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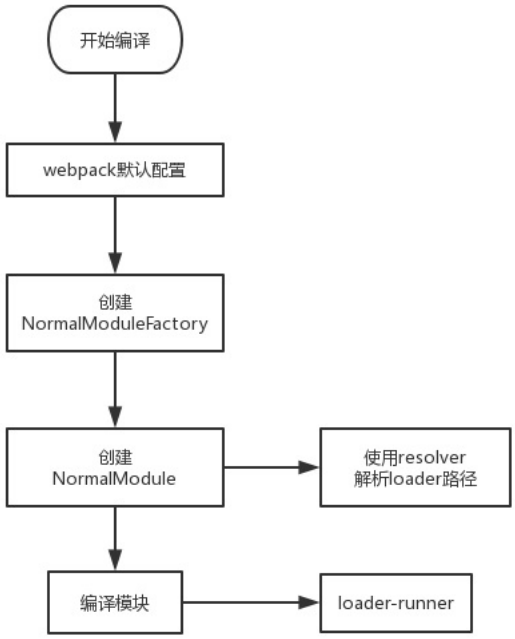
1. loader运行的总体流程

- Compiler.js中会为将用户配置与默认配置合并，其中就包括了 loader部分
- webpack就会根据配置创建 NormalModuleFactory,它可以用来创建 NormalModule
- 在工厂创建NormalModule实例之前还要通过loader的resolver来解析loader路径
- 在NormalModule实例创建之后，则会通过其 build方法来进行模块的构建。构建模块的第一步就是使用 loader来加载并处理模块内容。而 loader-runner这个库就是 webpack中 loader的运行器
- 最后，将loader处理完的模块内容输出，进入后续的编译流程



2.babel-loader

- babel-loader (https://github.com/babel/babel-loader/blob/master/src/index.js)
- @babel/core (https://babeljs.io/docs/en/next/babel-core.html)
- babel-plugin-transform-react-jsx (https://babeljs.io/docs/en/babel-plugin-transform-react-jsx/)

属性 值 this.request /loaders/babel-loader.js!/src/index.js this.userRequest /src/index.js this.rawRequest ./src/index.js this.resourcePath /src/index.js

```
$ cnpm i @babel/preset-env @babel/core -D
```

```
const babel = require("@babel/core");
function loader(source,inputSourceMap) {

    const options = {
        presets: ['@babel/preset-env'],
        inputSourceMap:inputSourceMap,
        sourceMaps: true,
        filename:this.request.split('!')[1].split('/').pop()
    }

    let {code,map,ast}=babel.transform(source,options);
    return this.callback(null,code,map,ast);
}
module.exports = loader;
```

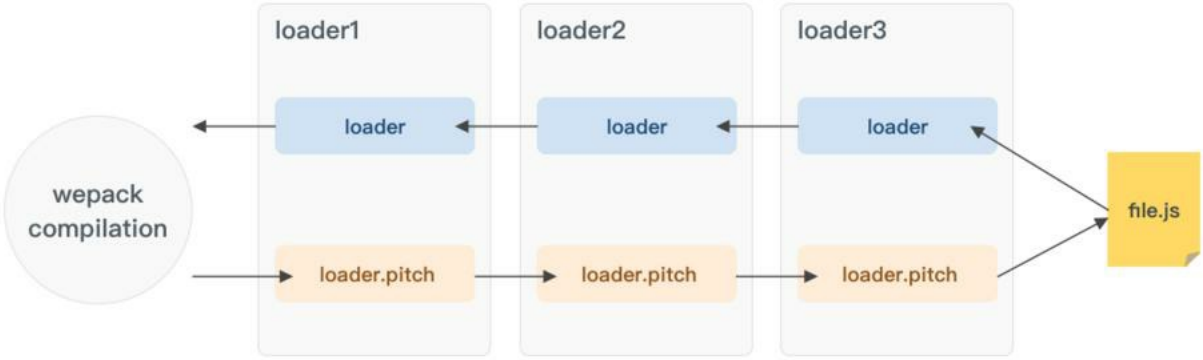
```
resolveLoader: {
    alias: {
      "babel-loader": resolve('./build/babel-loader.js')
    },
    modules: [path.resolve('./loaders'), 'node_modules']
},
{
    test: /\.js$/,
    use:['babel-loader']
}
```

