**Documentation - GLOW MetaWareNN Backend**

**Purpose:**

The purpose of this document is to give an overview of MetaWareNN Backend implementation and to explain workflow from the GLOW framework.

**Overview:**

Machine Learning models are being loaded using the ML frameworks. The execution of the models is happening in the host environment (x86 / ARM platform). In order to enable graph execution in other platforms/devices, these ML frameworks added specific implementations to convert ML models to graph Intermediate Representation (IR) and then use the IR to execute the graph in expected devices(DSP, etc).

In GLOW, many backends like Habana, NNPI, OpenCL, etc have unique implementations for each of the mentioned backends to convert the ONNX/Caffe model to Backend specific IR which is in the form of a compiled function. Similarly, to execute the graph in Synopsys hardwares, we have added MetaWareNN Backend in GLOW framework to generate MetaWareNN IR.

GLOW loads ONNX and Caffe models and converts them into GLOW Function and being passed onto the backends.

**GLOW - MetaWareNN Repository:**

* Forked [GLOW](https://github.com/pytorch/glow.git) repository from commit id [916b8914e0585c220b6186a241db0845c8eff5a9](https://github.com/SowmyaDhanapal/glow/commit/916b8914e0585c220b6186a241db0845c8eff5a9) created a [metawarenn\_dev](https://github.com/SowmyaDhanapal/glow/tree/metawarenn_dev) branch to incorporate MetaWareNN Backend related code changes.
* Applied build file changes to add MetaWareNN Backend in GLOW build files.
* Added code changes to generate high level MetaWareNN Graph, apply graph transformations(passes) & generate low level MetaWareNN Graph
* **In Default flow**, Converted the low level MetaWareNN Graph to the MetaWareNN Executable Graph and serialized it to a binary file
* **In Invoke NNAC flow**, Generated a MetaWareNN Graph proto from the low level MetaWareNN Graph and serialized it to a binary file. EVConvert python module which is integrated in MetaWareNN library will generate a Caffe prototxt & Caffemodel from MetaWareNN binary proto file, and finally evgencnn executable will generate a EV binary by taking the Caffe files

**Trigger MetaWareNN Backend:**

* [Register](https://github.com/pytorch/glow/blob/76aeb5c7a1b0437f7a093997fcf37a160fa2a12c/lib/Backends/MetaWareNN/MetaWareNNFactory.cpp#L5) the MetaWareNN backend to the GLOW backend factory
* Run inference with image classifier executable with ***backend set as MetaWareNN*** to invoke the backend specific implementations and graph format conversion to low level IR.

**Build subgraph from GLOW Function and its execution:**

[MetawareNN.cpp](https://github.com/SowmyaDhanapal/glow/blob/metawarenn_dev/lib/Backends/MetaWareNN/MetaWareNN.cpp) - Base file for MetaWareNN Backend which lists the MetaWareNN supported nodes from the GLOW Function and creates subgraphs for each supported set of nodes

[MetaWareNNDeviceManager.cpp](https://github.com/SowmyaDhanapal/glow/blob/metawarenn_dev/lib/Backends/MetaWareNN/MetaWareNNDeviceManager.cpp) - One of the top level files which adds the list of subgraphs(GLOW Functions) to be [stored](https://github.com/SowmyaDhanapal/glow/blob/3809847c1db40641ac7a8226ccefee2e3aebdbb1/lib/Backends/MetaWareNN/MetaWareNNDeviceManager.cpp#L48) and initiates subgraph inference through [runFunction](https://github.com/SowmyaDhanapal/glow/blob/3809847c1db40641ac7a8226ccefee2e3aebdbb1/lib/Backends/MetaWareNN/MetaWareNNDeviceManager.cpp#L22) function

[MetaWareNNFunction.cpp](https://github.com/SowmyaDhanapal/glow/blob/metawarenn_dev/lib/Backends/MetaWareNN/MetaWareNNFunction.cpp) - Creates MetaWareNN High Level Graph structure from GLOW function and applies basic passes to get a Low Level MetaWareNN graph.

If Invoke NNAC is enabled, serialize it to a binary file using MetaWareNN GraphProto and invokes nnac python script which takes the MetaWareNN serialized binary and invokes [EVConvert](https://github.com/SowmyaDhanapal/metawarenn_lib/tree/metawarenn_dev/mwnnconvert/evconvert) python module to generate Caffemodel and Caffe Prototxt which is used by evgencnn executable to generate EV binary

**MetaWareNN Library Documentation:**

Refer to [this document](https://github.com/SowmyaDhanapal/metawarenn_lib/blob/metawarenn_dev/docs/Documentation-MetaWareNNLibrary-Structures.docx) for the details on MetaWareNN Library class structures, Optimizers, Serializations & Shared memory handlings.

