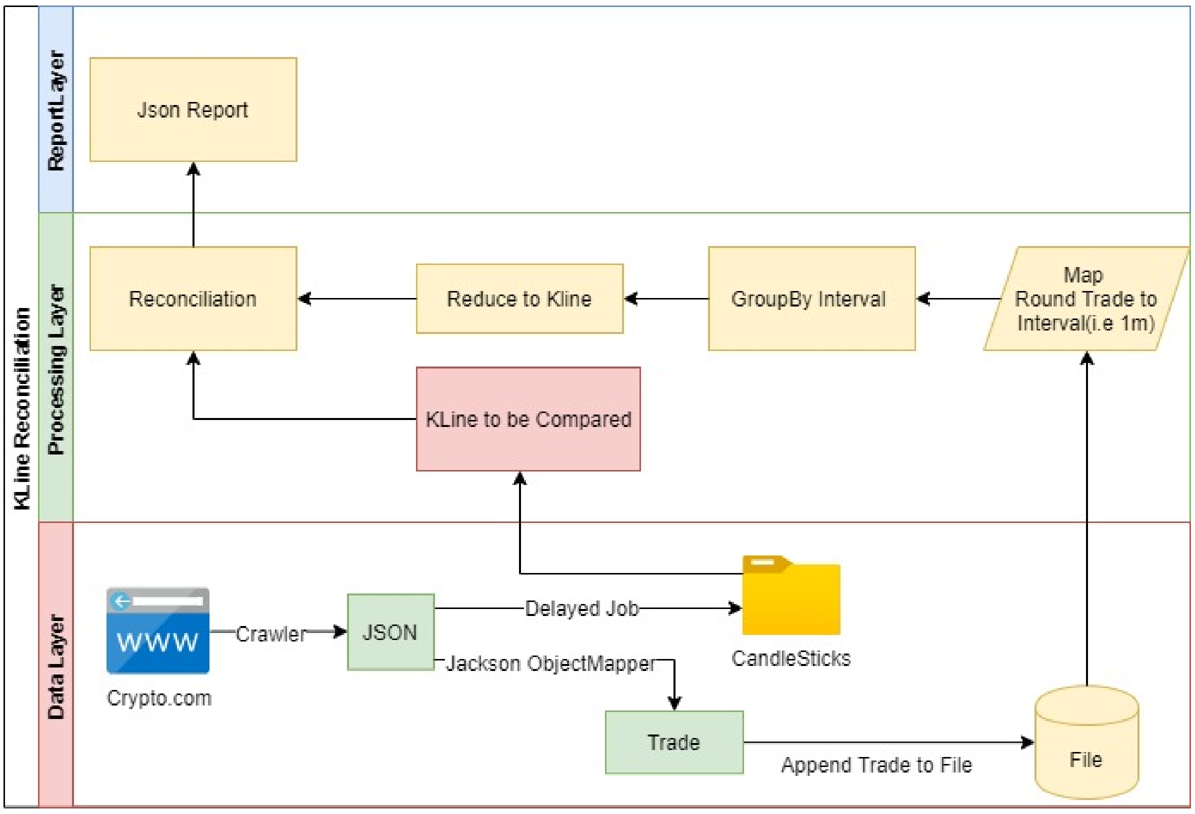
Overall Design



How to Run

1. Start the main com.crypto.candlestick.CandlestickApplication with -Dspring.profiles.active=dev
   which will start two scheduled job in com.crypto.candlestick.marketdata.Crawler,

```
@Scheduled(fixedRate = 1000 * 10) //every 10seconds
public void saveTradesToFile()

//Inital delay to wait the trades to accumulate 20minutes, every 8hour,only
need once
@Scheduled(initialDelay = 1000*60*20, fixedRate = 1000 * 60 * 60 * 8)
public void saveKlinesToFile()
```

   - **saveTradesToFile** will accumulate the trades and parse to Java and then save the json into tradesJsons.txt
   - **saveKlinesToFilea** with initial delay 20 seconds, to query the candlestick and save both them to files

