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Microservices and DevOps

DevOps and Container Technology

Introduction

Henrik Bærbak Christensen

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Henrik Bærbak Christensen

- Associate Professor
  - Computer science department / Aarhus University
  - Interests: Software architecture, software engineering, teaching
  - Leader of part-time education in SW engineering
- Industrial experience
  - Architect and developer for a product suite of meteorological systems for Danish airports.
  - Collaborations with Danish companies: Danfoss, SSE, KMD, B&O, Terma, Rambøll, Jyske Bank, Uber, and many others…
  - Imhotep: Courses and consulting, www.imhotep.dk
  - Have (had) 24/7/365 system in production

MSDO

- The ‘fagpakke’ is a progression of three modules

  - *DevOps and Container Technology*
  - *Scalable Microservices*
  - *Development project in Microservices and DevOps*

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The courses

- Technology focus
  - The technologically oriented module
    - Understand and use the toolstack
    - **Testability**, and Modifiability are central Quality Attributes
- Architecture focus
  - The architecturally oriented module
    - Architectures for systems, microservices
    - Availability, Scalability, Deployability are central QAs
- Project focus
  - Have a go at your own (in groups ☺)

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Some Story

- Relatively new Fagpakke – 2nd time it runs…
- Standing on Shoulders
  - Cloud computing and Architecture
    - Case Study, Docker, cloud stuff
  - Reliable Software and Architecture
    - Testing focus, CI and CD aspects

- *Reliability and Testing will play a major role*
  - As it is vital for modern *continuous deployment* and *DevOps*

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Disclaimer…

- Things in this area *moves extremely fast*
  - Fifth time I do a Docker based course
    - The Docker Engine API has *changed every single time ☹!!!*
- The amount of tools out there is *dauntingly large*
  - I have probably missed a lot that would be beneficial
    - I am very open to your experience, recommendations, …
    - And share internally – learn from your fellow students !!!
- Tools are picked from *pedagogical considerations*
  - Meaning some ‘widely used but hard to master’ is missing
- The downside of a concrete case is…
  - *I may not easily incorporate your recommendations*

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Course Website

- All information can be found on BrightSpace
  - First time we use it so it is bound to go wrong ☹
  - So – feedback!

- Or at the backdoor to slides…
  - https://baerbak.cs.au.dk/c/msdo/menu.html

- [Demo]

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Organization

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The major ’components’

- Seminars – some may become *virtual if you like*…
  - Three in each course
  - 7 hours on selected Fridays (and Tuesdays and …)
    - Lecturing, group exercises, discussions, lunch
  - Cover ~2-3 weeks of material
- Weekplans (**heartbeat!**)
  - Learning goals, reading, (slides), exercises
- Mandatory exercises = *Primary learning vehicle*
  - In groups of **two -three** persons
  - Must be passed to attend exam


MsDO Weekplan 2

The learning goals for Week 36 are:

Virtualization and Container Technology, Cloud Computing. Docker Basics.

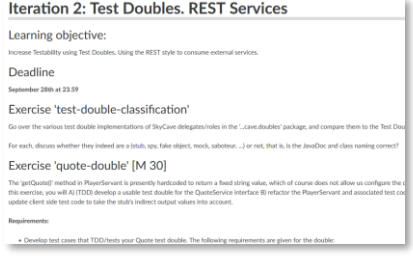
Literature:

- [Newman, 2015] Chapter 6, "From Physical to Virtual", p. 122-126
- [Nygard, 2017] Optional: Chapter 7
- [Smith et al., 2005] Cursory: Focus on the classification of VM. Download on BS (Online)
- [Mell et al., 2011] Full paper (Online)
- [Merkel, 2014] Cursory: Full paper (Online)
- [Anderson, 2015] Optional: Full paper (Online)
- [Docker, 2020] Reference material: Docker (Online)
- [Ratan, 2017] Optional: Full paper (Online)

Slides:

- W2-1 Virtualization (powerpoint) // (PDF)
- W2-2 Docker (powerpoint) // (PDF)
- W2-3 Take Small Steps (powerpoint) // (PDF)
- W2-4 Cloud Computing (powerpoint) // (PDF)
- W2-5 Docker Exercise (powerpoint) // (PDF)

Notes for this weekplan:


Iteration 2: Test Doubles. REST Services

Learning objective:

Increase Testability using Test Doubles. Using the REST style to consume external services.

