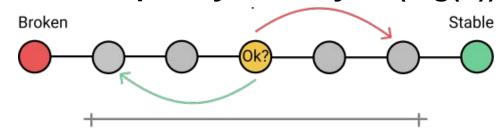
CSE 403 Software Engineering Winter 2023

Software architecture

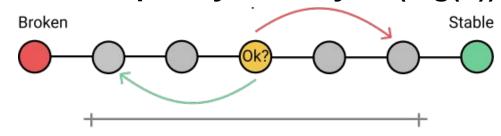
Recap: In-class exercise

• Git bisect time complexity is always O(log(n))

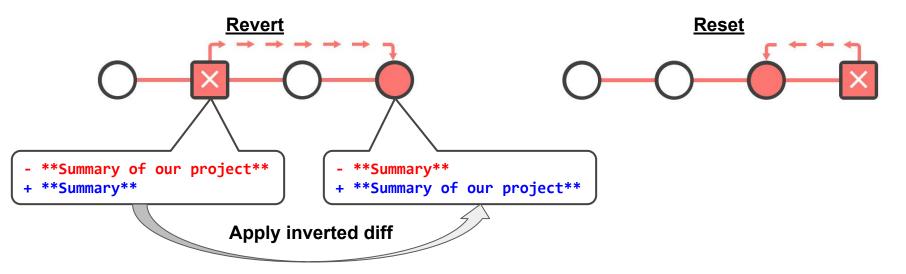


Recap: In-class exercise

• Git bisect time complexity is always O(log(n))

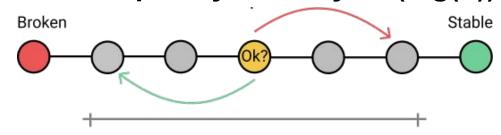


• Git revert vs. git reset



Recap: In-class exercise

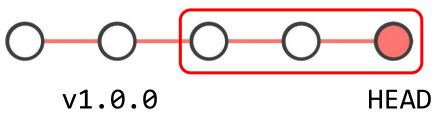
• Git bisect time complexity is always O(log(n))



• Git revert vs. git reset



• git rev-list v1.0.0..HEAD (or HEAD ^v1.0.0)



Today

- Software architecture vs. software design
- Common software architecture patterns

Software architecture vs. software design

Why software architecture and design?

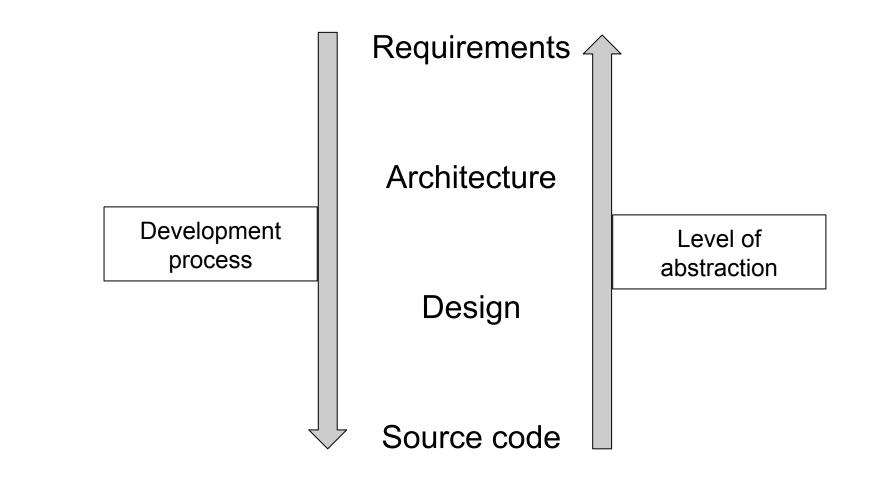
"There are two ways of constructing a software design:

one way is to make it so simple that there are obviously no deficiencies;

the other is to make it so complicated that there are no obvious deficiencies." [Tony Hoare]

Goals: separation of concerns and modularity.

Architecture vs. design



Abstraction

Building an abstract representation of reality

- Ignoring (insignificant) details.
- Focusing on the most important properties.
- Level of abstraction depends on viewpoint and purpose:
 - Communication
 - Component interfaces
 - Verification and validation

Different levels of abstraction

Source code

				And Construction		unideal			
	RUNCHERSON, MARINE	Martin Contractor	Plant of the line data in the line		PERCENTRY STREET		POST OF A REAL PROPERTY.	P. Sty Lat. Propilition 1	
					California and a second			- LA SALE AND	
	Party and the second second		States of the Party of the	Subject to				And And And And	
				State of the local division of the		statutes produced in	Contraction of the local sector of the local s		ERAL COLT
A THE LOP THE AREA	defended with Defended	d versioner and	South State Concerning		CONTRACTOR NO.	Martin Constant		Contract View & Street,	
		NUMBER OF STREET	and toda to				BRUT BACK OF		
	1.					IN A LUCE ON SHE	Real Property A	and the second se	
Par Con Car	States in the	CONTRACTORNES.	COLOR D. C. MOREN		COMPANY OF THE OWNER.		Service Marcol		Contract of the local division of the local
							a second of	AND A DAMAGE	Contraction of
Constant of the	52-50-68-50-55	GREET STOCKETS	COLOCET IL COM			Strand Street Street	Special Constitution of the	The Auto of States of Stat	
				The Property of				Linds Cold BY	
inseries			Manual Action of the other of	2010/01/02/02/02/02/02/02/02/02/02/02/02/02/02/		845-194726-8297	DWILLS NUMBER	plant (Marille & Kraffe)*	
Seconder Per	Barris and Street Street	Chine House and the second							CONTRACTOR NAMES
33.6846668			MELOWARD COLUMN	a free second of	STREET, D'ANTIN THE	Contra Parameter			
Non-the Designation	STATISTICS AND INC.	W2.92-04205	STATUTE LITTLE - AND	1004250035851			And Sectors Concern		
CENTER OF					Contrast of Contrasterior	Concessions (1975		State of Concession, Name	
SAME TO A PROPERTY.	Street of Carriers	MENER OTHER DESIGNATION	STATISTICS AND ADDRESS OF	Banad publiche mit Stand Ph					
			Carlos Anna						
	MR. Netter Bash			etzt za antiava	30x 25x 2702		HERE THE PARTY AND	REPART CONTRACT	
Standards Bank	STREET, SALES	Construction of the	and the second second second		NEW YORK				
le serve delse	6					State of the last		CLEAN ADMAGEN	and the second
along Transaction	The state of the state	th. W. W. House					0054260388575		
		Constant and Constant		ALC: NO			CONTRACTOR DE LA CALINA DE LA C	Support Support	- 1 Machine Science
AND CONTRACTOR	的加速的正式的行用	ACCREATE COMPANY IN ADV	1203 1400 1003		ALC: NOT THE	REAL CONTRACTOR	Street Street Street		a province of
						The state of the second	CONTRACTOR DATE	The state of the s	THE REAL PROPERTY.
Section of the sectio	Here works to work the	Acres Statistics	FOR SHOLLNESS PR	Borne Branner	SATE AND ADDRESS OF THE OWNER.		ALL AND DESCRIPTION		
			Contractory	CONTRACTOR OF THE OWNER		NUTRING CON	A THE CONTROL OF	CHILLY MARCHINE MORELY	Contraction of the
20000000000000		BERGERGER	\$1.4720 meth.275727		The second second second		Participant in the second		E.S.S.S.S.S.
Contraction of the second	the state of the	and and a state of the state	North Andrews	- And Andrews	and the second second	Service reactions	a contractor and	The State State State	STATISTICS OF

