www.paddlepaddle.org.cn

飞桨

TVM with PaddlePaddle

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SCHEDULE

01 PaddlePaddle Frontend

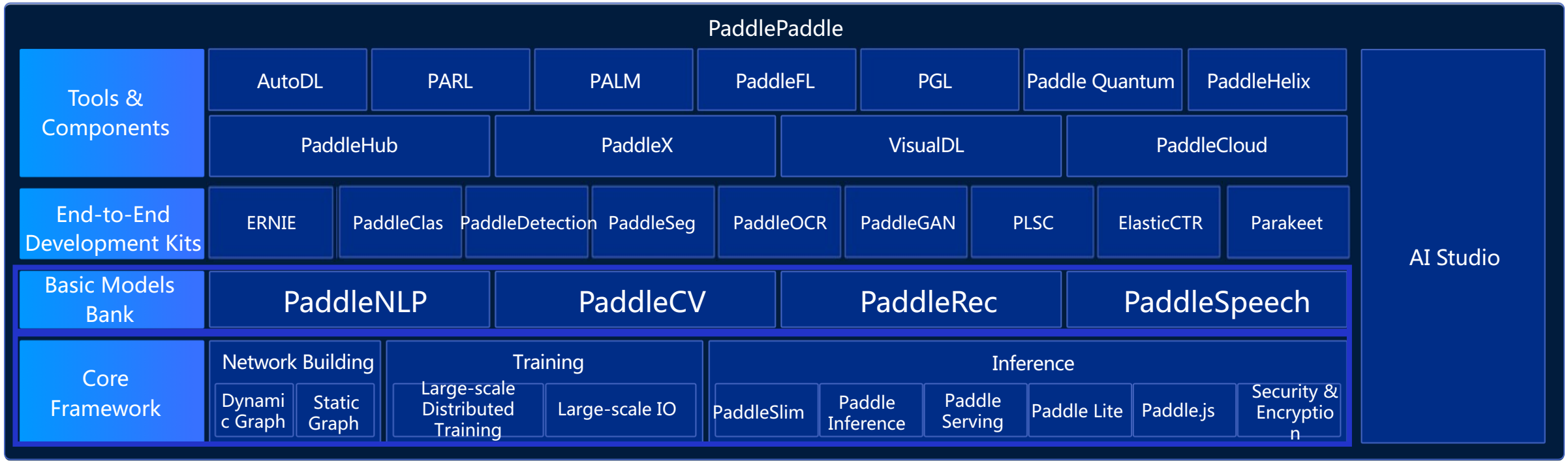
02 Speed up Paddle.js on web browser

03 TVM for KunlunXin Chip

Overview of PaddlePaddle

PaddlePaddle

- Agile framework for Industrial-level development of deep neural networks
- Supports Ultra-Large-Scale training of deep neural networks
- High-Performance inference over ubiquitous environments
- Industry-leading and fully open sourced models and development kits