Deadline

September 28th at 23.59

Exercise 'test-double-classification'

Exercise 'quote-double' [M 30]

Requirements:

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Template for seminars

- Presentations
  - outlining some topics
- Work in groups
  - analysis, reading, application, discussion
- Wrap-up
  - common understanding...

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I will not cover all…

- I am terribly chatty ☹
  - Maybe my stories are funny, or sleepy?
- I will try to make working seminars
  - You will work more and listen less
  - I will not cover all
    - Not all slide sets are going to be presented
    - Reading material will be left – for reading!

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Learning Vehicle

SkyCave

SkyCave

- We will return shortly but…
- SkyCave is a *(almost) functionally complete interactive multi-user client-server system with a terrible UI.*
- Log into the ‘SkyCave’, create contents, and share messages with fellow ‘skycave explorers’…

SkyCave Demo: Local to Mxx

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Start ‘daemon’

Start ‘cmd’

```
csdev@m51f19hbc:~/proj/cave$ ./gradlew -q daemon
2019-09-23T14:25:06.188+02:00 [INFO] frds.broker.ipc.http.UriTunnelServerRequestHandler :: method=handleReq
uest, context=reply, statusCode=200, payload='{"playerName":"Mathilde","playerId":"user-003","sessionId":"4
a036b3f-78ea-4faf-abca-0b27a647f9c0","authenticationStatus":"LOGIN_SUCCESS"}', version=4, responseTime_ms=9
2019-09-23T14:25:14.531+02:00 [INFO] frds.broker.ipc.http.UriTunnelServerRequestHandler :: method=handleReq
uest, context=request, objectId=user-003##4a036b3f-78ea-4faf-abca-0b27a647f9c0, operationName=player-move,
payload='["NORTH"]', version=4
2019-09-23T14:25:14.533+02:00 [INFO] frds.broker.ipc.http.UriTunnelServerRequestHandler :: method=handleReq
uest, context=reply, statusCode=200, payload='true', version=4, responseTime_ms=3
2019-09-23T14:25:14.539+02:00 [INFO] frds.broker.ipc.http.UriTunnelServerRequestHandler :: method=handleReq
uest, context=request, objectId=user-003##4a036b3f-78ea-4faf-abca-0b27a647f9c0, operationName=player-get-sh
ort-room-description, payload='[]', version=4
2019-09-23T14:25:14.540+02:00 [INFO] frds.broker.ipc.http.UriTunnelServerRequestHandler :: method=handleReq
uest, context=reply, statusCode=200, payload='"You are in open forest, with a deep valley to one side."', v
ersion=4, responseTime_ms=1
```

```
csdev@m51f19hbc: ~/proj/cave 107x21
csdev@m51f19hbc:~/proj/cave$ ./gradlew -q cmd -Pid=mathilde_aarskort -Ppwd=333
Starting cmd with Cpf File = cpf/http.cpf
Trying to log in player with loginName: mathilde_aarskort

== Welcome to SkyCave, player Mathilde ==
Entering command loop, type "q" to quit, "h" for help.
> n
You moved NORTH
You are in open forest, with a deep valley to one side.
```

Interact.
Type ‘h’ for help

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Learning Vehicle

- MSDO's focus is on state-of-art practice based upon best theory and methods
- But we learn and try techniques *in practice*
  - Infrastructure as code: Write it for SkyCave
  - Testabilty: Ensure SkyCave is automated tested
  - Rest/Broker: Do it for SkyCave
  - DevOps: Do it for SkyCave
  - Microservices: Strangle SkyCave
  - Scaling: Make SkyCave run 10.000.000 users
  - X: Do X on SkyCave…

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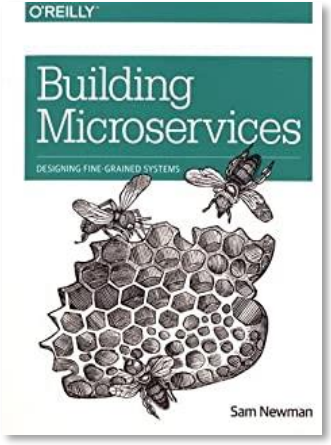
Literature

Sources

- Main literature
  - [Newman, 2015] Sam Newman (2015) Building Microservices - Designing Fine-grained Systems. O'Reilly.
  - [Nygard, 2017] Michael T. Nygard (2017). Release It! Design and Deploy Production-Ready Software. 2nd Edition. Pragmatic Bookshelf