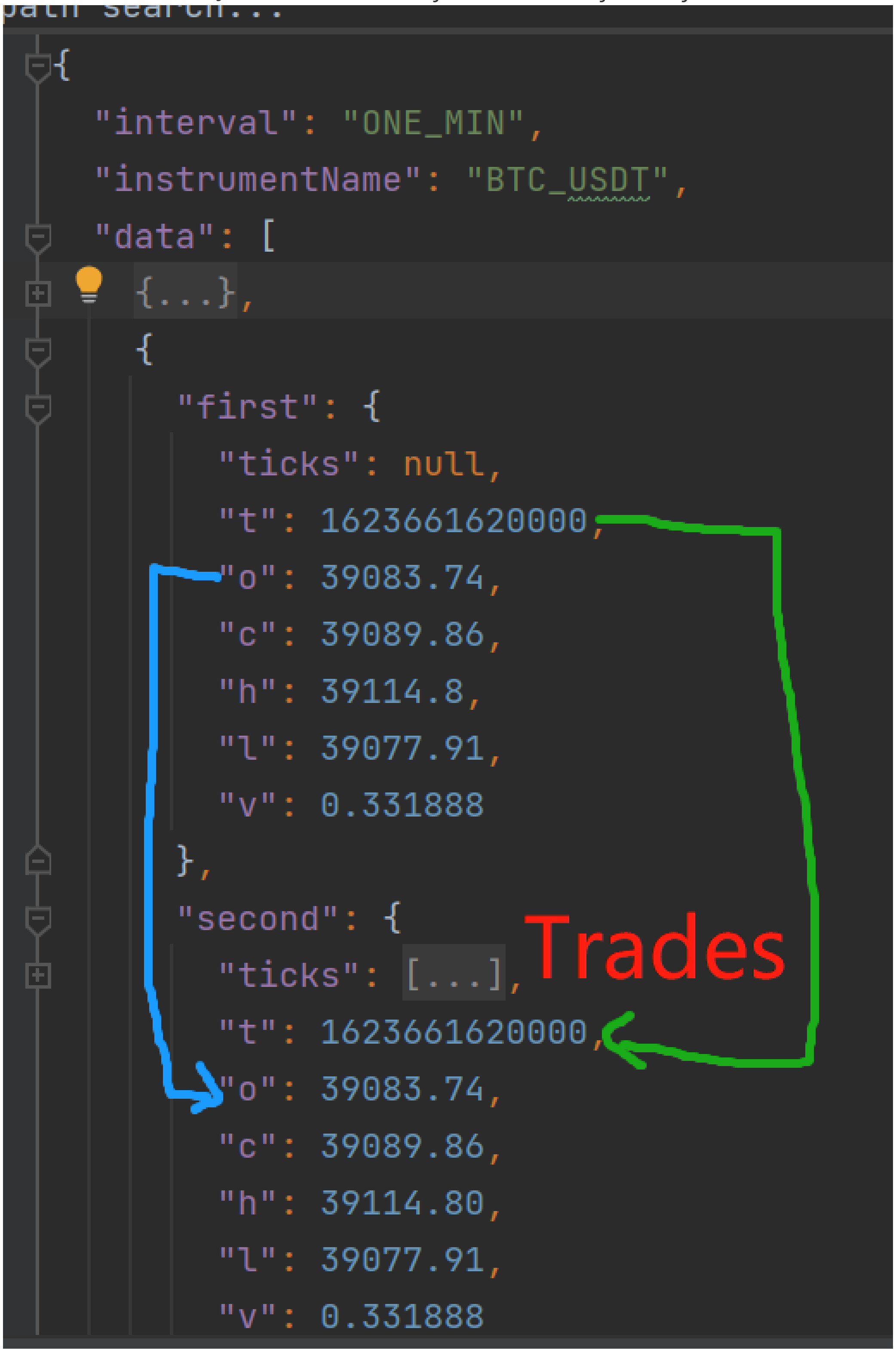
How to Reconcile

```
@Test
    void recon() {
            ReconResult reconResult = kLineRecon.recon("data/input/kline-
202106141730.json","data/input/tradesJsons-202106141730.txt");
```

```
            String resultJson = JsonUtils.objectToJsonStr(reconResult);
            System.out.println(resultJson);//dump the reconciliation result as
json to visualize the consistency
            List<Pair<CandleStick, CandleStick>> data = reconResult.getData();
        int size = data.size();
        LOG.info("Total size" + size);
        //Exclude the first and last one, as insufficient trades, only compare
the ones in middle
        if(size > 2){
        //The First one's close must match

 Assertions.assertTrue(data.get(0).getFirst().getClose().compareTo(data.get(0).g
etSecond().getClose())==0,"Close not match");
        //The Last one's open must match
        Assertions.assertTrue(data.get(size-
1).getFirst().getOpen().compareTo(data.get(size-
1).getSecond().getOpen())==0,"Close not match");
        for(int i = 1; i < (size -1); i++ ){
        Pair<CandleStick, CandleStick> pair = data.get(i);
        CandleStick first = pair.getFirst();
        CandleStick second = pair.getSecond();
        LOG.info(DateUtils.tsToDatetime(first.getTimestamp()).toString()) ;
        LOG.info(first.toString());
        LOG.info(second.toString());
        LOG.info(second.getTicks().toString());
        //Assertions.assertTrue(first.getVolume().compareTo(second.getVolume())
== 0, "Volume not match");
        Assertions.assertTrue(first.getOpen().compareTo(second.getOpen()) ==
0,"Open not match");

 Assertions.assertTrue(first.getClose().compareTo(second.getClose())==0,"Close
not match");

 Assertions.assertTrue(first.getHigh().compareTo(second.getHigh())==0,"High not
match");
        Assertions.assertTrue(first.getLow().compareTo(second.getLow())==0,"Low
not match");
        }
        }
        }
```

