

```
<arcgis-map zoom="4" center="-118,34">  
  <arcgis-search position="top-right" />  
</arcgis-map>
```

Creating Geoprocessing Tools

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2024 ESRI DEVELOPER SUMMIT

```
<arcgis-map zoom="4" center="-118,34" />  
view.goTo({  
  center: [-126, 49]  
})  
.catch(function(error) {  
  if (error.name !== "AbortError") {  
    console.error(error);  
  }  
});
```

Creating Geoprocessing Tools



Geoprocessing tools provide an integrated and familiar experience for analysts to perform data management and spatial analysis in ArcGIS. By creating a geoprocessing tool, others can reuse your methods and workflows with their own data without requiring them to learn or use code. This session will show you how to create and design geoprocessing tools, choose appropriate parameters, write custom validation routines to fine-tune the user experience, and author help so the tool can be used correctly by others. Approaches for debugging, error handling and messaging will also be covered.

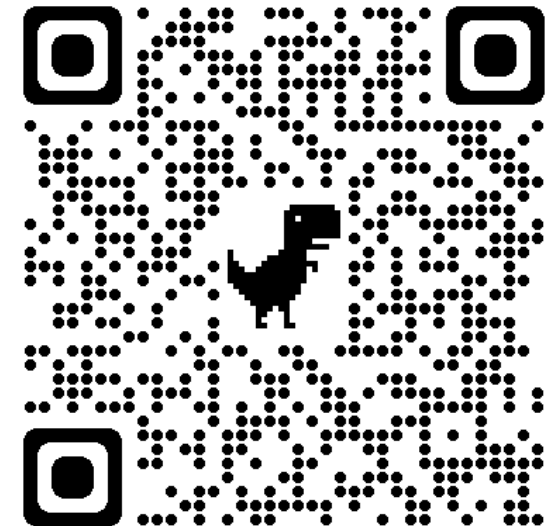
Session Type: Technical Session

Access Type: In-Person, Recorded, Live stream

Topic: Spatial Analysis and Data Science

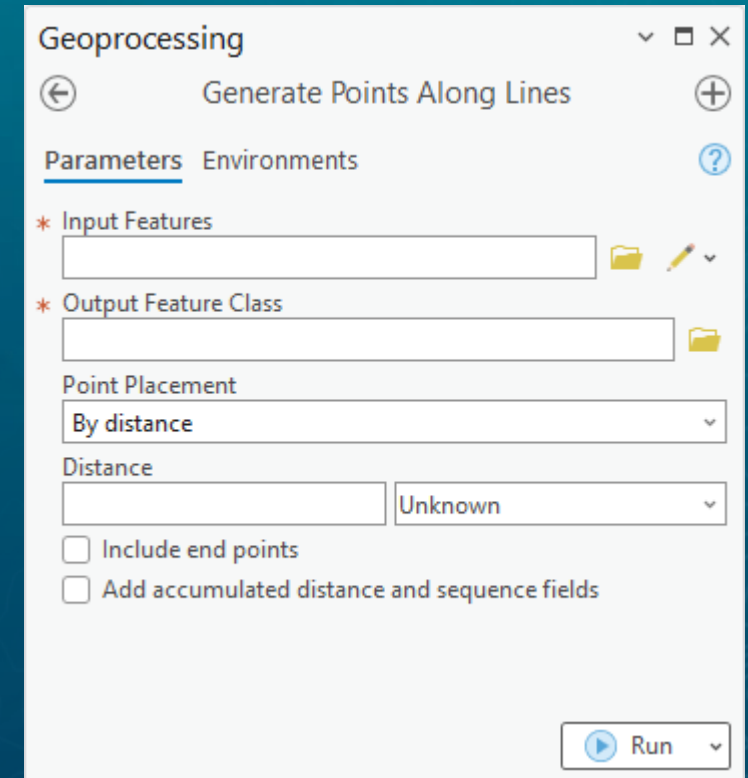
Session Level: Beginner

<https://github.com/dWynne1/ds2024-creating-gp-tools>



Why we build tools

- Extend Pro
- Organize functionality
- Take advantage of Pro's geoprocessing framework
- Multiple ways to use a tool
 - Geoprocessing pane
 - Python
 - ArcGIS Pro SDK (.NET)
 - ModelBuilder
 - Share as a geoprocessing service