**Clone the Repository:**

* *git clone --recursive* [*https://github.com/SowmyaDhanapal/glow.git*](https://github.com/SowmyaDhanapal/glow.git)
* *cd glow*
* *git checkout metawarenn\_dev*
* *git submodule update --init --recursive*

**Modifications to make in the repository:**

*Refer this* [*README.md*](https://github.com/SowmyaDhanapal/glow/blob/metawarenn_dev/lib/Backends/MetaWareNN/README.md) *file to get the detailed steps to compile and run the inference for sample models*

**Flow chart:**

Workflow diagram of the MetaWareNN backend has been depicted in this flow diagram link

[Flow chart - GLOW MWNN Backend](https://viewer.diagrams.net/?highlight=0000ff&edit=_blank&layers=1&nav=1&title=Flow%20chart%20-%20ONNX%20runtime%20EP%20and%20TFLite%20Delegates#R5V1bk5u4Ev41U3XOw1CAEJfHuSbZnSRTOyc7u08pAbLNLkYsl5nx%2FvojCclcPcYe8DWpVEACgdXdX3%2FqlsQFuJm%2FfUpQPPtKfBxe6Kr%2FdgFuL3Rd01Sd%2FsdKFkUJtEXBNAl8cVFZ8BT8i0WhKkrzwMdp7cKMkDAL4nqhR6IIe1mtDCUJea1fNiFh%2FakxmuJWwZOHwnbpc%2BBnM1Gqq2pZ8RkH05l8tKOLmjmSV4uCdIZ88lopAncX4CYhJCuO5m83OGS9JzvG%2F%2FEn%2BfVz8MvVbZY%2F%2FwWju2fjl8uisftNbln%2BhgRH2bBNC2Gm2UJ2GPZp%2F4lTkmQzMiURCu%2FK0uuE5JGPWasqPSuveSAkpoUaLfwLZ9lCKAPKM0KLZtk8FLX0VySLP9j9CpSnf4rm%2BMntW%2B1sIc56doPorpTkiYffuQ4IdUTJFL%2FXHiyuYx1T0SnRyZ8wmWP6kvSCBIcoC17qioeE%2Fk6X15UiogdCSvz0R4qT7%2B5fzAp0NUQuDotbL3QzpO93ncYoqsnK%2FCdnunc9IVF2mfLevqIXaGb8VlbSo6n4n7fiyoJPD9%2BfZSF9E7d5IS0rniiL9XXKBCr9IpSvolil2jAdeJ0FGX6KEZfQK8WeuopMgjC8ISFJ%2BL0Am77qM92bJsgPqPgrdT60gOOz%2FskS8jeu1DiOqdlwY8V5wUmG394VtajVLUcRNwl41KAAi9cK2BiibFbBGVm2gX7Q04qKbGDkxhkbOexp5NaBGDliepLgSc3AZ1nG3OUVa1S%2FnwbZLHcVj8zpyRN5nS%2FQ7QxFKEYhqw2pj6LmHBJq0fe6Z6tARb7jA9N0fAtA3XYtZDv2ZOJMNKg5mmt5qk8vDQN2w5d5TIWNE3r4%2Fdu3PzgheCDIx4nixTE1qgdoM99ZwksPQDLeAyR2MScA0m7LC4GG2N%2F2vezVKjhVNNGCL9Qs642gK16YCtNEcwZVkZvG72HlwQnzBk0mWO8Qp26AvYuTv9we5FkXpiS%2FRf9s7wbhaG6Q9pLpeV2uzrccV90cPjdxdaqi1X3dkhhXfZ3Z4evADn2deca%2Bzurp65wD8XUfNt%2BtAecpd%2Fl494Kp8Luws28If0RJFmQBiTiKV86W%2BA3hsH2zfMYWgLw5WFonCZamo5h2HSytAwRL%2B4zB0ukJltLpHS5aCutmSJlM3f%2FoJkc12rxaO%2FwvO%2BYMrxe8fn3%2B9o1WCpg8Ktp7jby%2FceSn9PArztAzVRn2W%2B6pBNAr05%2FoZ3FhpWDKfqdC8YJBqmnunREnGAkMXtXzHybJ4%2BjNJGEyVYvoknqfR17Dl2zoIJwzcRAA9HQQcIcOQkbxz9JDSORf7yLAgbiIVgxXQM%2BWANZwAWuAx93AqLVqBw1r1T7Etm%2BMabs2VKCjln9AzY4NtcOOdUuRibR9cT3tnFM9Wt9cj3Z0yZ53qcfATMz3oQOhp1kT1VItzTUwQj4CLjRc35oAR6XW4Xr2FkyMxFkwpz%2BKDXJjlKY%2F5%2FQVpmyUyxmZPSy7qgObekn%2F3ZB5HITbBCHd5OOjYG281NleWY6pGEYdHc0ulgMV0IGOu0yRaeecI9P6Jsk0%2B6TQcclYHhjIqQ%2F4hcf%2FBTpMG7RngAS5Nl5qYHzaAxxFdSp%2FrJphQ91UdNiy7WWOYG%2B0Z88JgZpZl1a%2BI8O2exo22FWQq6fQrHNG475Ck6Z1Imi8DZE7dJ5bnshAmEzbaKY%2BcEoLJwEKWV9vQmHVbIaZ6%2BMOMOx2gJsEIAchw%2FZpkmGgWPWQH7TbDlOzdMU090yGnTOGX4mq6%2BH3UKJ%2BA5PhJZD4JRTwkXKcECqzQQlxZR718RFiQ1W0GiOuGbcJqb0fICGWCniWhFjvGweU8YgDIcT6OQdvewtNP43grcDcGxIxMBLxyUNnuu3c%2BmsUefIn3OOX8pjV6PilPFLiBU%2B7D8yIl8%2FZS0hXP9GQbsPp1XyepXVEd%2B09r37Qzzm0q%2FcN7eonGtoVU8vVR0Zes7eMQ%2Bk9g1dRIWZ9r2a1g4DBMQd%2BDX2ZvJZ2brftXNf2n8XRzznYq%2FcO9g4%2BcBW3PpKAe2mhOKb0BkJrbKehCsWbirsa2rB8jQ%2BQ5nOOIvfXhtOKIh8pP2ZnP8Wpks6KhVnD0uG73z%2Fh6Ia9zH748GlGdS1DMa0KH4Z1yOtaDgz3TYi3Ce%2BmMxSz2kmI367Yvgz7xMqG%2FC3TVG3UJX8D6LfQGh5dQd8gMRg8JLHC16p1X%2BvYQ%2FnaHfP1u9%2FptW4QId4rk2JK1qoM1ChcHRxzTBoa703ScIwOOHL2DEdy7sELCnPRx%2B%2BlI9UgZQKpJilYVkJFXEwJRmz1QZ4G0fRCZDe71eeYiQLPxLj5hJ57cfyT6V3Mp06yrlJiV%2BEEQgNg4IjazeMjUx75uE3yzFMc4QRlXF5iiciJSaLo%2ByJHBh7MgVdlCiN4XD5vk86ndpF7WZ50GEODCEg37xMvn3NwWgdxboGHD64sGAvbTL3u4iDsP%2BPMsRS4MaL1hC%2B9BV%2BHrtjvzUoxB0YMFIbpZiOOk0Pr6rBu0Bk%2FM0FOvCSIsw90MrVwj3nWLAmmU5ykJ%2Bk4owh5PNE0pAhYo1tKoM1Xa73tLjiIplUiU2c9hy6PHaJMxyyVcgwRs338tjcOxMyBDp4Kd7jCcgI2BKIONjoCuWyVqRVlOBG52qE3nQgJ8pe4U8hujcy2ecriI3oQHYPRbSVcytVSXNBXLlzNGtg%2B%2BQM2owFqkJXjuJEcEYmitySPsmCOS1EATQcmhL6GHNfHE0%2FXDB%2B6KgCWZ6oQeJ6BHc1kxLNxv0cYv76n%2BPMS%2BNyLVqSx%2BXAiXmQzEjXGdj9jVxdCAg4YVkiP%2FIFbju%2B6bEUO%2BZhdy2xrXKZhi4vmRfr1iIYhmqNUIyyNWX9dU%2F4sXY4%2BqmMSTds8yNJzSAKObkhyEjw6xVnpw3D0EiQkKlgDFQVlbm7IbSHB%2F%2BRBUkRC6Fvq6tMiInG64PcSEhbxrSyPlU6aeFJypM5GG3rE2ZzwsYnXKUCJtyGQqSty1aD91Ni5ArlYcPYyKolf6O0ew38Vv