Example: Linux Kernel

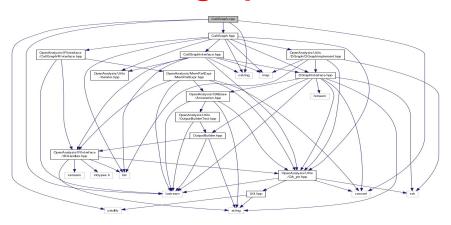
- 16 million Lines of Code!
- What does the code do?
- Are there dependencies?
- Are there different components?

Different levels of abstraction

Call graph

Source code

NAMES OF TAXABLE PARTY.	distances where the	Contraction of Francis	Clar Million Revision	Salit-salitable	State of the second sec	ALC: 1934	LOW MITCH BOLLARS	States of Street Street, or other, or	an or in such that is a
	a and a start		PRODUCT SQN orre	darger and the	Martinetal	$17 \leq 1$	1-3405-97-24 1-2405-2202-68	And Williams	
15-PET-10-10-10-10-10-10-10-10-10-10-10-10-10-	P41012274-ARCT/92-901	COLD VALUE ADDRESS	NUMBER OF THE PARTY OF THE OWNER.	And Address of the other of the	and the second strategy of the	Bullette ALC (PolICE)	Provident March Andrews	BALLY TORONTON-A.M.S.	C.R. PROPERTY A
·····································	ARCIN, Marci, Marcine	HEARSON BRANDSH	Martin Martin	States and a state	Property and the lot of the lot o	INTERPORCEMENT	MERCALLINESS P.C.		SHAMP-CONCEPT
10/12/02/12/12/12/12			FOR PERSONAL PROPERTY.	100100000000	STATISTICS AND INCOME.	2020202000000		Property and the second second	HISTOPPACTS.
		And the Address of th	SPACE LEVEL		SALE ALL AND A STATE	Manager and American Street St		- KAN BATT AN	State of Lot Manual
	DOMESTIC: NO.		E TRANSMITTER OF	ETABLEN/PORT.	And an owner of the second second		CONTRACTOR -	a which we say cherry	Service devoid
And Million Contract (March 1970)	No. of Lot of Lo	PERSONAL PROPERTY AND INCOME.	Salar Large Carter			INCOLUMNATION OF THE PARTY OF T	SP20 MPERCENCELLE		SCONDELDICIY'SA
A MARCH PLANAPENDE			States of States of States		MARCHAR MARCH	NUMBER OF STREET	averal support.		THE REAL PROPERTY AND ADDRESS OF
STATION STATIST	822200228-0216822	2010/2012/2012/2012	Manager Park, Striket, Company, St.	MARCH STREET,	E-ROALCORDAGE		Million Mail 127270	Martin Property and	Editoria
STATISTICS.	256-0373347593	ROUTE PLANT	Constantine of Co	Sector Station	and the second second	the second second	Same of Contract, St.		
CLIPHON STREET	And states in the second second	And a state of the	E POM DEPONITION	NUMBER OF STREET,	1001012/02/02/02	COLUMN TO A COLUMN	and a second	PROBABLY STATEMENT	101100-0010-000-0
CHOICE STREET, SHORE	E WARDER	State of the second second	and the second	CONTRACTOR POLICIPAL		State and State	AND AND STREET	Contract Contractor Street, or	2027230A040
winster - Serie		ABROATS BALLEY	10-04 TO-54 No.		THERMORY	Here keesering	Real Property lines	FRANCE COLOR	Consecutive Sector
A DESCRIPTION OF THE OWNER.	KADMAPPORTON	INCOMENTAL ADDRESS	CONTRACTOR OF	STREET, STREET, STREET,	the second second second second	REPUBLICAN DURING	STATISTICS AND INC.	STREET, STREET	CONT. TELEPISTICS.
NUMBER OF STREET	MERCEANING THE PLAN	BERNEL HOLES	Control States, Married	and the state of the	DEARD TA SCHOLAR	ATTRY HE FYR RD-DEFACING	Status - realized inc.	State of the second sec	ENGLACED DURING
ALCONT OF STREET	BURNEY BURN	1112554000 40076a	Contra Contervine Con	Second Street Party	Restoration of the local	IN ALL CONSIST	Address of the other states	INTERCOMPACTOR AND A	100000000000000000000000000000000000000
ALCONTRON	ATENCERATE	THE REPORT OF STREET,	Mary Sold States			In Add of States	Name In Landson	State of the state	
gent case case i	Manager and states of		COLOR OF THE OWNER	SHATCHPROPERTY.	STREET WITCH	Provide States of States	1.Solutions	101101-02-01010-0101	
	Participation and an an an and an an	\$1000 - 34 h 7 to 16 / 40 all -	DERIFICIAL TRANSIC	State and a Cardy Pro-	A MAR 0.46, FVE J., 69,000	a Carlot And And Carlot Revenue	Public Court for Ministra	STATISTICS AND D	ALCONOMIC AND ADDRESS OF
NAMES OF TAXABLE PARTY.		RULE WYCHOLD WORTH			States and the second	CALLER ST.	Card-Scine Spine Provider 1		CHEVRON AND IN THE
THE CAMPANE	Contraction of the second	HARD GERENA	Name of Action of Contract, Name of Contract, Na	States and	ENVIRONMENTS:	EPERMINANT:	attaing marginger.	TRACE ANOTHER	SOUTH A DESCRIPTION
COLUMN DISCOUT	STADIO DATE		CONTRACTOR OF	To a subscription in the subscription of the		Stand Street State	W-LINSIC PR	BURNELON, DAMESTICS	
APRIL AND A STATE	1.	MARKE COMPACTION.	ALTER AND AND ADDRESS.	Sector providence of the	2014071 10.07 1008	No. Tomor Content Content	Martin Contractor and	THE OWNER WATCHES	1014011110-07770
Are had been and	Name (March 1997)	Production of the second		TELEWISHE		And in the state of the second	MULTINE COLUMN	LAALOOM PR.	and shares and
A STATE	the state of the second	Road of Concession, 1	Second and	Martine La Martine	States Street ride	Contraction of Co	Strates a station is	Survey of the local division of	2010 Party (0.01/1-2-1)
	POST CONTRACTOR	DESTRUCTION OF	MET OF BOARD	24/2(12-3/4 × 91)	KINAAJDHIJAAAA		ENTERNANCE STORES	200703045004	SINKS SHOW
11100-012-02-02-02	Construction of the local	WARD IN COLUMN	Child Provide States	COLUMN TO THE PARTY TO THE PART	and an end of the second s	BUBLINGTOCHUSE	And taken of the local division of	Rabin Contractor Property	Sector and
Contraction of the second	ADDITION OF THE OWNER.	SCHOOL SCHOOL SCHOOL	San and the second second		OCCUPATION NO	1056RC2480H.2018		States States	Contract of the second
Contraction of	BELLEVER STATE	Charles the re-	Real Property in which the			Kong and the state of the state	20210/0222/2017	In the second second	SUBJECT OF STREET, ST
	the life of a local strength	121208124/97072	Contraction of the other	COMPANY AND AN	STAIN DISH ATTEN				25 Aug 294 454
are induced in the Party	And all of the little states in the little states of the little states o	PC TERMANE LUMINE, p1	Starting Street, Stree	of the Contract Proc. Differences	Martin and Antonia Con-	And Lot Marth	PERCENT COLORAD BATA	Contract of the Carlot Ser	NONA-CO-MORPHICS