Multi-industry Model Zoo

PaddlePaddle

More than 200+ Official models, covering NLP/CV/Speech

E-2-E Development Kits	PaddleClas		ERNIE		Parakeet	ElasticCTR	PARL	PGL
	PaddleOCR	PLSC						
	PaddleDetection	PaddleSeg						
Model Zoo	PaddleCV		PaddleNLP		PaddleSpeech	PaddleRec		
Task Level	Image Classification	Object Detection	Lexical Analysis	Emotion Analysis	Text-to-Speech	Fusion	Robot Controlling	Node Classification
	Image Segmetation	Video classification and Motion Positioning	Similarity Computing	Language Model		Sorting	Recommendation System	Personalized recommendation
	Character Recognition	Metric learning & Key Point Detection	Sematic Representation	Conversational System	Speech Recognition	Recall	Resource Scheduling	Long texts Classification
	Image Generation	3D Vision	Machine Translation	Reading Comprehension and Q&A		Content Understanding	AI games	KG
Algorithm level	MobileNet、ResNet、VGG、GoogleNet、Inception、SENet-vd、Res2Net、DenseNet、DPN、Xception	SSD、Faster-RCNN、Mask-RCNN、RetinaNet、YOLOv3、CBNet、GCNet、Libra R-CNN、FCOS、EfficientDet、CornerNet、PyramidBox	Lexical Analysis、BERT finetuned、ERNIE finetuned	Senta、EmoTect、EmotionDetection	DeepVoice3 ClariNet WaveNet WaveFlow TransformerTTS FastSpeech Parakeet	Multitask(share-bottom/MMOE/ESMM)	PPO GA3C	GaAN Graphsage SAGPool GATNE
	DeepLabV3+、ICNet、PSPNet、U-Net、LaneNet、HRNet、GCNet、Fast-SCNN	TSN、Non-Local、StNet、TSM、Attention LSTM BSN、BMN	SimNet、DAM、MPM	Language model		DIN、DCN、DNN、DeepFM、XDeepFM	SAC IMPALA	
	DB、EAST、Rosetta、CRNN、STAR-NET、RARE	Metric Learning/Simple Baselines	ERNIE、XLNet、BERT、ELMo、DuSQL	ADE、DGU、DAM、DuConv、AKGCM、MMPMS、PLATO		GRU4Rec、SSR、GNN TDM、NCF、Multiview-S	DDPG IARL TD3	Erniesage Strucvec Node2vec metapath2vec
	CGAN、DCGAN、Pix2Pix、CycleGAN、StarGAN、PSGAN	PointNET++、PointRCNN	Transformer、JEMT、Seq2Seq、MAL	DuReader-Baseline、KT-NET、MRQA2019-Baseline、MRQA2019-D-NET	DeepSpeech、DeepASR	Tagspace TextClassification	DQN A2C MADDPG	xformer
								Pgl-ke
Framework and tools level	Large-scale Distributed Training			Industrial Deployment				
	PLSC-Large Scale Classification			PaddleSlim	Paddle Lite	Paddle.js		
	PaddlePaddle Core Framework							

PaddlePaddle Frontend for TVM

PaddlePaddle frontend is released with TVM v0.8!

- 115+ operators and 100+ models supported

```
import paddle
import paddle.vision.models as models

model = models.renset50(pretrained=True)
model.eval()
# save model as static model
input_spec = paddle.static.InputSpec(dtype="float32",
      shape=[None, 3, 224, 224], name="image")
paddle.jit.save(model, "save_dir/model", [input_spec])
```

Export PaddlePaddle model for deployment

```
import paddle
from tvm import relay

model = paddle.jit.load( "./inference/model" )
mod, params = relay.frontend.from_paddle(model)

with tvm.transform.PassContext(opt_level=3):
      lib = relay.build(mod, target, params=params)
```

Convert to TVM Relay by PaddlePaddle frontend

For more details please refer to TVM tutorials: https://tvm.apache.org/docs/how_to/compile_models/from_paddle.html

PaddlePaddle Frontend for TVM

PaddlePaddle

- Plans of PaddlePaddle Frontend
  - Support 200+ PaddlePaddle operators
  - Control Flow operators
  - Quantize Model(QAT) by PaddleSlim