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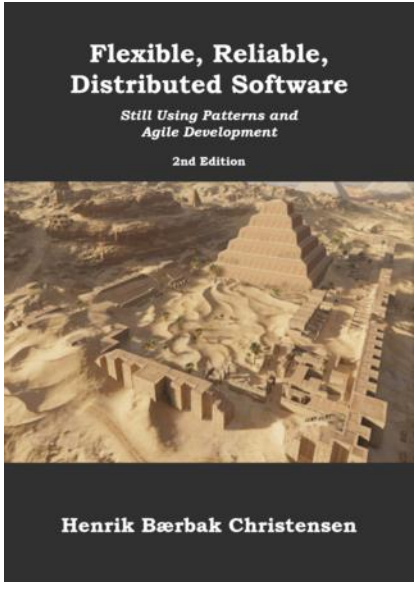
And…

- My own little contribution on Broker and REST
  - Find it for 12$ at https://leanpub.com/frds/



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Other Sources

- Other material are often (research) papers
  - I will make them available through the ‘Literature’ link in Brightspace…
  - If I forget ☺, drop a note on the Forum …
- And I assume a lot on patterns, TDD, testing, …
  - Use my two books or other sources with similar contents

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A Personal Note

- We are at a University, at Natural Science faculty
- Ideally, all our material should be scientifically validated
  - Peer reviewed journals and papers from acknowledged sources…
- Sadly, I find that CS researchers *too often* loose themselves into deep problems of little practical relevance
  - And more sadly do nothing about the *real problems* that industry has…
- The interesting solutions all too often comes from
  - Accumulated experiences, expressed by gifted individuals

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Science And Experience

- Provable correct theory – statements that are true
- Example: *Design Patterns*
  - DPs are accumulated design wisdom, expressed in a agreed-upon format
- Example: *Test-Driven Development*
  - Beck and Cunningham formulated how they found coding should be done
- Example: OO programming
  - First scientific evidence that it *is more productive than procedural programming* came in … 2012! (Or was it 2011?)

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Bottom Line

- This course builds upon *accumulated best practices that are basically/often scientifically unverified!*
  - Most of the course material is basically *hypotheses!*
    - Quite a few people find that it *works in practice and improves one or more architectural/process quality attributes*
- Authors are *gifted individuals, not researchers!*
- Which means ***lack of strict definitions and terminology!***
  - Newman and Nygard often ‘define’ stuff by examples and vague handwaving ☹
  - **I will try to give my own shot at more strict formulations ☺**
    - *I am a researcher and scientist so then it must be science ☺*

Cutting Edge?

- On-going debate in IT-Vest of what a fagpakke should do:
  - *Present the cutting-edge research at the very frontier of human knowledge, presented by the most talented researchers at Danish universities*

[Fielding et al., 2000]	Fielding, Roy T. Taylor, Richard N., (2000) *Principled design of the modern Web architecture* . (Online)
[Fowler, 2005]	Martin Fowler (2005) *Event Sourcing*, (Online)
[Fowler, 2006]	Martin Fowler (2006) *Continuous Integration* (Online)

- Had a complaint by a student about some papers were from 2004 ☺
- *I use whatever literature I find best communicate key knowledge and skills…* *Even if it is from 2004 ☺*

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The Exam

How it works…

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Weird Exam Format

- This course is highly tool and practice oriented.
- The exam is a *practical one…*
  - Show that you have learned by doing it. Based on SkyCave!
- 1½ hour at the computer **on (Date on BS)**
  - Solve some exercises, upload to BS + Docker hub.
- Individual!
- Grade:
  - Basically confirm you group's grade
  - I may change the grade if your performance is radically different from group performance…

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Group Grade

- Your group collects **points** for solving central exercises
- The points accumulate (sounds reasonable, right?)
  - 10 + 20 = 30
- At a ‘checkout time’ I will convert points to a grade.
- Algorithm: Given point interval from 0 to N points
  - Below 50% of N: *Failed*
  - Interval from 50% of N to N is divided into three brackets:
    - Low 30%: Given grade 4
    - Middle 30-80%: Given grade 7
    - Upper 80%-100%: Given grade 12
- *Subject to experience along the way…*

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Intent This Time

- Relatively few exercises that award points
  - That is, manageable workload
- Quite a few exercises that does not
  - Support for training
- Avoid *gamification and stressing and panicking*
  - First time, people worked hard to get that extra 7 points ☹