Tool structure

- Parameters
- Validation code
- Source code

The screenshot displays the 'Tool Properties: Generate Points Along Lines' dialog box. The 'Parameters' tab is selected, showing a table with columns: Label, Name, Data Type, Type, Direction, Category, and Filter. Below this, the 'Validation' tab is active, showing Python code for a class `ToolValidator`. The code includes parameter retrieval, validation logic for percentage and distance, and a try-except block for adding a spatial index.

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```

```
import arcpy

class ToolValidator(object):
    """Class for validation tool parameters"""

    if __name__ == '__main__':
        in_features = arcpy.GetParameterAsText(0) # String
        out_fc = arcpy.GetParameterAsText(1) # String
        use_percent = point_placement[arcpy.GetParameter(2)] # Str -> Bool
        end_points = arcpy.GetParameter(5) # Boolean
        chainage = arcpy.GetParameter(6) # Boolean

        describe = arcpy.Describe(in_features)
        spatial_info = namedtuple('spatial_info', 'spatialReference extent')
        sp_info = spatial_info(spatialReference=describe.spatialReference,
                               extent=describe.extent)

        if use_percent:
            percentage = arcpy.GetParameter(4) / 100 # Float
            create_points_from_lines(in_features, out_fc, sp_info.spatialReference,
                                     percent=percentage, add_end_points=end_points,
                                     add_chainage=chainage)
        else:
            distance = arcpy.GetParameterAsText(3) # String
            distance, param_linear_units = get_distance_and_units(distance)
            distance = convert_units(distance, param_linear_units,
                                     sp_info)

            create_points_from_lines(in_features, out_fc, sp_info.spatialReference,
                                     dist=distance, add_end_points=end_points,
                                     add_chainage=chainage)

    try:
        arcpy.management.AddSpatialIndex(out_fc)
    except arcpy.ExecuteError:
        pass
```

Toolboxes

- Tools are organized in a toolbox
- We can build Python-based tools in two ways:
- Script tools – ArcGIS toolbox (.atbx) or Legacy toolbox (.tbx)
 - Parameters defined through the Pro UI
 - Validation is Python code
 - Source is Python code