02

Speed up Paddle.js on web browser

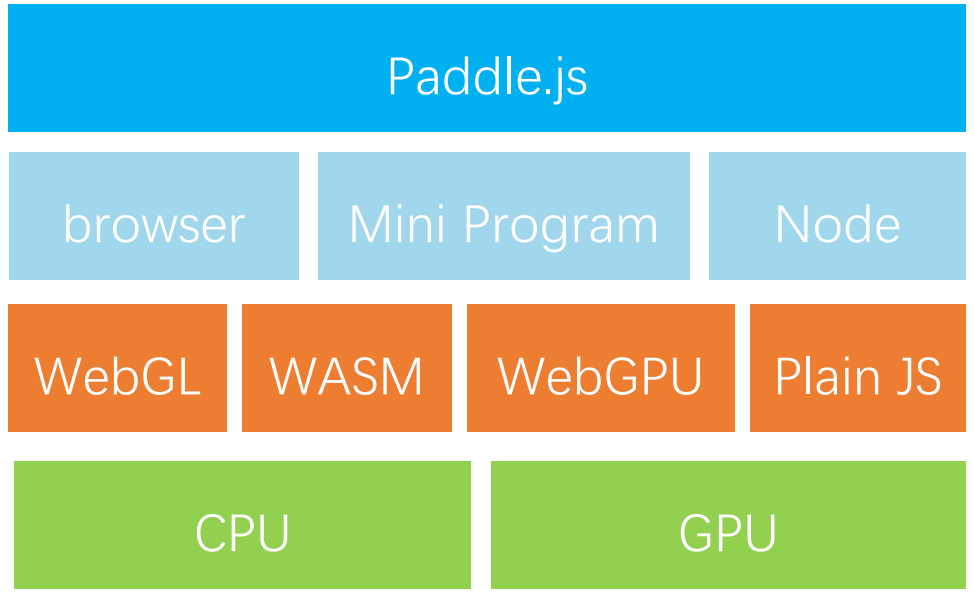
Yuguang Deng

Paddle.js Team

Architecture and Motivation

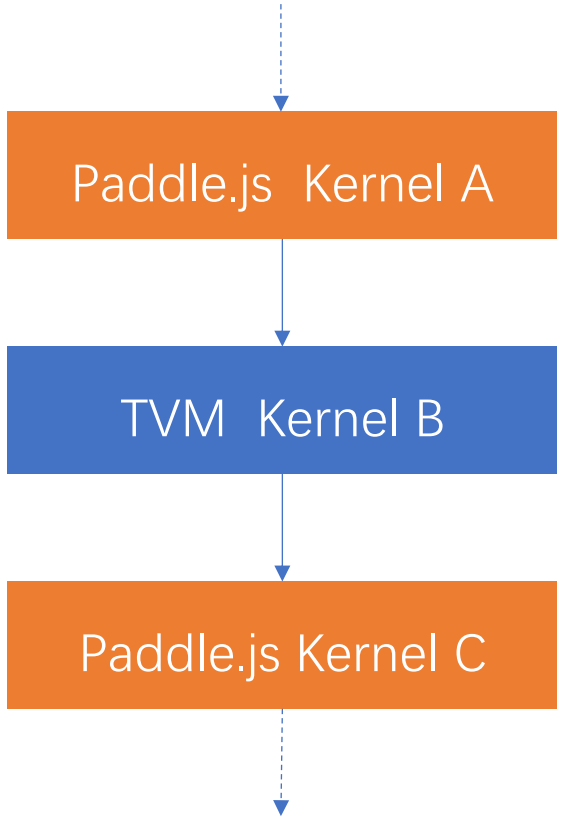
PaddlePaddle

- Overview of Paddle.js
  - Paddle.js is a library for executing machine learning algorithms in JavaScript.
  - Paddle.js models run in a web browser Mini Program , Node.js environment
  - Paddle.js is part of the PaddlePaddle ecosystem, allowing more developers to migrate from JavaScript to machine learning community
- Motivation
  - Mobile devices are very fragmented and lack of standard API to access GPU and CPU directly in web browser.
  - Operators in the models are not fully optimized
  - WASM runtime is supported on TVM
  - The new RPC Session via websocket makes it possible for AutoTVM to run in the browser