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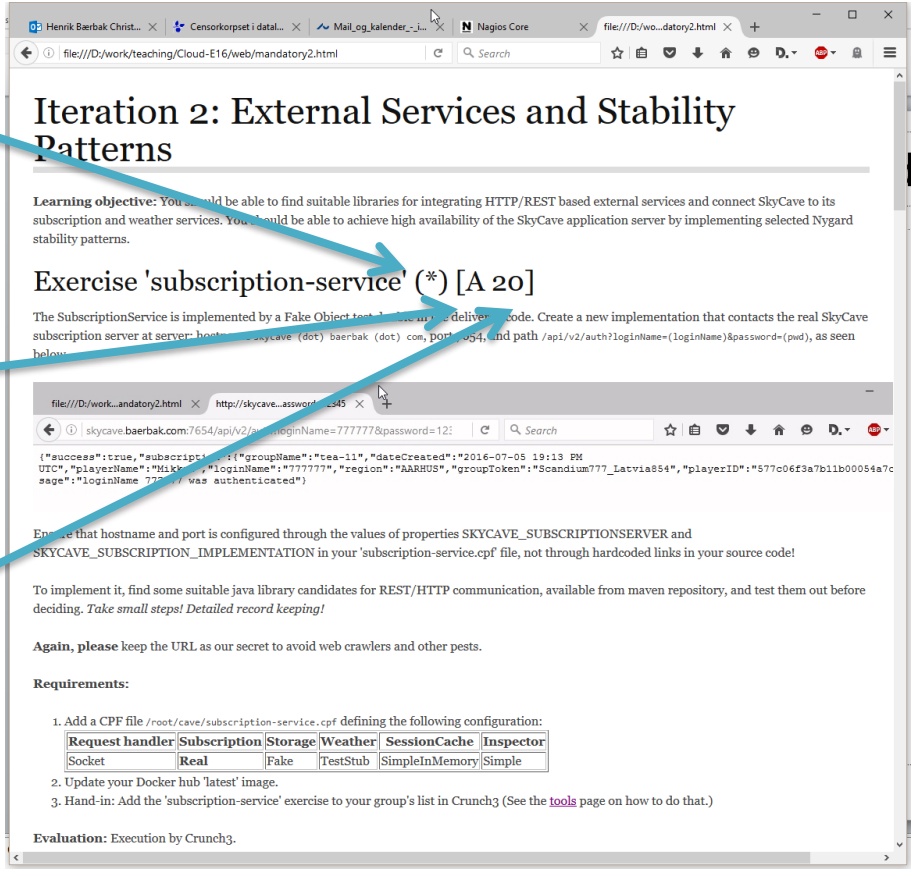
Exercises

- Named exercises
  - (*) = mandatory
    - Must be solved
    - Ticket to final exam!
  - **A/M**
    - A = Crunch assess
    - M = Henrik assess
  - 20
    - = Max points



Iteration 2: External Services and Stability Patterns

Learning objective: You should be able to find suitable libraries for integrating HTTP/REST based external services and connect SkyCave to its subscription and weather services. You should be able to achieve high availability of the SkyCave application server by implementing selected Nygard stability patterns.

Exercise 'subscription-service' (*) [A 20]

The SubscriptionService is implemented by a Fake Object test double in your deliverable code. Create a new implementation that contacts the real SkyCave subscription server at server: host skycave (dot) baerbak (dot) com, port 7654, and path `/api/v2/auth?loginName=(loginName)&password=(pwd)`, as seen below:

{"success":true,"subscription":{"groupName":"tea-11","dateCreated":"2016-07-05 19:13 PM UTC","playerName":"Mikk...","loginName":"777777","region":"AARHUS","groupToken":"Scandium777_Latvia854","playerID":"577c06f3a7b11b00054a7c","message":"loginName 777777 was authenticated"}

Ensure that hostname and port is configured through the values of properties SKYCAVE_SUBSCRIPTIONSERVER and SKYCAVE_SUBSCRIPTION_IMPLEMENTATION in your 'subscription-service.cpf' file, not through hardcoded links in your source code!

To implement it, find some suitable java library candidates for REST/HTTP communication, available from maven repository, and test them out before deciding. *Take small steps! Detailed record keeping!*

Again, please keep the URL as our secret to avoid web crawlers and other pests.