	Statistics and a second state	Electricity and and consult	PERSON OF THE PLANETS.	and the set of a finite of the		CRAFT IN ALLAST &	Providence in a second	INF ROAT ATTACKS IN CO.	1.11
And the second local	Shipping and the second second		HOLD VIE TOTAL CANS	DR-REPORTS	100000000000000000000000000000000000000	Description of the second			STATISTICS.
No. 12021	A Designation of the local division of the	form of the other by the set				\$718/05/00/5/10/5/	L'ANDRE CONTRACTOR AND	Add of Manual Address of the	SERVICE STREET
Sector Sector	Promisi and a state	and an address of	250000000000000000000000000000000000000	OR THE R. P. LEWIS CO., LANSING, MICH.	201-2010/06/07/07/06		The state of the second second	Contraction of the Addition of the International Contraction of the International Contractional Contrac	IGEORGENCEEN
A CONTRACTOR OF THE OWNER, NO.	Control Operation	REVENUE ANTIMACTICS	Charles Address of all should be	COLLEGE OF COLLEGE OF C	10200000000000000	Dates Toronto	ID080023357.808	NUMERORY PERSON.	
Nor-BYNCHIA.35	State (1) being the los	and a state of the last	Balletin Street,	and the second second second	the Assessment of the Astron	INTERSCOTORY AND			Line Arrithmetrics (Mr. 1981
NAME AND ADDRESS OF TAXABLE	AND A PACING AND	States of the states of	Disate and and	States 12 States	Partie with weather a	States of the second	RE-LEEKSWORF		
Anno Mala de Cortos	State of the state	Anna Maria Contaria (DECOMPORTS PROFILE	Bits-DRUGHLANDARCOLD	MNTO/RECEIBERGY	Company of the second	Martine and and	AND DEC ON COMPACT AND THE ROLE OF	101111-101110-000000
A DESCRIPTION OF A DESC	the water have	Main States	and the second second	AND A REPORT OF THE REAL	CONTRACTOR OF BUILDING	Charles Strengthered	No real a service	STREET, STREET	
A STREET	HEANGDONER:	ELECTROPOLICE.	CONTRACTOR AND	0127232200000		President Color of the	101 01 10 C (V ->)	Shink Strategy	2010/02/02/02/02/02
and the state of the second	A Constant of the local diversion of the loca	In the state of the state	Contraction of Street,	RESPONDENCE.	Day of an and the start of the	Store and a second state	an and a state of the		SAVE DROWN
Statements Bank	THE REPORT OF THE PARTY	Same and same	bier bier bier	Constant of the second	SECONDERVISED IN THE REAL PROPERTY AND INCOMES	Contract of Street	Reading and the second s	Supplication of the	State Street av
Carlanda Marin	REPORT FEILER	122222	LUTING ALTERNATION	Body Tatulation Without office		Real Road Processing Street of the	Contract (and () and (101012-001209-0207	160X085ctr.275
CALC: YAND MALT	NOT THE A CHARMEN	Contract of Contract on Contract of	and a second sec	#25557965.45T	(1990) (1990) (1990)	STORE STORE	DERAN ARE RO	CARLS AND ADD.	CONTRACTOR NO.
MARCH HOUSE	CONSTRUCTION OF STREET	A Providence of	Cir. Critochelle	Philippine and the second	BERNELSON'S MED	and an annual second	SCHOOL SECTION AND ADDRESS.	ADM/CAMMATSPACE	BODD BOLDEN
Column Line Station	Tenner Street	Stat From a stranged	Distance and the second of			NATION PARA	ROELCIGD OLIVERSITE	255250,095212026	
AND DEPENDENCE	Call Property Property.	Philippin and Market	KING TO CLOSED CO.	STORE - STREET	PONTS WORKS	failer strengt	CONTRACTOR OF STATE	Contract of the second	HPa/GOHPGAR
			San Barris	ALC: NO	STREET, PROPERTY OFFICE	Gillion A. S. S. Lail	201240030640296-004		How you have
Arthur Articity Co.	A Deciment of the second second	17 - VAD # # (T-O)		The second second	PPECK REPUBLY		Marriel Print Print Print		
VARIATI STRATCH	No. of Concession, Name of Street, or other	101-100x1+12001081100493	STATISTICS.		A DEPOSIT PROF.	ENDT.3/32515/0030/PD	Barris #18	INTERACTORNEEDA	
ALC: COLOR DE LA	Service Joseph	100/2297/2007/4/073	and the shares of	100110-0000-00000-0	UNITED STORES		STORAGE ADDRESS	Chiefe College and	T4220182137822
And the second second second	amontal VAR	Support of the local division of the local d	min mattering	Sill'Autor Coldes		Dentration of the second		The Post of the Avenue of the	Statute of the Address of
Sevenese the car and	DE ETA PLA DE AVIES	CHERCO AND DECISION	2001-A.S.amUV(2047202)	138-3060807003040	and Charles and Area	BOX ADD IN THE ARE	And a state of the second state	and the second second second	
Charles and	and the states	And in case of the local division of the	Cond. Workships	dame.	Contraction of the	CONCERNMENT OF A DESCRIPTION OF A DESCRI	alminer available		
Think () . Think then	CONTRACTOR NO.		AND ADDRESS STORES	DIMESTOCKY SCORE	READING	an con sector NARCONCER	NUT TO AND AND	SAUD UDATES	
Service Con	Hardware and the second	Street, stands and star	Cold Section 2.	Long Francisco	STATISTICS IN FUR-	WARRANG WE WARRANT	KRUNPERGRAMMEN		
BREENAL WEEK	CONSTRUCTION OF CONSTRUCTION	DEPERTING AND A	ELLIPSING PROPERTY.	PERMINERS/	ID CREMERTING ASSESS	NET STATE			102510859.9h3
dia 2 North add in	102.0942/00207202	State State State of	2210-201230-0055	STATISTICS AND AND A	ENG-DOMESSING	Industriaux-managements	A TRACTORY	CHILL X MICHAEL MORELLY	STOCKSON CONTRACTOR
and the second		Shand route history	San a standard and	LOSSESSMERTS	CARS-DASCINGS	Contraction of the	1001 01 9921 933	1010112 PO10200	- office and points
ALC: NOT THE REAL PROPERTY OF	Diversion to be subscribed.			Safety and a state of the second seco	STATES AND ALL AND	No. of the second	Presenter		1.512.3.8.3.4
BALLEY CONTRACTOR	diaman and a second	BARGER	E1400000.70079		Beneral Street Brief		Contraction of the second	Manager and	
Contraction of March	ALL PROPERTY.	and some of the lot of the	NUMBER OF STREET		and the second second	Sensing Colling Co.	all of the sum of the local division of	Him Or Service Service	