3.pitch

- 比如a!b!c!module, 正常调用顺序应该是c、b、a，但是真正调用顺序是 a(pitch)、b(pitch)、c(pitch)、c、b、a,如果其中任何一个pitching loader返回了值就相当于在它以及它右边的loader已经执行完毕
- 比如如果b返回了字符串"result b", 接下来只有a会被系统执行，且a的loader收到的参数是result b
- loader根据返回值可以分为两种，一种是返回js代码（一个module的代码，含有类似module.export语句）的loader，还有不能作为最左边loader的其他loader
- 有时候我们想把两个第一种loader chain起来，比如style-loader!css-loader! 问题是css-loader的返回值是一串js代码，如果按正常方式写style-loader的参数就是一串代码字符串
- 为了解决这种问题，我们需要在style-loader里执行require(css-loader!resources)

pitch与loader本身方法的执行顺序图

```
|- a-loader `pitch`
  |- b-loader `pitch`
    |- c-loader `pitch`
      |- requested module is picked up as a dependency
    |- c-loader normal execution
  |- b-loader normal execution
|- a-loader normal execution
```



3.1 loaders\loader1.js

loaders\loader1.js

```
function loader(source) {
    console.log('loader1',this.data);
    return source+"//loader1";
}
loader.pitch = function (remainingRequest,previousRequest,data) {
    data.name = 'pitch1';
    console.log('pitch1');
}
module.exports = loader;
```

3.2 loaders\loader2.js

loaders\loader2.js

```
function loader(source) {
    console.log('loader2');
    return source+"//loader2";
}
loader.pitch = function (remainingRequest,previousRequest,data) {
    console.log('remainingRequest=',remainingRequest);
    console.log('previousRequest=',previousRequest);
    console.log('pitch2');

}
module.exports = loader;
```

3.3 loaders\loader3.js

loaders\loader3.js

```
function loader(source) {
    console.log('loader3');
    return source+"//loader3";
}
loader.pitch = function () {
    console.log('pitch3');
}
module.exports = loader;
```

3.4 webpack.config.js

```
{
    test: /\.js$/,
    use: ['loader1', 'loader2', 'loader3']
}
```

4.loader-runner

4.1 loader类型

- loader的叠加顺序 (https://github.com/webpack/webpack/blob/v4.39.3/lib/NormalModuleFactory.js#L159-L339) = post(后置)+inline(内联)+normal(正常)+pre(前置)

4.2 特殊配置

- loaders/#configuration (https://webpack.js.org/concepts/loaders/#configuration)

符号 变量 含义 -!

noPreAutoLoaders 不要前置和普通loader Prefixing with -! will disable all configured preLoaders and loaders but not postLoaders !

noAutoLoaders 不要普通loader Prefixing with ! will disable all configured normal loaders ! !

noPrePostAutoLoaders 不要前后置和普通loader,只要内联loader Prefixing with !! will disable all configured loaders (preLoaders, loaders, postLoaders)

4.2 查找规则执行

```
let path = require("path");
let nodeModules = path.resolve(__dirname, "node_modules");
let request = "-!inline-loader1!inline-loader2!./styles.css";

let inlineLoaders = request
  .replace(/^-?!+/, "")
  .replace(/!!+/g, "!")
  .split("!");
let resource = inlineLoaders.pop();
let resolveLoader = loader => path.resolve(nodeModules, loader);

inlineLoaders = inlineLoaders.map(resolveLoader);
let rules = [
  {
    enforce: "pre",
    test: /\.css?$/,
    use: ["pre-loader1", "pre-loader2"]
  },
  {
    test: /\.css?$/,
    use: ["normal-loader1", "normal-loader2"]
  },
  {
    enforce: "post",
    test: /\.css?$/,
    use: ["post-loader1", "post-loader2"]
  }
];
let preLoaders = [];
let postLoaders = [];
let normalLoaders = [];
for(let i=0;ilet rule = rules[i];
    if(rule.test.test(resource)){
        if(rule.enforce=='pre'){
          preLoaders.push(...rule.use);
        }else if(rule.enforce=='post'){
          postLoaders.push(...rule.use);
        }else{
          normalLoaders.push(...rule.use);
        }
    }
}
preLoaders = preLoaders.map(resolveLoader);
postLoaders= postLoaders.map(resolveLoader);
normalLoaders = normalLoaders.map(resolveLoader);

let loaders = [];

if(request.startsWith('!!')){
  loaders = inlineLoaders;

}else if(request.startsWith('-!')){
  loaders = [...postLoaders,...inlineLoaders];

}else if(request.startsWith('!')){
  loaders = [...postLoaders,...inlineLoaders,...preLoaders];
}else{
  loaders = [...postLoaders,...inlineLoaders,...normalLoaders,...preLoaders];
}
console.log(loaders);
```