Toolboxes

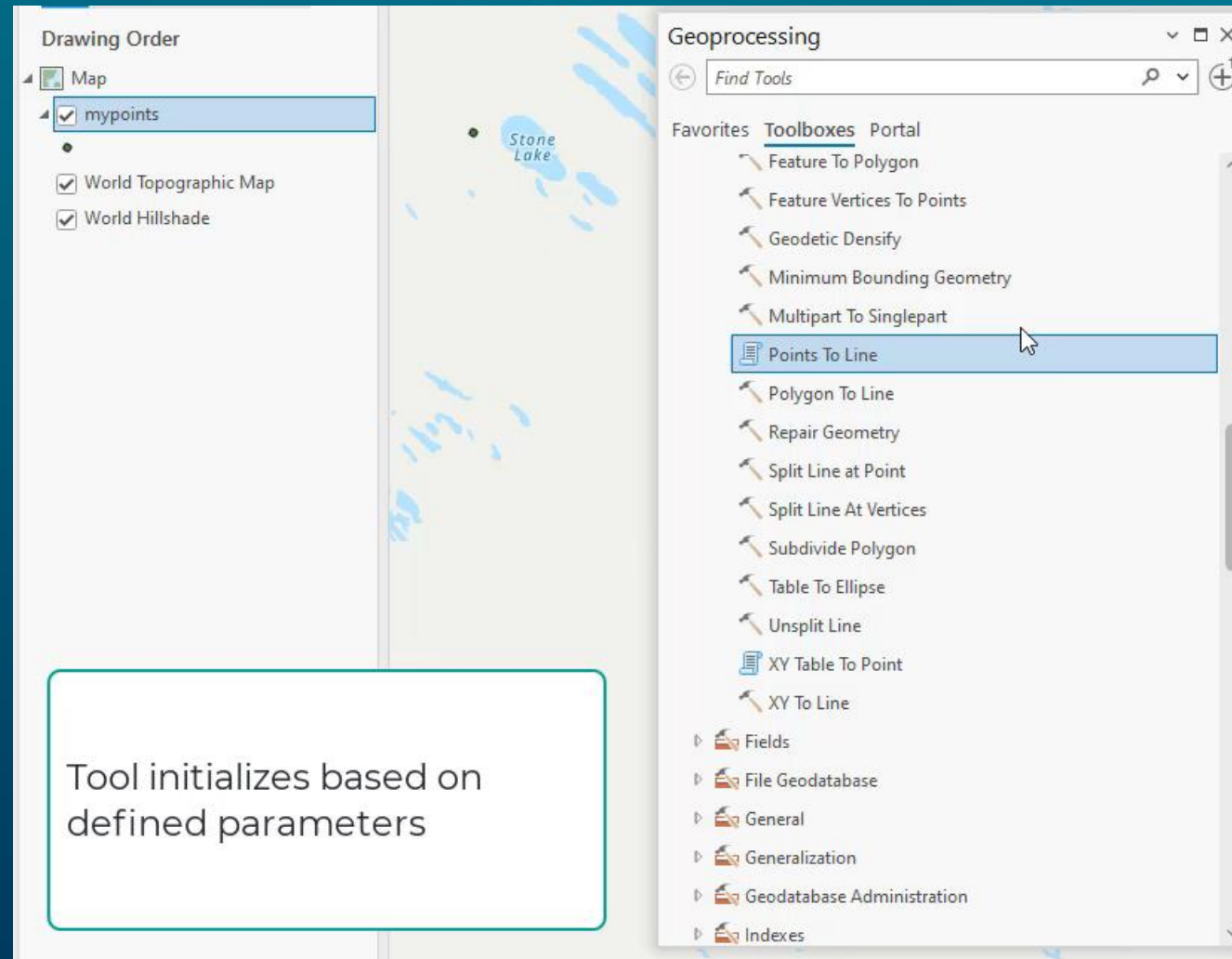
- Tools are organized in a toolbox
- We can build Python-based tools in two ways:
- Python toolbox (.pyt)
 - Parameters are Python code
 - Validation is Python code
 - Source is Python code

```
1 import arcpy
2
3
4 class Toolbox(object):
5     def __init__(self):
6         self.label = "Sinuosity toolbox"
7         self.alias = "sinuosity"
8
9         # List of tool classes associated with this toolbox
10        self.tools = [CalculateSinuosity]
11
12
13 class CalculateSinuosity(object):
14     def __init__(self):
15         self.label = "Calculate Sinuosity"
16         self.description = "Sinuosity measures the amount that a river " + \
17                             "meanders within its valley, calculated by " + \
18                             "dividing total stream length by valley length."
19
20     def getParameterInfo(self):
21         #Define parameter definitions
22
23         # Input Features parameter
24         in_features = arcpy.Parameter(
25             displayName="Input Features",
26             name="in_features",
27             datatype="GPFeatureLayer",
28             parameterType="Required",
29             direction="Input")
30
31         in_features.filter.list = ["Polyline"]
32
33         # Sinuosity Field parameter
34         sinuosity_field = arcpy.Parameter(
35             displayName="Sinuosity Field",
36             name="sinuosity_field",
37             datatype="Field",
38             parameterType="Optional",
39             direction="Input")
40
41
```

ArcGIS toolbox format (.atbx)

- JSON-based format with an open specification
- Stores tools, scripts, and models
- Introduced at Pro 2.9
- Same look and feel as the traditional Legacy toolbox (.tbx) format
- Better cross-release compatibility and persistence

How a tool works



Parameters

- Parameters are how you interact with a tool
- Parameters provide simple rules
 - Does an input exist?
 - Is the input the right type?
 - Is this value an expected keyword?