Example: Linux Kernel

- 16 million Lines of Code!
- What does the code do?
- Are there dependencies?
- Are there different components?

Different levels of abstraction

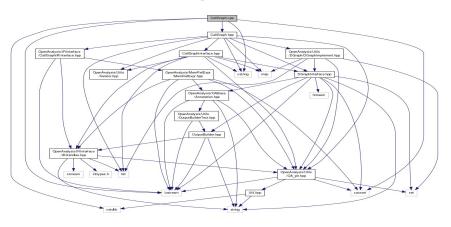
Call graph

Source code

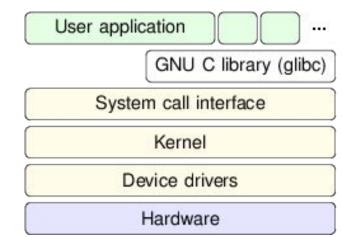
NAME AND ADDRESS OF	Survey and the second	Property lies with many	SEALING SELECT	SERVICE AND COMP.	SALENDARDAM.	10000000000	I'm the set of the owner.	summer and the state of the sta	and the second se
And the second second	NUT BURNING BUTCH	6.300 Serie (2019-10	- ALLER BON offe	deleteration of		Table of art films	Constant of the second second	2 - Wallack	
	Note and The State April 1991	CONTRACTOR APPROVAL DUCK	CENTRY PLAN, 2018, CO.	10-03-2074-153C-354	and recently in an other set	COTTACTION DISCOURCE	Address Practices, Construction	NAME AND ADDRESS OF TAXABLE PARTY.	
	The state of the state	STATISTICS.	Salar Barris			100025-0551	10.277.229256	States in Lines	
012/03/12/03/16			And the second second	P.DOLENSPIERT	STORES SALES	200-200-200-200-	POST OF A STREET, STREET,	P.Stylenbergerer	STREET, STREET, ST. ST. ST.
· · ·	10,2011/101010101010101	A STATE OF A COMPANY AT THE ATT			WANTER BARRIES	Activation of the local division of the	1000 H 1000		Sale and the second
a subscript of the	KSE-AC-AC-ALBERT	Numerous and the second	pripage and a low	10-X1+3X12-24)	(MANUPLAPER/03D)	Statements and statements	And a second sec	101-101-102-101	Carl Construction and
102.39.00.2020	STREET, MARKET	MARTIN CONCERNS	Employed in the second	ENDOUTINFY OFFICE	SPARIN SPORT	star links dans other."	E PERSONAL PROPERTY AND	E TRACEMORY SHITE	122002 (000012
	Party and the other own	States of the local division of the local di	States of States of States	Ether Provident	Manual Paral		Statistics of the	Service and	
A set of the set of th	BAR GAR PRINT	Labor of Labor Conversion States	STREET, GURTLEDGA	262409000000000000	11420-02-07-02-00-0	STREET ALL STREET AND A	Contraction of the second second	State of State of State	Editoriane
CONTRACTOR OF THE	0.512-09-28824-082-6	Adding and the owners of	Statistics of the second	MAX PROVIDE	Edical Consider	Parameter and the second second	No. of Contract of Contract of	(Star On Village Williamson)	The state of the second
OT BALLANS	200.0223/07503		Constantine of the		CONTRACTOR DATE	the state of the state of the	State of Long Long Long	Same and a second	
A YMELIGHT CHIEF BASS	20 and the second	ALL CONTRACTOR	- No Torrad	Endforth & Principles	stant process of a contract	Million and Mile	Statute Court	CONTRACTOR AND A CONTRACTOR	slavybuildAttorio
	THE REPORT OF A DESCRIPTION OF A DESCRIP	And the Barristo	BURGANCOVICIANS -			of state of Location in them.	Salar Tolla Tilla	TORN PORTA	
Part Anna Seam		(ARRONAR REFIELD)	and Talk high	A STREET AND INC.	distanting of the	- HELLER BOARD		200000000000000000000000000000000000000	2012/02/02/02 12
AND DO NOT	COMPACT REAL	WEEKS LOW SCHOOL	CONTRACTOR AND A	2002/02/22/2017	STREET, PARTY AND ADDREET, PARTY	Distantion of the local	SERVICE AND ADDRESS	100000000	STATUTO ACTING
LINES OF THEE	In a second second	Real Color In Color	CONTRACTOR OF STREET, LOR &	Section Street Party	Second Second Second	TONCOUNT OF CONCERN	Statement Statement	and the second second second	2024/02022/04/2020
	A CONTRACTOR OF THE						And Westmann Pro-	And Personal Property in the local sector of t	
	ADDRESS DEADLES	ALL AND ALL ALL AND AL	CONTRACTOR OF A	2012033322320	Propagation and and	COLONAL DISTANCE	SAN STRATES	E-CARLES CONTRACTOR	INFORTONE STOCK
100000		ALCOHOL: SHORE	Concert of The Concert	Sand Contract of the	CONTRACTOR OF A		1000 to The Dataset		COMPANY OF THE OWNER
	Sal and A subsection.	ALL WOOD DO NOT	ACCRETE ACTIVATION ACTIVATICATIVATICATIVATICATI ACTIVATICATI ACTIVATICATIVATICATI ACTIVATICATI ACTIVATICATIVAT	STORE STORE STORES	ALL OCCUPATION AND A DATE		Party March 198 March	COMPANY IN ADDRESS OF TAXABLE NO.	Sector and the sector
10.22 (Do- 110.85)	Discontaction of the	RULEWICKOLD MONTH		Relation of the second	CHARLEN PERSONNER	ASSAL MELLES	Carl Some Start Strate	Barris and and the	CHARLEN PROPERTY AND
A CAPE VEL	Electron of the	HARD GERENA	SPHOPEPHICK	State of the second second		PROPERTY AND A CONTRACTOR	attaingenry direct		
	State of the state of the	Serie Serie Alars	Salar House	To a subscription in the subscription of the	170.00000000/02/02	Star Square and		Access of Constraints	17220000000000
E-Sterower	100000	CONTRACTOR	Am. 112.100	STATISTICS.	10140171 10.477 YOLK	NY THREE YOU AND TAKEN	W-Considers	THE REAL PROPERTY OF A COMPANY	101000113042378
Planting and the local	Family . (West, Survey	the second of the barries	自己的	State of the second second		MCCORP. Mar. Towners	Mart Marting	Linds Cold BY	
CALC: NO.	How sin this water	Rolling to be with the	Same and some of the	MONTON MARKEN	STORAGE AND		Trans - saling -	Contraction of the owner owne	OTH DATE OF A PARTY
	NUTLING BURGEN	THE PARTY OF THE PARTY OF	THE OWNER WERE		2004639332646	A Property of the second	Designation of the statements	Concerning of the second second second	CONNAUGH CANAD
5455 S-73 S-8 10-9	Color Andread		BUILDING PROFILE AND AND A	AND A COMPANY COMMENTS	Sector Sector	0000, JAC1 N 3K SERVE	Ex the St. Ves XX states	Auror research and a	and an
	The second second second	NAMES BOTOM DA	State of the second	Contraction along	OCTO-PROPERTY A	2004K-2385K-2658	POSTAL CONCEPT	Construction of the second	Contract of the second se
	Berland and		State of the local division in which the	Mary Manager and Mary 2010	SHALLOGHTON	KURDING THE THE ARE			
A COMMENSION	Artificial Products of the	12.000.049.000	and Party Adar of	COLUMN AMAG NO	STERES PROFILE	Company of the Party of the Par	WAREAR ERACIANS	DIMERTON ON CONTRACTS	