Requirements:

1. Add a CPF file `/root/cave/subscription-service.cpf` defining the following configuration:

Request handler	Subscription	Storage	Weather	SessionCache	Inspector
Socket	**Real**	Fake	TestStub	SimpleInMemory	Simple

2. Update your Docker hub 'latest' image.
3. Hand-in: Add the 'subscription-service' exercise to your group's list in Crunch3 (See the tools page on how to do that.)

Evaluation: Execution by Crunch3.

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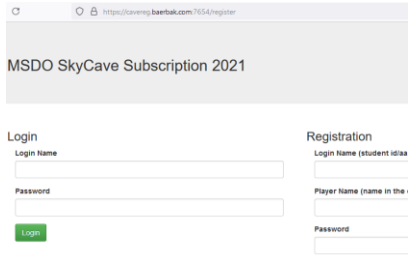
Handing in

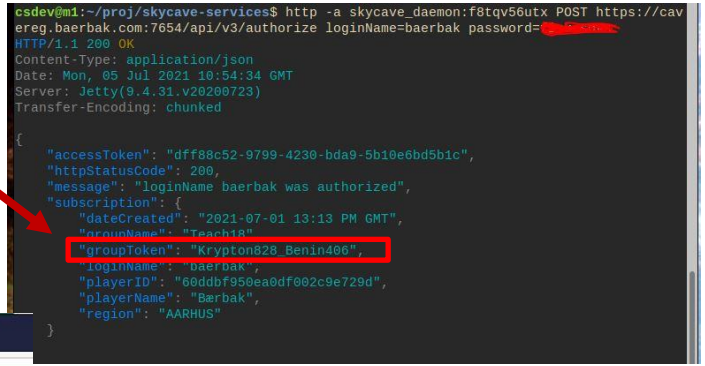
- Either
  - **M** (= Manual)
    - Hand-in required material in **BlackBoard**
    - I will review, comment and grade your work, **one attempt**
  - **A** (= Automatic)
    - Mark the exercise as *solved* on Crunch web page
    - Crunch will re-run its test cases every hour from 07-23
    - **Unlimited submission attempts**
      - *You simply improve your code base, Crunch will always run your latest Docker image*
  - ‘ ‘ (= None)
    - No hand-in or marking will take place

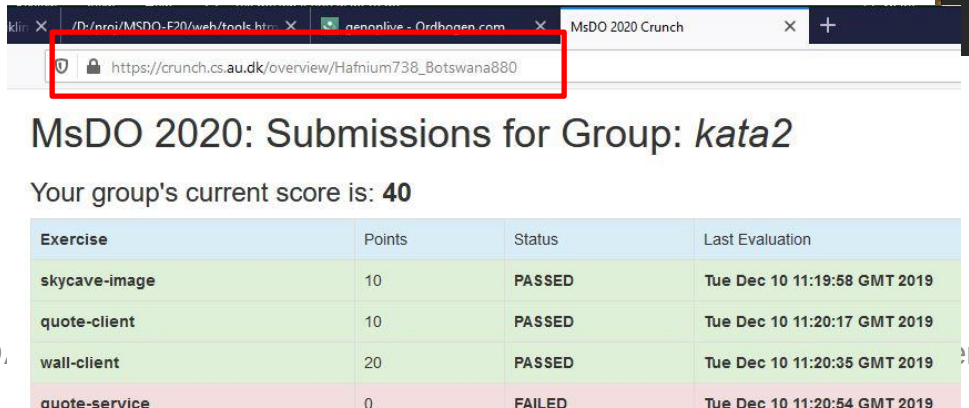
More info at Tools web page!

Crunch Hand-in

- Is a rather weird system – sorry…
  - A) in one of the exercises, you register on ‘cavereg.baerbak.com:7654’
  - B) Authentication will return a ‘groupToken’ for your **group**
  - C) use that as link to crunch:







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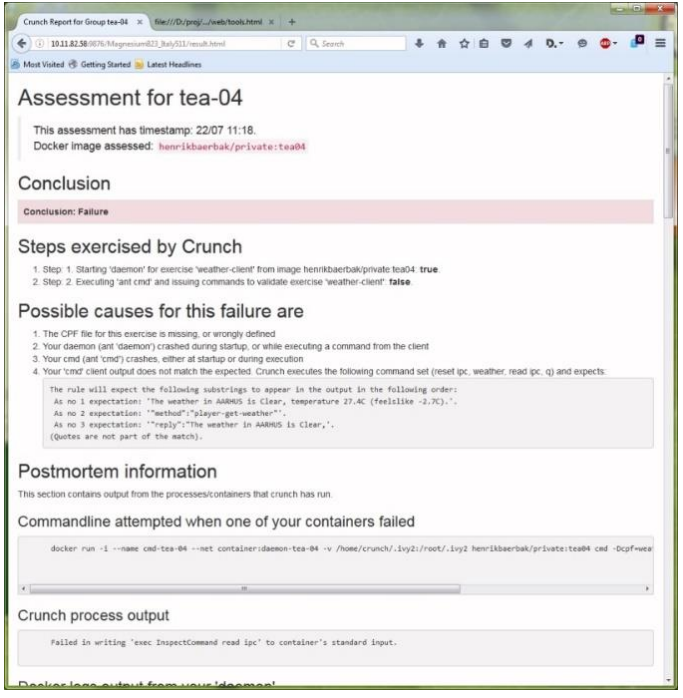
Feedback

- **A** / Crunch exercises
  - Crunch will output diagnostics
    - Tell me if you need more info!
    - And – report any errors and issues!



- Experience
  - Third time Crunch helps me out
  - Generally I get no complaints
    - Meaning: “It is probably working well”
  - But – tell me!!!
    - I had to update Crunch this time, as the Broker log system has changed…

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Feedback

- **M** / Brightspace exercises
  - Submit required artefacts to BS's hand-in page
  - I will assess and provide feedback as necessary
  - Along some *learning goals*

Learning Goal	Assessment parameters
Submission	The provided file names are full path source code file names that match the contents of the image that that Crunch downloads (So I can easily find your files!)
Test Code	The test code is simple (no complex constructs, basically only assignments, simple private method calls, very basic for loop). The test code reflects using the TDD principles (Isolated Test, Evident Test, Evident Data, etc.). The production code is 'well' covered by test code (JaCoCo coverage is 'green' for most production code).
Test Double Code	The test double code is clean, well named, and follows the principles that makes it a test double. The argumentation of which type of double is present and correct.
PlayerServant Code	PlayerServant's 'getQuote()' and other code is correctly updated to use the QuoteService interface, and use the dependency injection system through CPF's to bind to the proper test double (in the 'http.cpf' configuration).

- Experience from F20
  - Many 'full point' hand-in's => few comments

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What's New?

Huh?

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What's New?

- Perhaps rather irrelevant for you ☺; you are following this course, not the previous one, right?
- Anyway…

- MSDO 2021
  - Finally, finally, I will cover a bit of security related stuff
    - Authentication using OAuth 2.0
    - Secure communication, TLS
    - Docker secrets (?), Docker image security hardening (?)
  - Fixing some terminology stuff concerning service tests…

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Corona Experience

- COVID-19 forced the F20 course to be almost entirely online
  - Online seminars using Zoom
  - Online exams
  - Additional ‘evening ½ hour FAQ sessions’ introduced
- Experience *Generally Positive*
  - Positive
    - Works well; avoid transportation
  - Negative
    - Informal talks with other students
    - [me talking into a screen with no ability to find ‘blank eyes’]

So…

- The exams *will be online using Zoom*
- But do all seminars need to be physical?
  - Think about it !
  - And let us discuss further down the line…

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There will be Dragons…

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Why we must talk…

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Our contract

- I promise to **guard you from my mistakes as best possible, fix problems as fast as possible**

- You need to promise me to tell me of problems!
  - We do not understand this exercise?
    - Most others will not either, and we must correct it
  - We have no clue as where to start on this exercise?
    - Ask me/on forum! Ask your fellow students! Google stack-overflow!
  - This score of our hand-in is completely wrong!!!
    - Tell me and explain why!

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The Group Aspect

Working on the Mandatory

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Working in Groups

- Always somewhat of a challenge
  - May work excellent
    - Improve morale, support each other, supplementary skills, discussions lead to improved understanding
  - May work less well
    - Differences in goals, ambition levels, working patterns, skill sets, commitment
    - *Only bad things happen quickly*
- *Form groups, be open on problems, stay in touch with me, be prepared to change, rotate today*

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Let us start the process…

- Please present *yourself*
  - Expected outcome of MSDO
  - Group aspects
    - Geography – where are you located
    - Working habits
    - Exposure to tool stack: Java, Gradle, docker and friends

Questions?