The screenshot shows the 'Generate Points Along Lines' tool parameters dialog. It has a title bar 'Geoprocessing' and a subtitle 'Generate Points Along Lines'. There are two tabs: 'Parameters' (selected) and 'Environments'. The 'Parameters' tab contains the following fields:

- * Input Features**: A text box with a folder icon and a dropdown arrow.
- * Output Feature Class**: A text box with a folder icon.
- Point Placement**: A dropdown menu with 'By distance' selected.
- Distance**: A text box and a dropdown menu with 'Unknown' selected.
- ☐ Include end points
- ☐ Add accumulated distance and sequence fields

At the bottom right, there is a 'Run' button with a play icon and a dropdown arrow.

Define the script tool parameters											
	Label	Name	Data Type	Type	Direction	Category	Filter	Dependency	Default	Environment	Symbology
0	Input Feat...	Input_Features	Feature La...	Required	Input		Feature Type				
1	Output Fe...	Output_Feature_Class	Feature Cl...	Required	Output			Input_Feat...			
2	Point Plac...	Point_Placement	String	Required	Input		Value List		DISTANCE		

```

    queryParameters =
    queryParameters().apply {
        filter = "price > .200"
    }
    viewModelScope.launch {

```

	Label	Name	Data Type	Type	Direction	Category	Filter
0	Input Features	in_features	Feature La...	Required	Input		
1	Output Rotated Features	out_rotated_features	Feature Cl...	Required	Output		
2	Rotation Angle	rotation_angle	Double	Required	Input		
3	Feature Set or Point	feature_set_or_point	String	Optional	Input		Value List
4	Rotate Feature Set	rotate_feature_set	Feature Set	Optional	Input		Feature Type
5	Rotate Point	rotate_point	Point	Optional	Input		
*			String	Required	Input		

Parameters

Accessing parameters in the code

- To access parameter values from arcpy, use:
 - `GetParameterAsText` – Value returned as a string
 - `GetParameter` – Value returned as a Python or ArcPy type (best for Boolean and numeric types)
- Use these functions with a 0-based index number:
 - `arcpy.GetParameterAsText(6)`
- Or starting at 3.2, you can also use a parameter name:
 - `arcpy.GetParameterAsText("dissolve_field")`

Communication within the tool (messages)

- Relay information using arcpy message functions
 - AddMessage
 - AddWarning
 - AddError
 - AddIDMessage – Supports Esri ID codes
- Note: Error messages are only messages, they will not end the script
 - Best to exit your code soon after, such as Python's `sys.exit()`

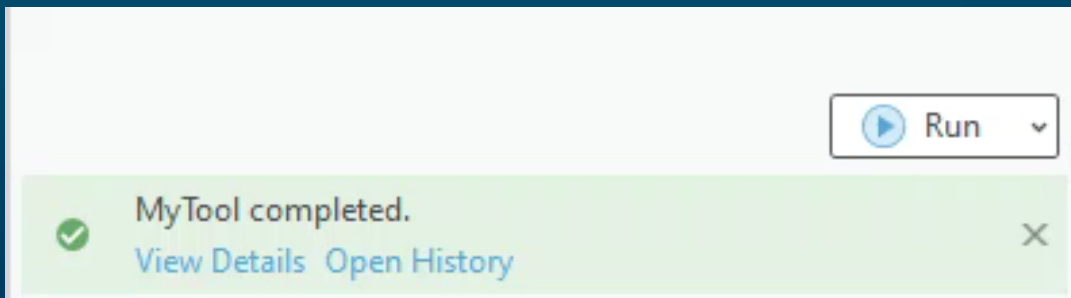

```
queryParameters =  
queryParameters().apply {  
    queryParameters["id"] = "price > 200"  
}  
viewModelScope.launch {
```

```
1 if __name__ == '__main__':  
2  
3     in_features = arcpy.GetParameterAsText(0)  
4     out_features = arcpy.GetParameterAsText(1)  
5     angle = radians(arcpy.GetParameter(2))  
6     option = arcpy.GetParameterAsText(3)  
7     feature_set = arcpy.GetParameter(4)  
8     point = arcpy.GetParameterAsText(5)  
9  
10    create_feature_class(in_features, out_features)  
11  
12    if option == 'POINT':  
13        # Create a geometry from the x,y-coordinates  
14        rotation_point = [float(i) for i in point.split(' ')]  
15  
16    elif option == 'FEATURESET':  
17        # Extract the point from the feature set  
18        with arcpy.da.SearchCursor(feature_set, 'SHAPE@XY') as cursor:  
19            for row in cursor:  
20                rotation_point = row[0]  
21                # Use the first point, skip any others  
22                break  
23
```