A MINICE DESTRUCTION	THE REPORT OF THE PARTY OF	Challenger Challen	HENG BORCHBERGE	100000000000000000000000000000000000000	407020454644464646		Section States and		12000-00100203
	Column 1 States - States	BLODY STREET	State of the second second second	STATE OF TAXABLE PARTY AND INCOME.	ADDE-CR AND DESCRIPTION	100-01-0-0000	101023200320288	2013/01/03322002	2022104271520526
COLUMN THE OWNER	Second and a lot of the		SCOULD THE STATE	BRADIO STREET	STORE STORE STORE				
Sales Parties	OPPLINGTONING BRIDE	fermilite and her and the second	and the state of the state of the	Contraction Property Prof.	COLUMN A CARDINATION .	Construction and provide	Mar. 2010/2012/2013	A 1. THE Y R. PAY A. HALLAS	entropy a company.
Sile Alexander	A.S. P. Spiller Problem	Phillip Automation (R		CARLON CONTRACTOR AND	system where sheet.	Include: 2 Added	Contractory	THE REAL PROPERTY AND	CONCERNMENT OF THE PARTY OF THE
Tropy of	Prost and a state of the	STATUTO CONTRACTO	Service Velocity	STATISTICS, PARTIES.	SHAPSAK SHOPE,	Population and Personal Con-	and the second states of the	a strategies a	1000000000000
100000000000000000000000000000000000000	NUMBER OF		51011132514000079	Banca publiche est Sandthe		NAMES OF TAXABLE PARTY.		WITH A DESIGNATION OF A	1210/04/02/05/02
CALLS ALL ALL ALL ALL	CONTRACTOR NO.	NUMBER OF TAXABLE	CALCULATION CONTRACT.	STATE OF STATE OF STATE	The star indicate and in	A DECEMBER OF A DESCRIPTION OF A DECEMBER OF A	NOL SIGNAL P	ALL AND A DESCRIPTION OF A DESCRIPTION O	
	And the state of the second seco			100000070000000	410 T 15 T 16 (1998 A 15"				start of the local strength of the
	State of the state of the	ALTER THE DAY TO T MAN	Intel 400 as Proceed	States of the other of the othe		STATISTICS.	Martin and and	The last with the sector	2.361100 12.661346
$\sim 10^{-1}$	Mill. Netter Amil-	Mark Street and			NOR - CANCELON-		1-11-14×41	COMPANY OF STREET	
CONTRACTOR OF THE OWNER.	A CONTRACTOR OF A CONTRACTOR A CONTRACT	The second second second	that an implement a memory of	The PROPERTY LACE AND	AND STREET BUT AND ADDRESS	ACTING OFFICE AND A TAIL OF			SUBATRONO PARTY AND
Contraction and the second	PST A SHCL NO. WHEN	SECONDECTION OF ALL ALL ALL ALL ALL ALL ALL ALL ALL AL	Party States Art preside	RELACEDERING	DMAR NOV SHOW AND A SHOP	Shoutheast other	STOCKED TRANSPORT	CALLER ADDRESS A	Date 3-for and call of a
	DILEM SCHOOL ST	Contra Series	STR759SNATES	20002-0002-0025	99608 (1968) 5 Z.B	No. of Concession, Name	States (Law (States)	Line and the	20020000000000
In which the second	SECRETIONS.	A. 400 St. 100 St. 10.		\$12.42(1)()()()(*****************************	16A 2329 (148) 309 (27	STATISTICS.	C Rey Long The	dunes and story	180 YOR GAR 2750
COLUMN PORTAGE	Com This is a control		Contractor and	English and the state	1011012002100	alart Addression	Contraction of the local distance of the loc	100000000000000000	STANDART PROPERTY.
	BREET OVER THE PARTY OF THE	AT A DAY OF A DAY	Property States	ANGLISCON, MALL		1107-0007022042		THE DR. P. CONTRACTOR	100.000 mails 2.1.194
ACTION OF A DATE OF	The section of the section	PR. IT.W. SHINES	Contraction of Contraction						
AN DEPENDENCE	Carl Point Proving	PROPERTY AND ADDRESS.	San States	SUBAL SUBAR	Him Contractory	Re speaker water to	allowed on pages why	STATISTICS.	FOR TO THE R.
		Party of the South	Dave March 141 Com					CENTRAL PROPERTY AND	CT Soldiers Schutzer
STRUCTOR STRUCT		12 - 14 - 5 - 5 - 5 - 5 - 5 - 5 - 5 - 5 - 5 -	and provide a sur-	In the second second	P.P.B. K. KORTHALF	Special States in a later	Sample of the other states.		Service and the service of the servi
1001110070500	2011年1月1日日1日日日	No. of Concession, Name	1203 200 2012	Carlos and a state		PERSONAL PROPERTY.		MPTO-MARK CAMPAGE	10.000000000000
00000000000	COLOR LANCON	10003120120000	ACCOUNT AND AND A	100100-00000-01000-0	00.001000.00000	CRAME STRATES	Concept Property in	the rest of the second second	
administration date.	information Arts		min emitteente	ELAND, BRANKSHIELE	STATE OF STATE	PERSONAL PROPERTY.	CONTRACTOR NO.	COLUMN TRUCK WE WITH	
WHERE A DRIVE THE REAL	PERMIT AND A TO		2007-Xam1720-0000	NUM PORTING COLOCUTS			Report Construction	C. I.W. T. S. M. C. S.	OR DYS MELOND IN LO.
Secure 2	the name and the	and a contract of the	Contraction and	description of	Store and Store of Store	Diff. White white and	along a dealers	and a substitution of	S
	STREET, STREET	STATISTICS.		DIMESTOCKY SCORE	The set by the lot of	Charles and the	ROTATION AND	AVALUE: AND A	ECONOMISSION UNITED
Particular Contraction of the local division	Manual Property in the State of		Alterative in the Particular of	Paul des aller and and and	STATISTICS STATE	ANCERED HE WARRANT.	RESPECTIVE.	Disk Mart and Property ID-	Contract over Aug. Strike
SECARTINE.	Personal Street	Participant and a state	ET L'AN AL MERICE	Pland Braining	Street and the street and	NUMBER OF	Address of the Party of		and young any
dia 2 Ventre kel. h	105.091200001120		2210-20-22-22-23	STATISTICS AND AND A	BWG-TROMMENT ONLY	INTERNATION OF THE PARTY OF THE	CONTRACTOR OF THE	CHER. 3130455-407-3679422-	WHICH AND PROPERTY AND
1.000	878-43 (BARA)	BURG TODOLED	Conversion of the second	STATISTICS IN COMPANY	State Addition of	BARBARDELS JOHN		Contraction (Sec.)	CONTRACTOR OF
a art mary dam. and a		Puttern Land William			DISTORTONIC OCC.	Contraction of the last	Presentation and	Sectors - Store - Sec	TROLLER BOOKS
	an and a serves	CHENCER, STREET	EL CARGE CONTRA	SINCERS LACENSE	Construction of the	NUMBER OF T	CONTRACTOR AND A CONTRACTOR	PARTICIPAL AND ADDRESS	LENE BOOM
Contra a Conse	ALTER THE LOCK	and and a state of the state	Software and started	and the second second	and the second second	Anna Contractor	No. of Concession, Name	rentile Service and	Frank Barrows