4.4 run-loader

- LoaderRunner (https://github.com/webpack/loader-runner/blob/v2.4.0/lib/LoaderRunner.js)
- NormalModuleFactory-noPreAutoLoaders (https://github.com/webpack/webpack/blob/v4.39.3/lib/NormalModuleFactory.js#L180)
- NormalModule-runLoaders (https://github.com/webpack/webpack/blob/v4.39.3/lib/NormalModule.js#L292)

```
let readFile = require("fs");
let path = require("path");
function createLoaderObject(loader) {
  let obj = { data: {} };
  obj.request = loader;
  obj.normal = require(loader);
  obj.pitch = obj.normal.pitch;
  return obj;
}
function runLoaders(options, callback) {
  let loaderContext = {};
  let resource = options.resource;
  let loaders = options.loaders;
  loaders = loaders.map(createLoaderObject);
  loaderContext.loaderIndex = 0;
  loaderContext.readResource = readFile;
  loaderContext.resource = resource;
  loaderContext.loaders = loaders;
  let isSync = true;
  var innerCallback = (loaderContext.callback = function(err, args) {
    loaderContext.loaderIndex--;
    iterateNormalLoaders(loaderContext, args, callback);
  });
  loaderContext.async = function async() {
    isSync = false;
    return innerCallback;
  };
  Object.defineProperty(loaderContext, "request", {
    get: function() {
      return loaderContext.loaders
        .map(function(o) {
          return o.request;
        })
        .concat(loaderContext.resource)
        .join("!");
    }
  });
```

```
  Object.defineProperty(loaderContext, "remainingRequest", {
    get: function() {
      return loaderContext.loaders
        .slice(loaderContext.loaderIndex + 1)
        .map(function(o) {
          return o.request;
        })
        .concat(loaderContext.resource || "")
        .join("!");
    }
  });
  Object.defineProperty(loaderContext, "currentRequest", {
    enumerable: true,
    get: function() {
      return loaderContext.loaders
        .slice(loaderContext.loaderIndex)
        .map(function(o) {
          return o.request;
        })
        .concat(loaderContext.resource || "")
        .join("!");
    }
  });
  Object.defineProperty(loaderContext, "previousRequest", {
    get: function() {
      return loaderContext.loaders
        .slice(0, loaderContext.loaderIndex)
        .map(function(o) {
          return o.request;
        })
        .join("!");
    }
  });
  Object.defineProperty(loaderContext, "data", {
    get: function() {
      return loaderContext.loaders[loaderContext.loaderIndex].data;
    }
  });
  iteratePitchingLoaders(loaderContext, callback);
  function iteratePitchingLoaders(loaderContext, callback) {
    if (loaderContext.loaderIndex >= loaderContext.loaders.length) {
      loaderContext.loaderIndex--;
      return processResource(loaderContext, callback);
    }

    let currentLoaderObject = loaderContext.loaders[loaderContext.loaderIndex];
    let fn = currentLoaderObject.pitch;
    if (!fn) return iteratePitchingLoaders(options, loaderContext, callback);

    let args = fn.apply(loaderContext, [
      loaderContext.remainingRequest,
      loaderContext.previousRequest,
      currentLoaderObject.data
    ]);
    if (args) {
      loaderContext.loaderIndex--;
      return iterateNormalLoaders(loaderContext, args, callback);
    } else {
      loaderContext.loaderIndex++;
      iteratePitchingLoaders(loaderContext, callback);
    }
    function processResource(loaderContext, callback) {
      let buffer = loaderContext.readResource.readFileSync(
        loaderContext.resource,
        "utf8"
      );
      iterateNormalLoaders(loaderContext, buffer, callback);
    }
  }
  function iterateNormalLoaders(loaderContext, args, callback) {
    if (loaderContext.loaderIndex < 0) return callback(null, args);

    var currentLoaderObject = loaderContext.loaders[loaderContext.loaderIndex];
    var fn = currentLoaderObject.normal;
    if (!fn) {
      loaderContext.loaderIndex--;
      return iterateNormalLoaders(loaderContext, args, callback);
    }
    args = fn.apply(loaderContext, [args]);
    if (isSync) {
      loaderContext.loaderIndex--;
      iterateNormalLoaders(loaderContext, args, callback);
    }
  }
}

let entry = "./src/world.js";

let options = {
  resource: path.join(__dirname, entry),
  loaders: [
    path.join(__dirname, "loaders/loader1.js"),
    path.join(__dirname, "loaders/loader2.js"),
    path.join(__dirname, "loaders/loader3.js")
  ]
};

runLoaders(options, (err, result) => {
  console.log(result);
});
```