Tool source code

Communication within the tool (progressor)

- Relay simple information to the Geoprocessing pane
- Can provide messages and step increments
 - SetProgressor
 - SetProgressorPosition
 - SetProgressorLabel
 - ResetProgressor



```
5 feature_count = int(arcpy.management.GetCount(in_features)[0])
6
7 # Set up the progressor to update every 5% of the features
8 if feature_count > 20:
9
10     arcpy.SetProgressor(
11         type="STEP",
12         message="Processing features ... ",
13         min_range=0,
14         max_range=100,
15         step_value=5)
16
17     step = feature_count // 20
18
19 for i in range(1, feature_count + 1):
20
21     # Your data processing goes here
22
23
24 if feature_count > 20:
25     if i % step == 0:
26         # Update the progressor message
27         arcpy.SetProgressorLabel(
28             "Processing feature {0}...".format(i))
29
30         # Update the progressor position
31         arcpy.SetProgressorPosition()
```

Parameter validation

- Parameters provide some simple 'free' validation
- Refine your tool's behavior with additional validation
 - Parameter interaction
 - Calculate defaults
 - Enable or disable parameters
 - Set parameter errors and messages
 - Define characteristics of your output (for ModelBuilder)
- Validation runs every time a parameter is modified

```
class ToolValidator:
    """
    Class to add custom behavior and properties to
    the tool and tool parameters.
    """

    ...

    def updateParameters(self):
        """Modify parameter values and properties."""

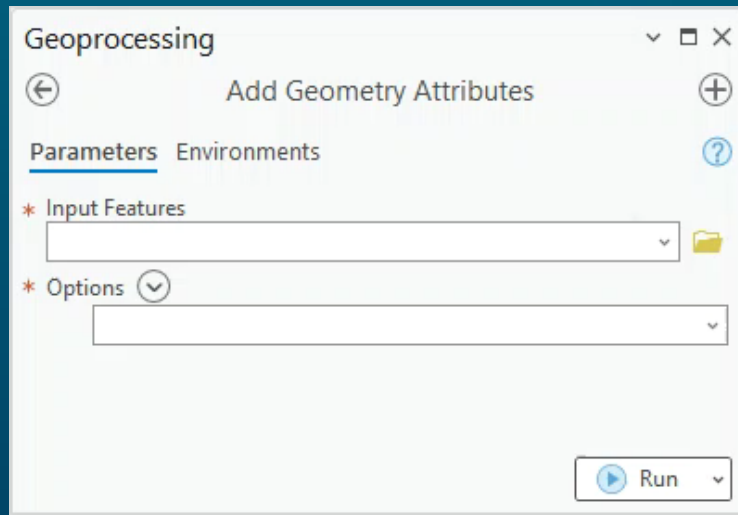
        return

    def updateMessages(self):
        """Customize messages for the parameters."""

        return
```


Validation – updateParameters

- updateParameters allows you to change specific parameter characteristics
 - Including values, filters, enabled, etc.