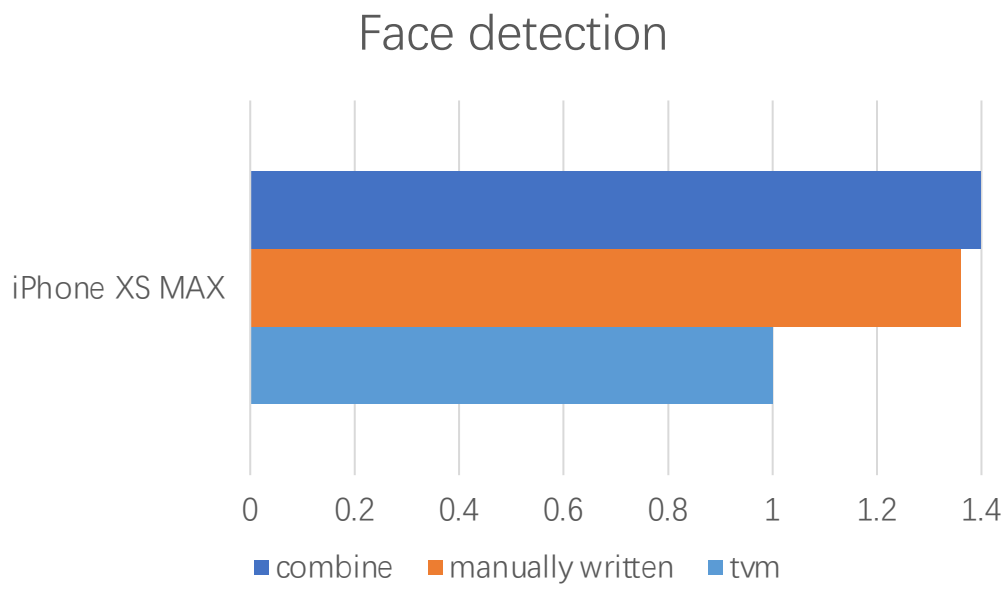
Development

- Create the model and runtime through TVM, and then optimize it with AutoTVM in the browser
- Track the running performance of TVM WASM runtime and Paddle.js respectively via profiler.
- Pick the best kernel implementations from the above. And then combine to new graph



Performance

- Face detection model is taken as an example from online application
- The end-to-end performance speedup 10% on lower device. The replaced kernel is not optimized by manually.
- TVM can help us locate the non optimized parts and give better solutions automatically



Future work

PaddlePaddle

- Online scenarios need to ensure the security of model assets, for example code confusion
- Extend the studies on other backend, like WebGPU、WASM with SIMD and muti threading APIs to fully utilize the GPU & CPU resources.