1. Run the com.crypto.candlestick.core.KLineReconTest under test/java directory which would Assert the OCHL
   and log the benchmark candlestick and generated candlestick,its underlying trades as json
2. Sample output
   - Sample output are under data/ouput directory

- Reconcilation Result Json is useful to verify the consistency visually as show below



```
{
  "interval": "ONE_MIN",
  "instrumentName": "BTC_USDT",
  "data": [
    {...},
    {
      "first": {
        "ticks": null,
        "t": 1623661620000,
        "o": 39083.74,
        "c": 39089.86,
        "h": 39114.8,
        "l": 39077.91,
        "v": 0.331888
      },
      "second": {
        "ticks": [...],
        "t": 1623661620000,
        "o": 39083.74,
        "c": 39089.86,
        "h": 39114.80,
        "l": 39077.91,
        "v": 0.331888
```

Get CandleStick examples

https://crypto.com/fe-ex-api/market-data/v2/public/get-candlestick?depth=1000&instrument_name=BTC_USDT&timeframe=1m

this url return 600, so 600 minutes range of trades, 10 hours

```
public String getCandleSticks(String instrumentName, Interval interval) {
        String url = URL_BASE + "get-candlestick?depth=1000&instrument_name=" +
instrumentName + "&timeframe=" + interval.getValue();
        return getJson(url);
    }
private String getJson(String url) {
        ResponseEntity<String> responseEntity = restTemplate.getForEntity(url,
String.class);
        return responseEntity.getBody();
        }
```

Get Trades examples

https://crypto.com/fe-ex-api/market-data/v2/public/get-trades?depth=1000&instrument_name=BTC_USDT
The trades are reversed ordered by ts
Due to the get-trades url only return the latest 200 trades, so start a scheduled job to query the trades
every 10 seconds, parse the trades json to object and save to file tradesJsons.txt, reversely ordered, so keep the order

```
    public List<Tick> getTrades(String instrumentName) {
        String url = URL_BASE + "get-trades?depth=1000&instrument_name=" +
instrumentName;
        ResponseBase<Tick> tickResponseBase =
JsonUtils.parseResponse(getInputStream(url), Tick.class);
        return tickResponseBase.getResult().getData();
    }
    private InputStream getInputStream(String url) {
        ResponseEntity<String> responseEntity = restTemplate.getForEntity(url,
String.class);
        String body = responseEntity.getBody();
        return new ByteArrayInputStream(body.getBytes());
        }
```

Use Jackson ObjectMapper map json to Domain Object

```
    public static <T> ResponseBase<T> parseResponse(InputStream inputStream,
Class<?> cls) {
        JavaType responseType =
objectMapper.getTypeFactory().constructParametricType(ResponseBase.class, cls);
        try {
        return objectMapper.readValue(inputStream, responseType);
        } catch (IOException e) {
        throw new RuntimeException(e);
        }
        }
    public static List<CandleStick> getCandleSticksFromFile(String fileName){
        try {
            InputStream inputStream = new
ByteArrayInputStream(Files.readAllBytes(Paths.get(fileName)));
```

```
            ResponseBase<CandleStick> response =
JsonUtils.parseResponse(inputStream, CandleStick.class);
            return response.getResult().getData();
        } catch (IOException e) {
            throw new RuntimeException(e);
        }
    }
```

Use Trades List to generate KLine i.e 1m

- using Map Reduce

1. first round the timestamp to 1 minute by divide 60*1000,other interval likewise
2. group the tick into map
3. reduce the map to kline

```
private Long roundToMin(Long ts) {
        return (ts / 1000 / 60 ) * 1000 * 60;  //End? time of candlestick (Unix
timestamp)
        }
public NavigableMap<Long, CandleStick> generateKLine(List<Tick> ticks) {
        // Round timestamp to nearest of every interval(1m), ordered by ts
        // other intervals can be generated from 1m likewise
        NavigableMap<Long, CandleStick> groupedTicks = new TreeMap<>();

        Map<Long, List<Tick>> ticksToReduce =
ticks.stream().map(mapToMin()).collect(Collectors.groupingBy(Tick::getTs));
        for (Map.Entry<Long, List<Tick>> e : ticksToReduce.entrySet()) {
            CandleStick candleStick = reduceToCandleStick(e.getValue());
            candleStick.setTimestamp(e.getKey());
            groupedTicks.put(e.getKey(), candleStick);
        }
        return groupedTicks;
    }
```