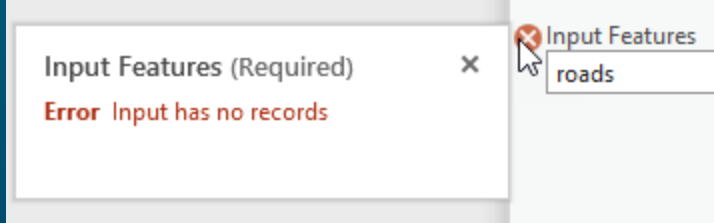


```
def updateParameters(self):  
    """Modify parameter values and properties."""  
  
    in_features = self.params[0].value  
    if in_features:  
        shape_type = arcpy.Describe(in_features).shapeType  
        if shape_type == 'Polygon':  
            self.params[1].filter.list = ['AREA', 'LENGTH', 'CENTROID']  
  
        elif shape_type == 'Polyline':  
            self.params[1].filter.list = ['LENGTH', 'CENTROID']  
  
        else:  
            self.params[1].filter.list = ['CENTROID']  
    else:  
        self.params[1].filter.list = ['AREA', 'LENGTH', 'CENTROID']  
  
    return
```

- Parameters in validation are accessed by a 0-based index.
- Or starting at 3.2 for script tools, the parameter name

Validation – updateMessages

- updateMessages allows you provide warnings or errors before running the tool
- Provides information in Geoprocessing pane in real time



```
def updateMessages(self):  
    """Customize messages for the parameters."""  
  
    in_features = self.params[0].value  
  
    if in_features:  
        selection = arcpy.Describe(in_features).FIDSet  
  
        if not selection:  
            self.params[0].setErrorMessage('Input has no selection')  
  
    return
```

- Note: only use message methods in updateMessages

```
    queryParameters =  
    queryParameters().apply {  
        filter { it.name == "price" && it.value == "price > 200"  
    }  
    viewModelScope.launch {
```

```
1 class ToolValidator:  
2     """Class to add custom behavior and properties to the tool and tool parameters."""  
3  
4     def __init__(self):  
5         """Set self.params for use in other functions"""  
6         self.params = arcpy.GetParameterInfo()  
7  
8     def initializeParameters(self):  
9         """Customize parameter properties.  
10        This gets called when the tool is opened."""  
11  
12        return  
13  
14     def updateParameters(self):  
15         """Modify parameter values and properties.  
16        This gets called each time a parameter is modified, before  
17        standard validation."""  
18  
19         if self.params[3].valueAsText == 'POINT':  
20             self.params[4].enabled = False  
21             self.params[4].value = None  
22  
23             self.params[5].enabled = True
```

Validation (and metadata)

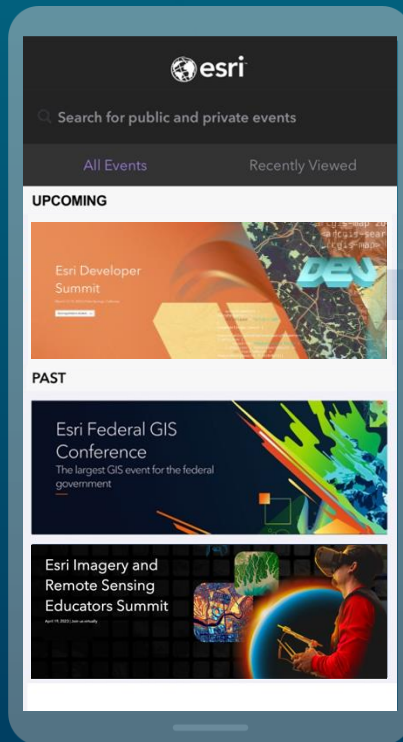
Symbology

- Use a layer file to set a parameter's symbology property
- Or, use the postExecute validation method (*new at 3.0*)
 - Runs when a tool completes
 - Use the arcpy.mp module