5. file

- file-loader 并不会对文件内容进行任何转换，只是复制一份文件内容，并根据配置为他生成一个唯一的文件名。

5.1 file-loader

- loader-utils (https://github.com/webpack/loader-utils)
- file-loader (https://github.com/webpack-contrib/file-loader/blob/master/src/index.js)
- public-path (https://webpack.js.org/guides/public-path/#on-the-fly)

```
const { getOptions, interpolateName } = require('loader-utils');
function loader(content) {
  let options=getOptions(this)||{};
  let url = interpolateName(this, options.filename || "[hash].[ext]", {content});
  this.emitFile(url, content);
  return `module.exports = ${JSON.stringify(url)}`;
}
loader.raw = true;
module.exports = loader;
```

- 通过 loaderUtils.interpolateName 方法可以根据 options.name 以及文件内容生成一个唯一的文件名 url（一般配置都会带上hash，否则很可能由于文件重名而冲突）
- 通过 this.emitFile(url, content) 告诉 webpack 我需要创建一个文件，webpack会根据参数创建对应的文件，放在 public path 目录下
- 返回 module.exports = ${JSON.stringify(url)},这样就会把原来的文件路径替换为编译后的路径

5.2 url-loader

```
let { getOptions } = require('loader-utils');
var mime = require('mime');
function loader(source) {
    let options=getOptions(this)||{};
    let { limit, fallback='file-loader' } = options;
    if (limit) {
      limit = parseInt(limit, 10);
    }
    const mimetype=mime.getType(this.resourcePath);
    if (!limit || source.length < limit) {
        let base64 = `data:${mimetype};base64,${source.toString('base64')}`;
        return `module.exports = ${JSON.stringify(base64)}`;
    } else {
        let fileLoader = require(fallback || 'file-loader');
        return fileLoader.call(this, source);
    }
}
loader.raw = true;
module.exports = loader;
```

5.3 样式处理

- css-loader (https://github.com/webpack-contrib/css-loader/blob/master/lib/loader.js) 的作用是处理css中的 @import 和 url 这样的外部资源
- style-loader (https://github.com/webpack-contrib/style-loader/blob/master/index.js) 的作用是把样式插入到 DOM中，方法是在head中插入一个style标签，并把样式写入到这个标签的 innerHTML里
- less-loader (https://github.com/webpack-contrib/less-loader) 把less编译成css
- pitching-loader (https://webpack.js.org/api/loaders/#pitching-loader)
- loader-utils (https://github.com/webpack/loader-utils)
- !! (https://webpack.js.org/concepts/loaders/#configuration)

```
$ cnpm i less postcss css-selector-tokenizer -D
```