03

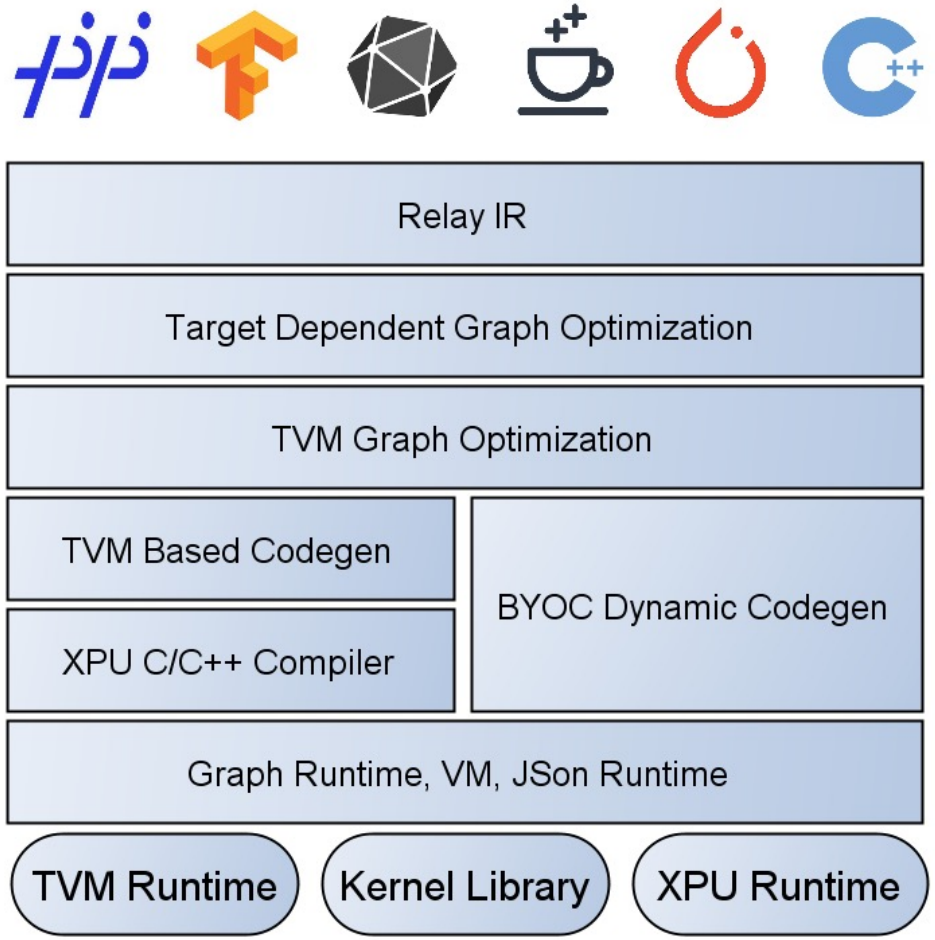
TVM for KunlunXin GP-AI Chip Family

Yin Ma

KunlunXin Compiler Team

Architecture

- Fully utilize the existing TVM framework.
  - Identical user experience coming from TVM
  - Use GraphRuntime to support static models
  - Use VM + BYOC to support dynamic models or models with control flow
  - Powerful Target specific optimizer
  - Massive XPU TOPI to call optimized device kernel library
  - Support Linux, Windows, X86, Aarch64 and other platforms
- Performance strategy
  - Map most operators to call optimized device kernel implementation.
  - Use TIR code generation to cover the long tail pattern.
  - Make all possible operators to run on device to reduce the cost of device copy



*XPU is the architecture name of one KunlunXin chip family.

Development

PaddlePaddle

- Model Importing
  - Parser for PaddlePaddle models, provided by Paddle TVM team.
  - Improve other parsers to import more models and dynamic shape
  - C++ wrapper to enable network creation, build and run in pure C++
- Relay Optimization
  - Convert to a double linked graph to enable large scale and complex rule-based pattern matching, operator replacement for fusion, var-length support etc.
  - Add device specific types and passes to support quantization
  - Add operators to support model parallelism inferencing
- Backend
  - New codegen to generate XPU C/C++ code and drive XPU LLVM based compiler
  - New BYOC connected XPU inferencer designed to handle dynamic shape in first place
- Runtime
  - Automatic device memory hierarchy optimization algorithm
  - Configuration file based memory location assignment framework
  - Support for dumping values in device memory after each layers for debugging

Performance

PaddlePaddle

- Well deployed already in many industry inference applications such as searching, quality inspection etc.
- Proven capability to deliver the peak chip performance for all kind of models in the real business engagement.

* Data above came from the testing with a fair setup between KunlunXin R200 accelerator and a comparable industry mainstream accelerator using our TVM based compiler in Sept, 2021

Future work

PaddlePaddle

- Current limitation
  - Auto tune and auto schedule is not enabled
  - Some schedule primitives are not supported
- Production-driven future development
  - Passing compiled models via memory stream
  - User friendly compilation flow to make compiled models to run on devices with different architectures transparently
  - Improve VM framework and reduce its runtime cost like those from dramatically increased operator counts
  - Need a way to reduce cost from date structure used in runtime like TVMArgs, such as hardening the type checking
  - Define new schedule primitives to fit KunlunXin hardware better
  - Engage with community for better collaboration and upstreaming
- We are hiring
  - Email to Yin Ma (yinma@baidu.com), Beijing, Shanghai, USA

Thanks!