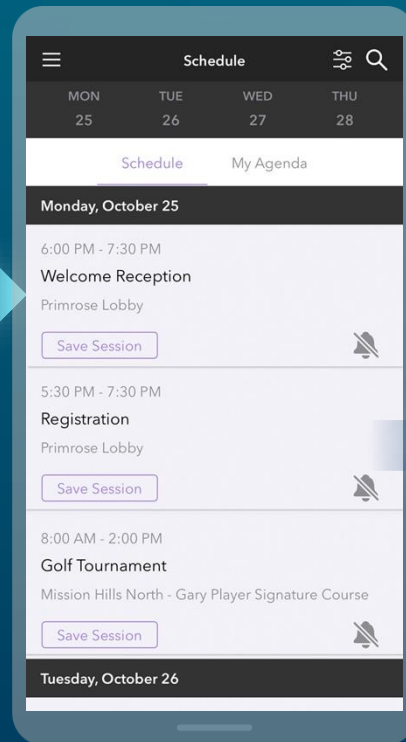
```
def postExecute(self):  
    """This method takes place after outputs are processed and added to the display."""  
  
    try:  
        project = arcpy.mp.ArcGISProject('CURRENT')  
        active_map = project.activeMap  
  
        if active_map:  
            out_layer = active_map.listLayers(os.path.basename(self.params[0].valueAsText))[0]  
  
            symbology = out_layer.symbology  
            symbology.updateRenderer('SimpleRenderer')  
            symbology.renderer.symbol.applySymbolFromGallery('Airport')  
            symbology.renderer.symbol.size = 12  
            out_layer.symbology = symbology  
  
    except Exception:  
        pass  
  
    return
```


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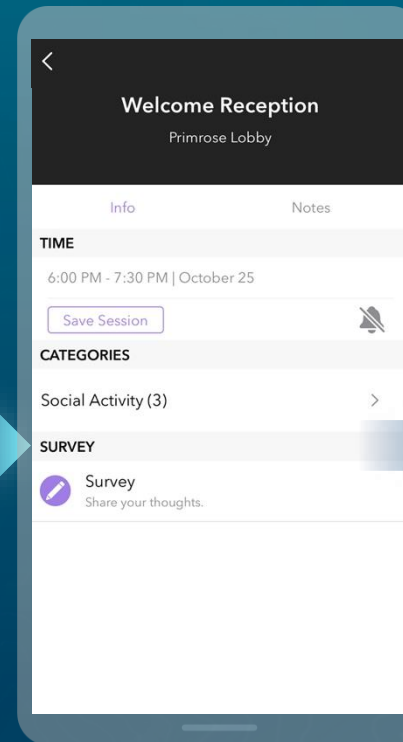
Download the Esri Events app and find your event



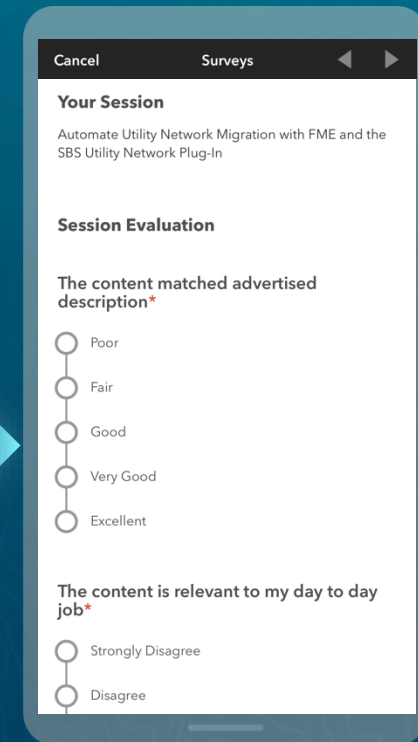
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view.goTo({  
  center: [-126, 49]  
})  
.catch(function(error) {  
  if (error.name !== "AbortError") {  
    console.error(error);  
  }  
});  
  
<arcgis-map zoom="4" center="118,34" />
```

```
// show the compass and pass the  
mapRotation state data  
Compass(rotation = mapRotation) {  
  // reset the ComposableMap viewpoint  
  rotation to point north using the  
  mapViewModel  
  mapViewModel.setViewpointRotation(0.0)  
}
```



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```
const layerList = new LayerList({  
  view: view  
});  
  
// Add widget to the top right corner  
of the view  
view.ui.add(layerList, "top-right")
```

```
<arcgis-map zoom="4" center="-118,34">
```