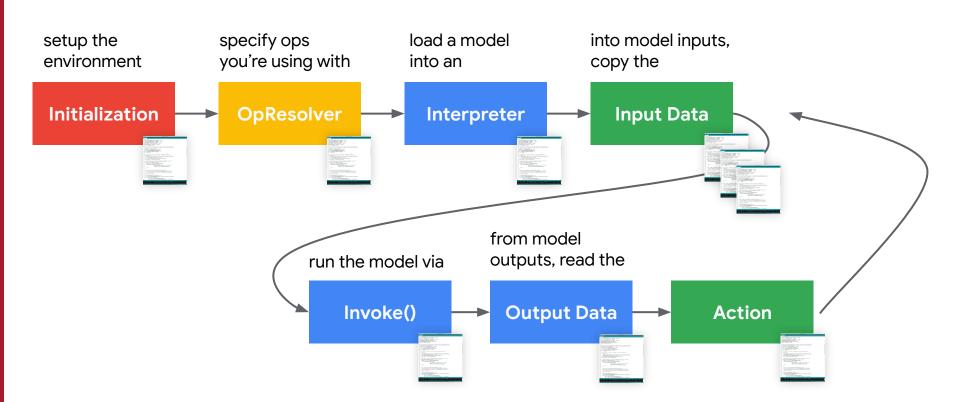
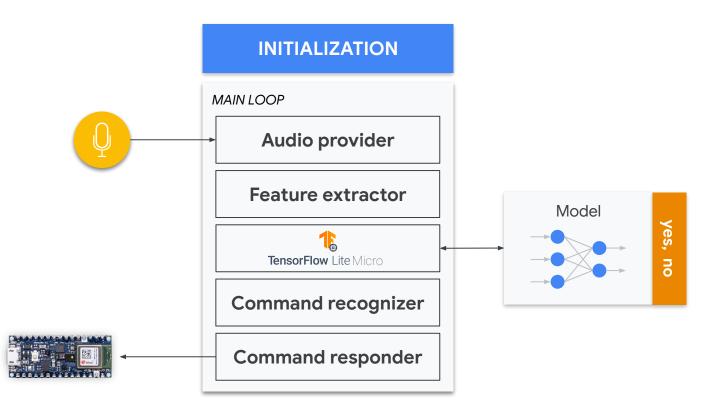
## KWS Summary