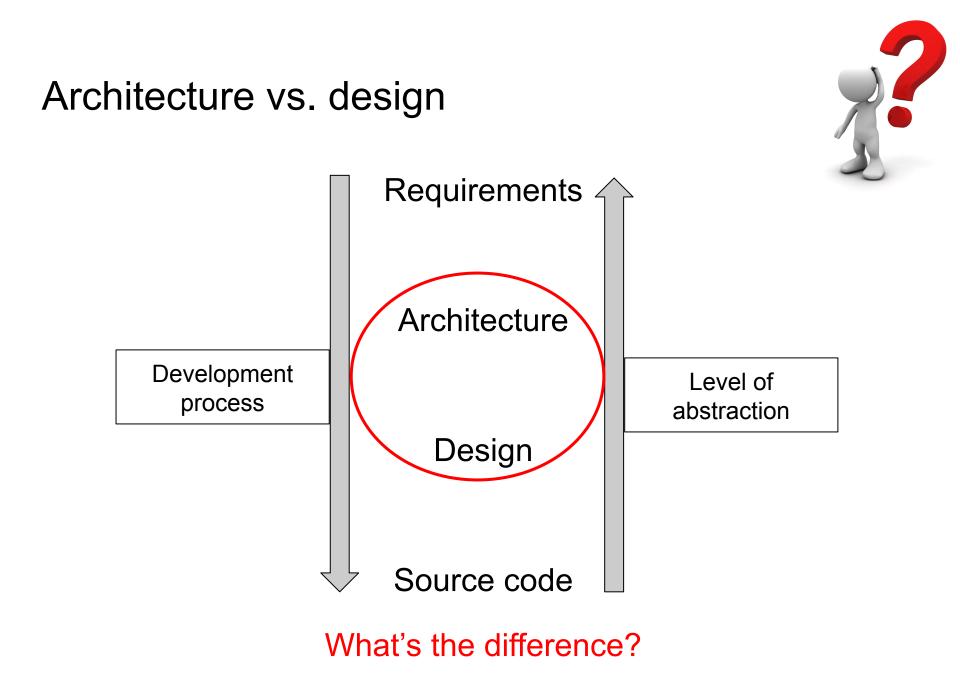
Example: Linux Kernel

- 16 million Lines of Code!
- What does the code do?
- Are there dependencies?
- Are there different components?



Layer diagram





Architecture vs. design

Architecture (what is developed?)

- High-level view of the overall system:
 - What components do exist?
 - What are the protocols between components?
 - What type of storage etc.?

Design (how are the components developed?)

- Considers individual components:
 - Data representation
 - Interfaces, Class hierarchy
 - o ...

Architecture vs. design

Architecture

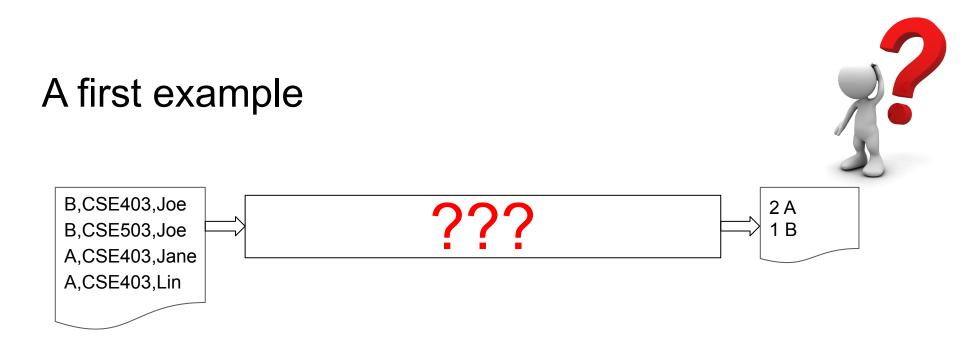


[Gates Center Architecture, LMN]

Design

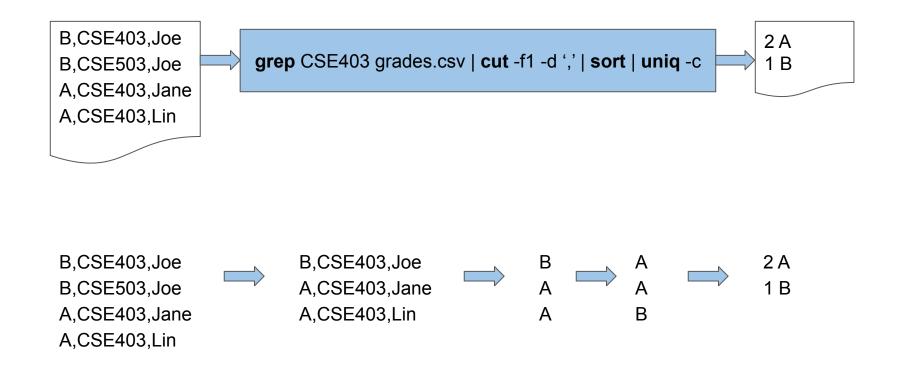


[Office design, New York Times]