Generate other interval i.e 5m from 1m Kline

```
public NavigableMap<Long, CandleStick> generateKLineFrom1m(List<CandleStick>
candleSticks,Interval interval) {
        NavigableMap<Long, CandleStick> result = new TreeMap<>();
        for (CandleStick cs: candleSticks) {
            long divisor = 1000*60*interval.getNMinutes();
            cs.setTimestamp(cs.getTimestamp() / divisor  * divisor);
        }
        Map<Long, List<CandleStick>> groupedCandleSticks =
candleSticks.stream().collect(Collectors.groupingBy(CandleStick::getTimestamp));
        for (Map.Entry<Long, List<CandleStick>> e:
groupedCandleSticks.entrySet() ) {
            CandleStick candleStick = reduce(e.getValue());
            candleStick.setTimestamp(e.getKey());
            result.put(e.getKey(),candleStick);
        }
        return result;
    }

    private CandleStick reduce(List<CandleStick> candleSticks) {
        int size = candleSticks.size();
        //candleSticks ascending order
        CandleStick candleStick = new CandleStick();
        if (size > 0) {
            candleStick.setOpen(candleSticks.get(0).getOpen());
            candleStick.setClose(candleSticks.get(size-1).getClose());

            BigDecimal high = candleSticks.get(0).getHigh();
            BigDecimal low = candleSticks.get(0).getLow();
            BigDecimal vol = candleSticks.get(0).getVolume();
            for (int i = 1; i < size; i++) {
                BigDecimal h = candleSticks.get(i).getHigh();
                BigDecimal l = candleSticks.get(i).getLow();
                if (h.compareTo(high) > 0) {
                    high = h;
                }
                if (l.compareTo(low) < 0) {
                    low = l;
                }
                vol = vol.add(candleSticks.get(i).getVolume());
            }
            candleStick.setHigh(high);
            candleStick.setLow(low);
            candleStick.setVolume(vol);
        }else{
            candleStick.setVolume(BigDecimal.ZERO);
        }
        return candleStick;
    }
```

- How to verify

```
@Test
    void generateKLineFrom1m() {
        String kLine1m = "data/input/kline-1m-202106142015.json";
        String kLine5m = "data/input/kline-5m-202106142015.json";
        ReconResult reconResult = kLineRecon.reconKline(kLine1m, kLine5m,
Interval.FIVE_MIN);
        System.out.println(JsonUtils.objectToJsonStr(reconResult));//dump result
to json
        List<Pair<CandleStick, CandleStick>> data = reconResult.getData();
        int size = data.size();
        LOG.info("Total size" + size);
        //Exclude the first and last one, as insufficient trades, only compare
the ones in middle
        if(size > 2){
            //The First one's close must match

 Assertions.assertTrue(data.get(0).getFirst().getClose().compareTo(data.get(0).g
etSecond().getClose())==0,"Close not match");
            //The Last one's open must match
            Assertions.assertTrue(data.get(size-
1).getFirst().getOpen().compareTo(data.get(size-
1).getSecond().getOpen())==0,"Close not match");
            for(int i = 1; i < (size -1); i++ ){
                Pair<CandleStick, CandleStick> pair = data.get(i);
                CandleStick first = pair.getFirst();
                CandleStick second = pair.getSecond();

 LOG.info(DateUtils.tsToDatetime(first.getTimestamp()).toString()) ;
                LOG.info(first.toString());
                LOG.info(second.toString());

 Assertions.assertTrue(first.getVolume().compareTo(second.getVolume()) == 0,
"Volume not match");

 Assertions.assertTrue(first.getOpen().compareTo(second.getOpen()) == 0,"Open
not match");

 Assertions.assertTrue(first.getClose().compareTo(second.getClose())==0,"Close
not match");

 Assertions.assertTrue(first.getHigh().compareTo(second.getHigh())==0,"High not
match");

 Assertions.assertTrue(first.getLow().compareTo(second.getLow())==0,"Low not
match");
            }
        }
    }
```

Flink

- Alternative try use Flink to process the data in realtime