## Dealing with the complexity

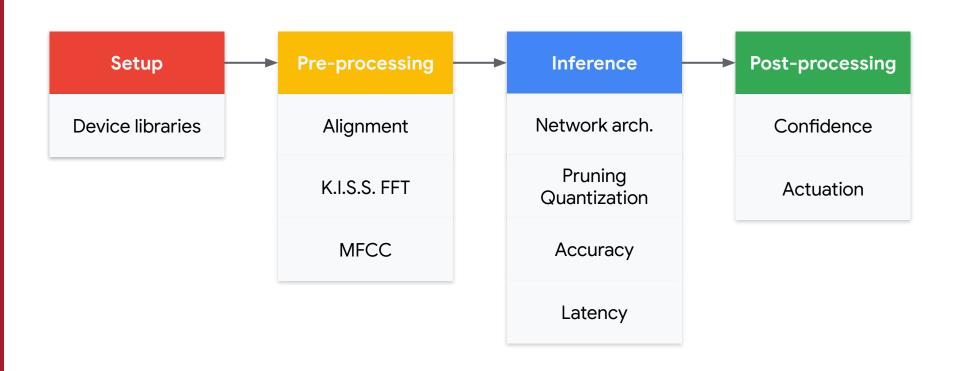
micro speech | Arduino 1.8.13 command responder.h Ø 0 1 1 1 1 micro\_speech 34 namespace { 3 Licensed under the Apache License, Version 2.0 (the "License"): 35 tflite::ErrorReporter\* error\_reporter = nullptr; . . 4 you may not use this file except in compliance with the License. 36 const tflite::Model\* model = nullptr; 5 You may obtain a copy of the License at . . 37 tflite::MicroI • • • micro\_speech - arduine micro\_speech - recognize\_commands.cpp | Arduino 1.8.13 **00 BES** http://www.apache.or 68 } 39 FeatureProvide arduino\_audio\_provider.cpp 69 40 RecognizeComma 53 9 Unless required by appl 70 TfLiteStat 15 41 int32\_t previo 54 void CaptureSamples() { ••• 10 distributed under the L 18 #include "audio\_provider 16 #include "recognize\_commands.h" 11 WITHOUT WARRANTIES OR CO 19 #include "micro\_features 72 43 // Create an a 56 const int number\_of\_se 20 #include "micro\_features 12 See the License for the 73 18 #include <limits> 44 // The size of // Calculate what time 13 limitations under the L 21 74 const const int32\_t time\_in 1/\* Copyright 2019 The 45 // determined 22 FeatureProvider::Feature 75 if (g\_is 20 RecognizeCommands::RecognizeCommands(tflite::ErrorReporter\* error\_reporter, g\_latest\_audio\_tim 46 constexpr int : feature\_size\_(feat fronte int32\_t average\_window\_duration\_ms, (number\_of\_samples 3 Licensed under the Ap 16 // Provides an interface 47 uint8\_t tensor feature\_data\_(feat 22 77 uint8\_t detection\_threshold, // Determine the index g\_is\_f 4 you may not use this 48 int8\_t feature 25 is\_first\_run\_(true 78 int32\_t suppression\_ms, const int32\_t start\_sa 5 You may obtain a copy else } 49 int8\_t\* model\_ 26 18 #ifndef TENSORFLOW\_LITE\_ // Initialize the feat 24 int32\_t minimum\_count) g\_latest\_audio\_tim 79 fronte 50 } // namespac 19 #define TENSORFLOW\_LITE\_ 27 for (int n = 0; n < f// Determine the index 80 25 : error\_reporter\_(error\_reporter). 51 http://www.apache 28 feature\_data\_[n] = ! 65 const int capture\_inde 81 26 average\_window\_duration\_ms\_(average\_window\_duration\_ms), Frontend 52 // The name of 29 } 21 #include "tensorflow/lit // Read the data to th 82 27 detection\_threshold\_(detection\_threshold), 9 Unless required by ap 22 #include "tensorflow/lit 53 void setup() PDM. read(q\_audio\_captu 30 } 83 28 suppression\_ms\_(suppression\_ms), 10 distributed under the 54 // Set up lo // This is how we let 29 minimum\_count\_(minimum\_count), g\_latest\_audio\_timesta 11 WITHOUT WARRANTIES OR 84 for (int 24 // Called every time the // lifetime 32 FeatureProvider::~Featur 30 previous\_results\_(error\_reporter) { 12 See the License for // NOLINTNEX 70 } 25 // human-readable name o 33 31 previous\_top\_label\_ = "silence"; // tra 57 static tflit 71 13 limitations under the 26 // argument, `score` has 34 TfLiteStatus FeatureProv 32 previous\_top\_label\_time\_ = std::numeric\_limits<int32\_t>::min(); // The 72 TfLiteStatus InitAudioRe 14 = 58 error report 35 27 // if the previous comma tflite::ErrorReporte 33 } 73 // Hook up the callbac 15 59 28 void RespondToCommand(tf 36 int32\_t time\_in\_ms, 34 89 // flo 74 PDM.onReceive(Capture 16 #if defined(ARDUINO) // Map the 37 if (feature\_size\_ != 90 35 TfLiteStatus RecognizeCommands::ProcessLatestResults( 75 // Start listening for 17 #define ARDUINO\_EXCLU // for 61 // copying TF\_LITE\_REPORT\_ERROR 76 PDM.begin(1, kAudioSam 18 #endif // defined(AR 91 36 const TfLiteTensor\* latest\_results, const int32\_t current\_time\_ms, // gen model = tfli 39 const char\*\* found\_command, uint8\_t\* score, bool\* is\_new\_command) { 77 PDM.setGain(20); 92 // The 63 if (model->\ 32 #endif // TENSORFLOW\_LI 78 // Block until we have 93 if ((latest\_results->dims->size != 2) || 20 #ifndef ARDUINO\_EXCLU // med 64 TF\_LITE\_RE 79 while (!g\_latest\_audic 21 41 return kTfLiteError: 94 39 // sic (latest\_results->dims->data[0] != 1) || 65 42 80 40 95 (latest\_results->dims->data[1] != kCategoryCount)) { 22 #include "command\_res // All 66 43 81 41 TF\_LITE\_REPORT\_ERROR( // out 67 82 return kTfLite0k; // Ouantize the time // inp 42 error\_reporter\_, 24 #include "Arduino.h" 68 return; 83 } // figure out which at 98 43 // To "The results for recognition should contain %d elements, but there are " 69 const int last\_step // inp 44 "%d in an %d-dimensional shape". 85 TfLiteStatus GetAudioSam 26 // Toggles the builtconst int current\_ster 45 conste kCategoryCount, latest\_results->dims->data[1]. 27// on which word was // Pull in o 46 latest\_results->dims->size): conste 28 void RespondToCommand 72 // This reli 49 int slices\_needed = c 47 102 return kTfLiteError: int32 // Set everything up t 29 // An easier // If this is the firs 103 48 89 if (!g\_is\_audio\_initic 30 // incur som 51 if (is\_first\_run\_) { TfLiteStatus init\_st 31 49 104 75 // needed by static bool is\_init TfLiteStatus init\_st if (init\_status != k 32 91 value if (latest\_results->type != kTfLiteInt8) { if (!is\_initialized 76 // 53 if (init\_status != return init\_status 33 51 if (vo TF\_LITE\_REPORT\_ERROR( pinMode(LED\_BUILT 77 // tflite::/ 54 return init\_status 52 error\_reporter\_. valu // Pins for the b // NOLINTNEX 55 g\_is\_audio\_initializ 53 "The results for recognition should be int8 elements, but are %d", 108 pinMode(LEDR, OUT 79 static tflit 95 is\_first\_run\_ = fal 54 latest\_results->type); if (va if (micro\_op pinMode(LEDG, OUT 57 96 // This next part show slices\_needed = kFec 55 return kTfLiteError; valu pinMode(LEDB, OUT 81 tfli 58 // latest audio sample 56 82 tfli // in the capture ring 38 // Ensure the LED 59 if (slices\_needed > kl 57 output Invalid library found in /l // overwrite the data 39 // Note: The RGB 60 slices\_needed = kFed 58 113 if ((!previous\_results\_.empty()) && // often enough and th 40 // Sense are on w 61 Invalid library found in /U 59 (current\_time\_ms < previous\_results\_.front().time\_)) { 101 // before that happens 41 digitalWrite(LEDR Invalid library fo 62 \*how\_many\_new\_slices 60 115 TF\_LITE\_REPORT\_ERROR( return Invalid library fo digitalWrite(LEDG 61 116 } error\_reporter\_, digitalWrite(LEDB const int slices to ke Invalid library found in /Us 62 "Results must be fed in increasing time order, but received a " is\_initialized = const int slices\_to\_dr Save Canceled. 63 "timestamp of %d that was earlier than the previous one of %d". Invalid library found in /Us 45