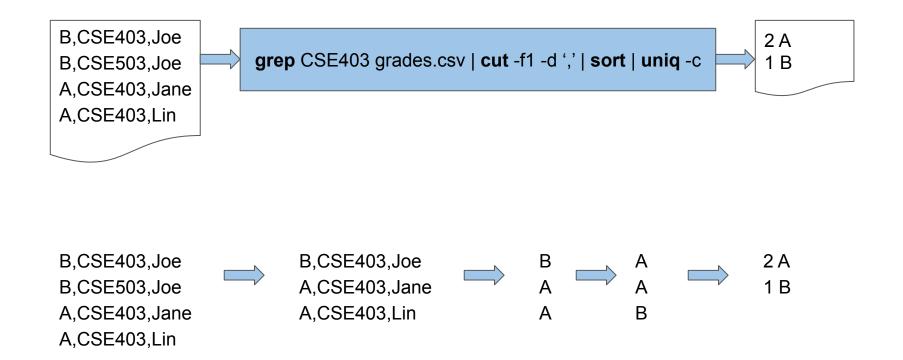


Goal: group and count CSE403 letter grades.

Pipe and filter

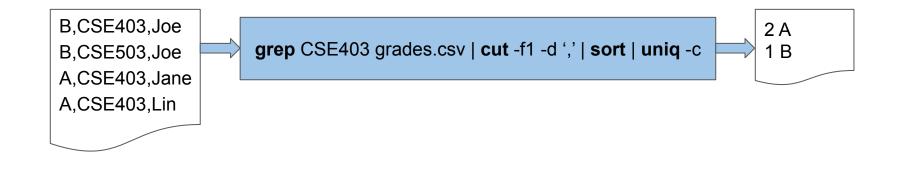


Pipe and filter



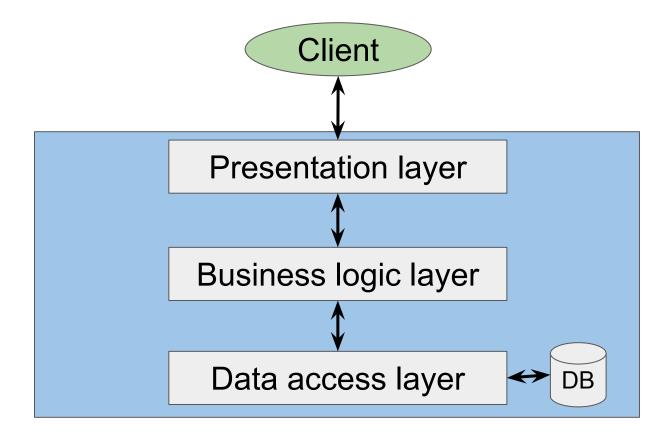
Pipe and filter is an architecture (not a design) pattern, why?

Software architecture: Pipe and Filter



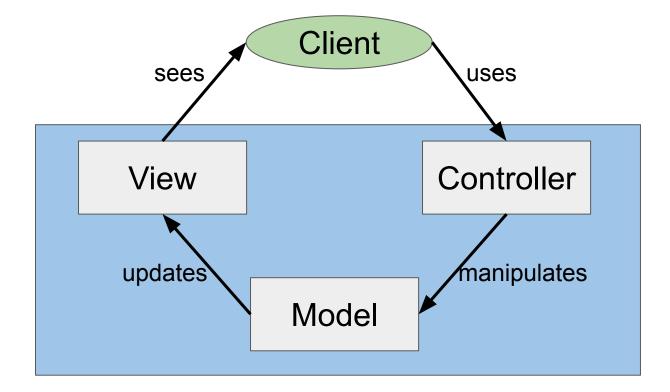
The pipe-and-filter architecture doesn't specify the design or implementation details of the individual components (filters)!

Software architecture: Client-server / n-tier



Simplifies reusability, exchangeability, and distribution.

Software architecture: Model View Controller (MVC)



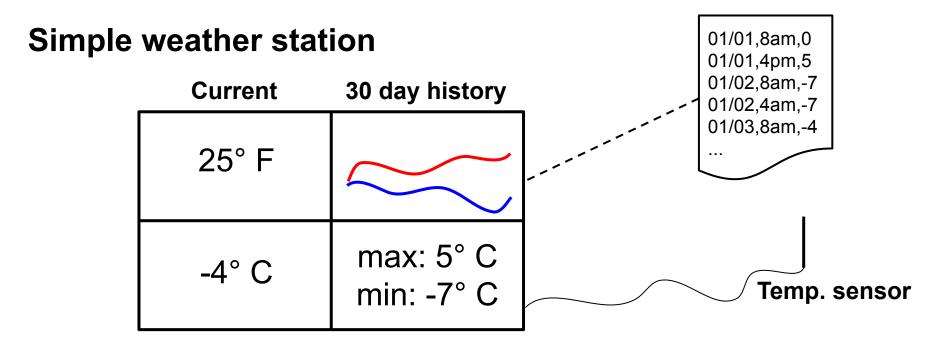
Separates data representation (Model), visualization (View), and client interaction (Controller)