2Evz5gSsDsEcaxiZFfoe3hcpOOHaUSPPXo7BfndxWts7RCgcc%2BTwS42miHSlXTbf%2B6r75Qy47RmFmznWlAB9HMKJ%2Fy3phlJ2Jb14y%2BjAgPOOevYdtuxfNWy2gq5zHG1FNLWXUBH%2FuMhDrTq6S5N7dqLxdj%2FPDVwzruUgr7blB4MfrgroGDLnfh%2Fv%2F2V1n3%2B%2FvS%2F9dzE3cTgx9tL80D337chG4v1sPm957jtoxuRvRO%2BdQYODz0nQcGAi5FTjQdvQN4biEp1KKsrdYv6Mk0LPBReiYp54PsF1mJqxJyqFxAYs3kzXE%2Fg9QW8ZW1ReC0MnTdd1%2F2IRHhEtTdM2NyL2%2BnaXrYrE6qPxqzPedGw0Xc%2BmGEeiE%2F7GCd%2BqIXr6wPXYggdRHGe8d%2BBKgPntMWH%2BSiZN4DCkHhinN26bjhabIw3vQtrlPxanZ7QtAAak%2FraFBKgtSoqqakdCzY0y1Zs0EaI5szBUb9Ms81i5HGmor4F2R%2BV48oAnZ6VKMJOJIhUwMcwrCr8aIpqrRvc87NHnAS0d5k3OoyZrXK%2FtoOZ2Qosh%2FZuZbvN%2BgxrTdMaM3uKn9ia6dqeMmuqDSOxGpo%2F8voUQz9nj9l3UbdUyCP3mMdD92%2FxS%2BDhr3L%2FzYLzg4Gj9O0dOOuplDseLN%2FXdpzGia7dtps7EGlLON3ZfpwHHKzNXTnH%2FItgr25O5bUuEz6Ixhlno3GdH0LZf0zWgHv1xsuTvawdlsPS9d74tLYJ2AYmbvN5XI59JWKQPCsggw9oW3mf8QHEPMlhra0rcjbLkvA7QOlwWivSOrv8WoZxzgvOjb4LzuHBf1BpdAj5DVfDZy0IEcGyIk8kl7K1Q2dFoC3FS9Qpmls2Qyb8vZIEpzGJfNFMSXL4pOXGV6BHg6fTXP0NLUU1G%2FDUwW901VCsDnCSyzN3Ak4iJFhJQTXyLkGD9J5PPsVqRIK0rhwi2GU2Rbqts3Ql0kOsdyWntQXrNq7kR%2ByL6YPSfIs5pSn2SOEfloA%2FOsjD8b7qtNctPkzFaoA86AKIAxjEwnMOKcO%2BIWV4GvuEfgQ2vjCPHSc880Q9fhEUZl1SxF1LUrAXHDnN8KulK9UMbWOrIA10BcYsoMj9K6uYYu4SU4wWcfzMFghFqRxDhAwolo5H6AlfxZDHMcUTPmzhC1qrKQf1WmrdWqLZyQarkhVF%2FQlpl9bUcXA0slnnmqbREcvo2iFqPKoJW%2FJdbcwDf0x2guZBuChuW6aAqDECgykADl8wE1%2Brpt5IEydrdcWLssqIJHOWQatWv4oOZvX8w42iMqT%2BDieX9Nd6bNjcdT%2FT0kuhcKxa6FytOqD6FInm1cqr8cosQVFKbWYum4%2Fw8oJXkvj1p1dvZ3A95dp62ex2Ns6Wnc1GfPIYqmXP%2B0Eah0j0ehCFQeXBk5CgrPpCTcdxH1BmEDJ9nhaBh3rMoXByyxBGUTth93S7kLZnOI5VgDp0FJm%2FlwDe9W07Xe0w5eY%2BmMOZstlhyis61cuTcHGdMAzu0bF1nztWry7n6b7zTeSuSY3meOBo7aZHJ2EQfx65dyFshDmWirime5dKPHz3tudF35AoZeuni3BlTEjIYWXBsVXMLeTLLCckDMlrcVlEfFzs04D5WbaOfDT9m6bQC%2B6DJGV3VhLBSV7SnG7y0mxJZy09tVmzbErGc1cw8LPiQtBuTWTWQBeK2oZiO23F3GKqYksvrxYT%2FZ%2Fs04%2B%2F7Yn%2B78vn27fbT79cqi21fExwXGiXnLNy9fjlzMRlOGpr3rnccrsiLWsk9topKb0lqd%2Fy6KylZDVg3un4ythORdTejaA0JjnR5vzE1GFMmirpxr5E1R7ql6L6Ljn%2B%2BcnKhLoCtJWz67UOHjWQ2OhpQkhWnXjMgK34aAW4%2Bz8%3D)