.
STEP Repository - https://step.esa.int/auxdata/orbits/
Copernicus Sentinels POD Data Hub - https://scihub.copernicus.eu/gnss/#/home

Question 54: If the same crop was sown in two different dates, can the classification algorithm detect this or will the result be two different crops?

Answer 54: Spectrally the same crop will appear the same, they will just be at slightly different stages of development; and by monitoring over a full growing season this difference is negated. However, there is other ongoing research that exploits SAR scattering parameters to detect crop growth stages using, for example, machine learning algorithms.

Question 55: What is the difference between corregistration and geocoding? When combining radar and optical data do you stack the images? And if so, which one do you use as reference for spatial resolution?
Answer 55: Coregistration: Geometrically align a dataset with another dataset that is already georeferenced. Geocoding: Assigning georeference to a dataset. Optical and radar data are geocorrected to the same projection, resolution, and extent. For now, we are using the Landsat-8 resolution (30 m) for all datasets.

Question 56: Who are the users of the crop monitoring and classification results, and for what and how they are using it?
Answer 56: There are numerous end users of this data ranging from federal, provincial, and local governments for policy development. Private industry such as rail transportation and grain elevators. Disease and pest scientists (looking for fields that don't rotate crop types frequently). There are many others but this is just a quick sample. Use case scenarios link:
http://appliedsciences.nasa.gov/sites/default/files/2021-10/AAFC_Data_Use_Cases_For_ARSET.pdf

Question 57: Is it important to gather ground data at the same time S1/S2/L8 pass by the area?
Answer 57: This is not necessarily important, as the crops will remain in the field for numerous satellite passes when looking at crop identification mapping. In countries where multiple crops (double crops) are grown in a single growing season it would be necessary to capture both crop types grown in the field though.

Question 58: How do you deliver results, how often, in what format, etc.?
Answer 58: For now, data is distributed a few months following the end of the growing season. All provinces are distributed typically no later than February the following year. The format is Geotiff, 30 m resolution, and available by province (please see Open Canada.ca: Open Government | Open Government, Government of Canada).

Question 59: Can the Annual Crop Inventory (ACI) be applied to tropical countries? For example, in Indonesia the Department of Agriculture used the Standing Crop method using remote sensing imagery for rice field factual conditions on the ground. (http://scs1.litbang.pertanian.go.id/)
Answer 59: The AAFC ACI provides a good roadmap, and our team is testing this roadmap in other regions. For example, we ran an experiment to test these methods over different cropping systems at sites around the world. However, some adaptations will be required to apply this method to your cropping systems. The international results are in this paper: *Dingle Robertson, L., Davidson, A.M., McNairn, H., Hosseini, M., Mitchell, S., de Abelleyra, D., Verón, S., le Maire, G., Planells, M., Valero, S., Ahmadian, N., Coffin, A., Bosch, D., Cosh, M.H., Basso, B., and Saliendra, N. (2020). C-Band synthetic aperture radar (SAR) imagery for the classification of diverse cropping systems, International Journal of Remote Sensing, 41: 9628-9649, doi:10.1080/01431161.2020.1805136.*

Question 60: Could we use GEE to do the co-registration process for Sentinel-2? Or is there a similar method to do this?
Answer 60: This is a question for our colleagues from RUS who will be presenting in session 4.

Question 61: One of the early slides mentioned something about land cover data that is updated every 5 years. Is an independent land cover data product being used to mask the areas to be classified? Or is establishing a cropland mask part of the classification process and the data referenced used in some other way?
Answer 61: A random selection of training sites over already existing land cover (non-agr) maps is used to classify the agr extent using current year's imagery. Crop classification is then performed within what has been classified as 'agriculture'. So in a way it is like a crop land mask.

Question 62: What is the minimum number of samples we should take for a particular plot for model development? How does one decide?
Answer 62: Ideally, at least 50 samples per crop should be collected, but it is not always possible. Look for as many samples as you can, especially for rare crop types.

Question 63: Do you predict crop yield? Do you classify grassland vegetation?
Answer 63: Crop yields at AAFC are estimated in a joint project with Statistics Canada (the Crop Inventory is a small component of this). Grasslands are one of the land cover

classes that we map on an annual basis. Though it is difficult to differentiate with pastureland, rangeland, and some forage classes.

Question 64: I work in a data-scarce environment and was wondering how the crop signature for wheat could be applied to developing countries.
Answer 64: We have not tested whether a “generic” crop signature (like wheat) could be applied over time or space. This will likely be challenging, given that signatures change due to cultivars, seeding dates, meteorological conditions, etc. However, new AI methods are assessing the transferability of signatures, assuming that a robust training set can be developed.

Question 65: What vegetation indices and bands are used for crop classification?
Answer 65: Spectrally for optical imagery the visible and Infra-red bands (L8: bands 2,3,4,5,6,7; S2: we try to match similar bands 2,3,4,5,8A,11,12) are used, while the SAR data provides information in the microwave portion of the electromagnetic spectrum. L-band data (once NISAR is launched) could be used.

Question 66: Can we use GEE for pre-processing S1? Or which did you use today in the tutorial?
Answer 66: Sentinel-1 data on GEE has already been pre-processed (except for speckle filtering).
https://developers.google.com/earth-engine/guides/sentinel1

Question 67: How do you account for the changes in backscatter in the near and far range when using ascending and descending images together? How much difference in backscatter can be expected between ascending and descending pass?
Answer 67: The Annual Crop Inventory deals with this by using images with overlapping footprints, so that the far range in one SAR scene will be the near range in another scene in both DSC and ASC orbits. This stacking of SAR images helps negate this issue over the entire Area of Interest. Also remember to try to collect training data across the SAR swath (near to far range).

Question 68: Is co-registering in SNAP equivalent to Mosaicking in Google Earth Engine?
Answer 68: It is not. In general co-registering and mosaicking are two different things. Mosaicking is stitching together images to create one mosaic. Co-registering is

matching a set of images (e.g. a stack) to each other so that in the end all the images in your stack have the same georeference frame.

Question 69: Do you measure spectral distance between crop type (something like Jeffries Matusita) and then use it for determining the time interval on the basis of which we create a mosaic?
Answer 69: No, we do not. We have done an initial assessment of some of the signatures.