5.3.2 使用less-loader

5.3.2.1 index.js

src\index.js

```
import './index.less';
```

5.3.2.2 src\index.less

src\index.less

```
@color:red;
#root{
    color:@color;
}
```

5.3.2.3 src\index.html

src\index.html

```
<div id="root">hellodiv>
<div class="avatar">div>
```

5.3.2.4 webpack.config.js

webpack.config.js

```
{
  test: /\.less$/,
  use: [
    'style-loader',
    'less-loader'
  ]
}
```

5.3.2.5 less-loader.js

```
let less = require('less');
function loader(source) {
    let callback = this.async();
    less.render(source, { filename: this.resource }, (err, output) => {
        callback(err, output.css);
    });
}
module.exports = loader;
```

5.3.2.6 style-loader

```
function loader(source) {
    let script=(`
      let style = document.createElement("style");
      style.innerHTML = ${JSON.stringify(source)};
    document.head.appendChild(style);
    module.exports = "";
    `);
    return script;
}
module.exports = loader;
```

5.3.5 两个左侧模块连用

5.3.5.1 less-loader.js

```
let less = require('less');
function loader(source) {
    let callback = this.async();
    less.render(source, { filename: this.resource }, (err, output) => {
        callback(err, `module.exports = ${JSON.stringify(output.css)}`);
    });
}
module.exports = loader;
```

5.3.5.2 style-loader.js

```
let loaderUtils = require("loader-utils");
function loader(source) {

}

loader.pitch = function (remainingRequest, previousRequest, data) {

  console.log('previousRequest', previousRequest);

  console.log('remainingRequest', remainingRequest);
  console.log('data', data);

  let style = `
    var style = document.createElement("style");
    style.innerHTML = require(${loaderUtils.stringifyRequest(this, "!!" + remainingRequest)});
    document.head.appendChild(style);
 `;
  return style;
}
module.exports = loader;
```

5.3.6 css-loader.js

- `css-loader` 的作用是处理css中的 `@import` 和 `url` 这样的外部资源
- postcss (https://github.com/postcss/postcss#usage)
- Avoid CSS @import CSS @importallows stylesheets to import other stylesheets. When CSS @import isused from an external stylesheet, the browser is unable to downloadthe stylesheets in parallel, which adds additional round-trip timesto the overall page load.

5.3.6.1 src\index.js

src\index.js

```
require('./style.css');
```

5.3.6.2 src\style.css

```
@import './global.css';
.avatar {
  width: 100px;
  height: 100px;
  background-image: url('./baidu.png');
  background-size: cover;
}
div{
  color:red;
}
```

5.3.6.3 src\global.css

```
body {
    background-color: green;
}
```

5.3.6.4 webpack.config.js

```
+      {
+        test: /\.css$/,
+        use: [
+          'style-loader',
+          'css-loader'
+        ]
+      },
+      {
+        test: /\.png$/,
+        use: [
+          'file-loader'
+        ]
+      }
```

5.3.6.5 css-loader.js

loaders\css-loader.js

```
var postcss = require("postcss");
var loaderUtils = require("loader-utils");
var Tokenizer = require("css-selector-tokenizer");

const cssLoader = function (inputSource) {
    const cssPlugin = (options) => {
        return (root) => {
            root.walkAtRules(/^import$/i, (rule) => {
                rule.remove();
                options.imports.push(rule.params.slice(1, -1));
            });
            root.walkDecls((decl) => {
                var values = Tokenizer.parseValues(decl.value);
                values.nodes.forEach(function (value) {
                    value.nodes.forEach(item => {
                        if (item.type === "url") {
                            item.url = "`+require(" + loaderUtils.stringifyRequest(this, item.url) + ")+`";
                        }
                    });
                });
                decl.value = Tokenizer.stringifyValues(values);
                console.log(decl);
            });
        };
    }

    let callback = this.async();
    let options = { imports: [] };
    let pipeline = postcss([cssPlugin(options)]);
    pipeline.process(inputSource).then((result) => {
        let importCss = options.imports.map(url => "`+require(" + loaderUtils.stringifyRequest(this, "!!css-loader!" + url) + ")+`").join('\r\n');
        callback(
            null,
            'module.exports=`' + importCss + '\n' + result.css + '`'
        );
    });
};

module.exports = cssLoader;
```