### Keyword Spotting Components

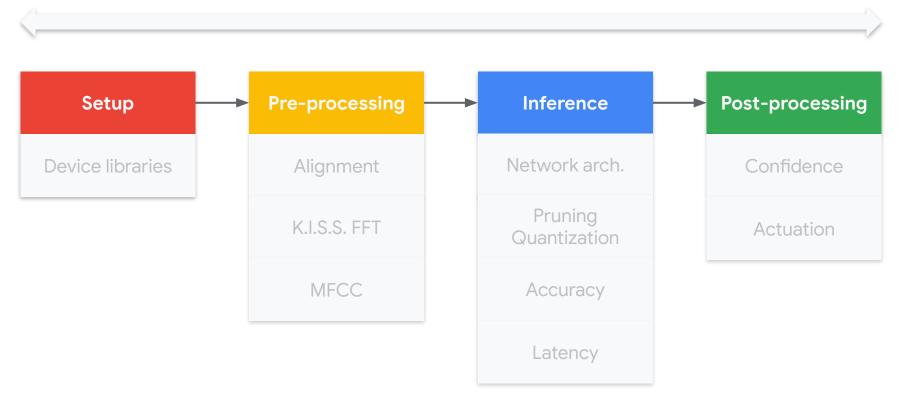


### Identify what you need to modify, and focus on that part.



# End-to-end application design

#### End-to-end application design



### **Post-processing**

Inference

**Pre-processing** 

Setup



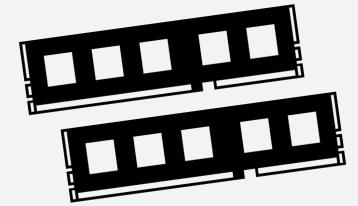


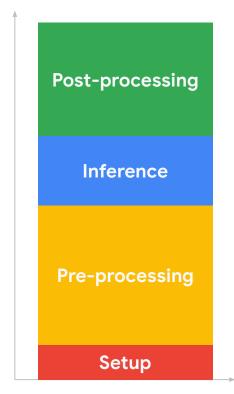
### **Post-processing**

Inference

Pre-processing

Setup





Memory Usage (kiloBytes)