Model View Controller: example

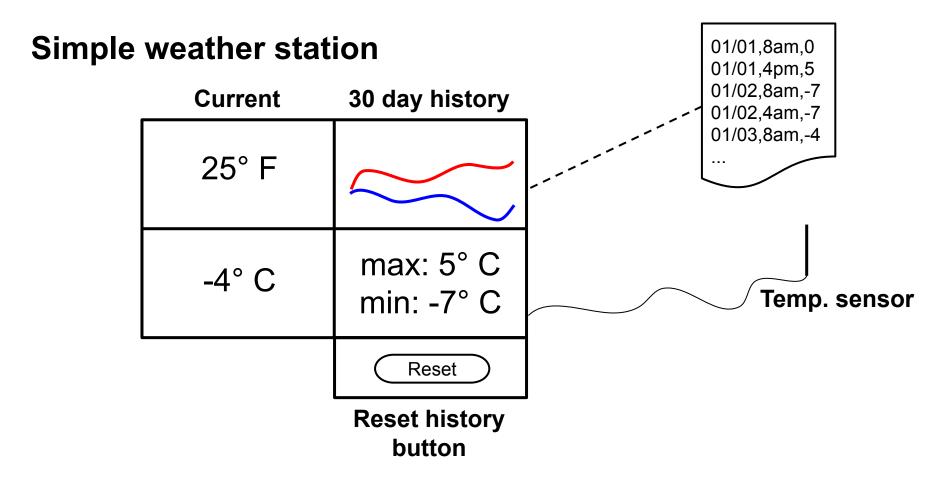
Simple weather station

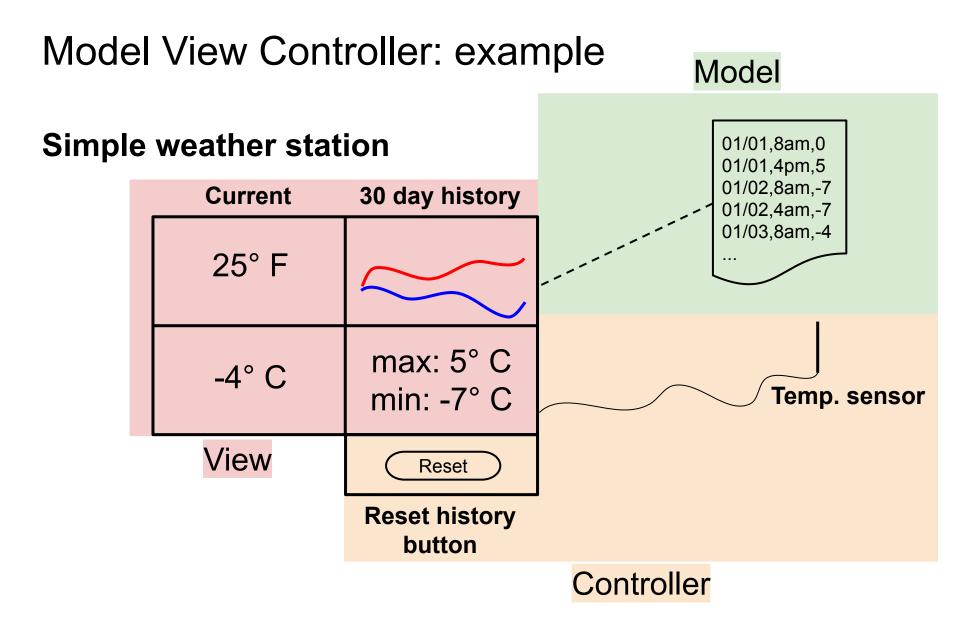
Current	30 day history
25° F	\sim
-4° C	max: 5° C min: -7° C

Model View Controller: example

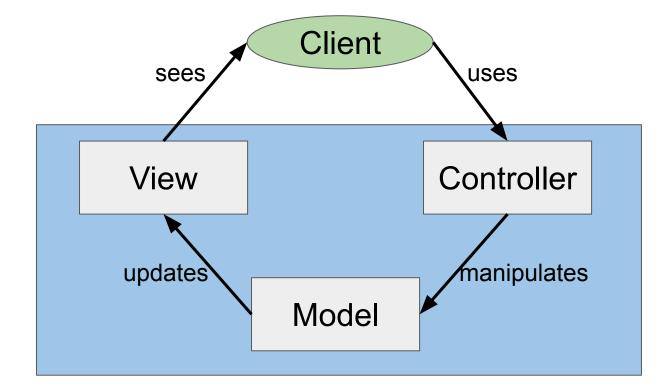


Model View Controller: example





Software architecture: Model View Controller (MVC)



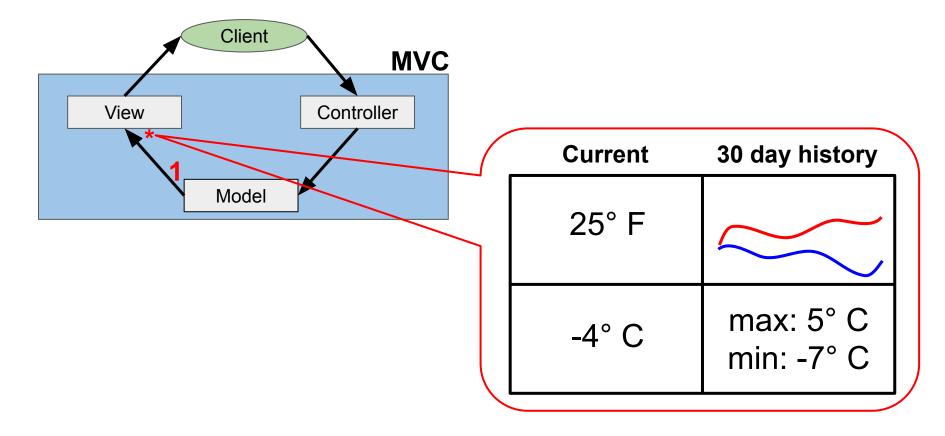
Separates data representation (Model), visualization (View), and client interaction (Controller)

MVC: another example

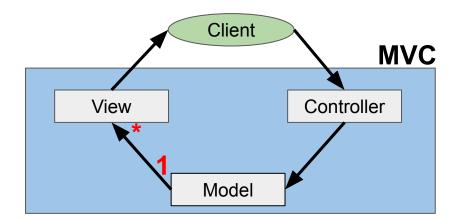
		Simple stats		
	10	Add number	Reset	
	Numbers: 6	Median: 2.0	Mean: 3.0	
1,2,2,2,1,10,				

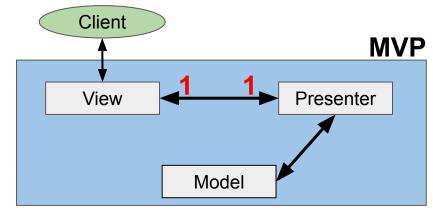
https://bitbucket.org/rjust/basic-stats

MVC vs. MVP vs. MVVM

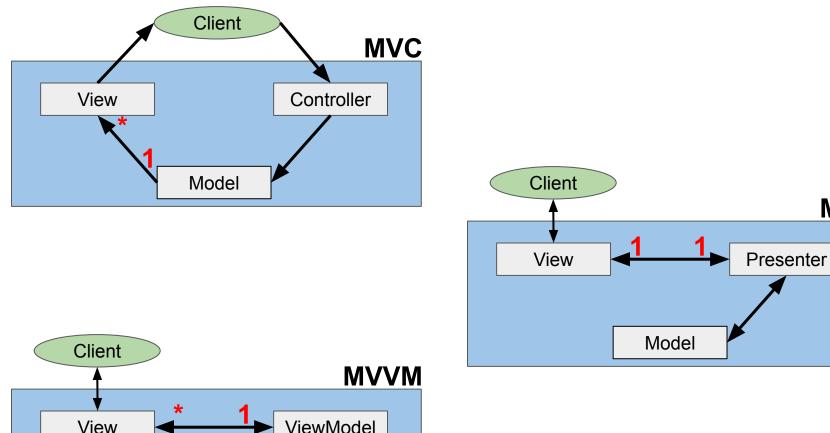


MVC vs. MVP vs. MVVM

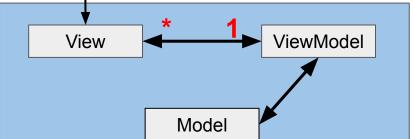




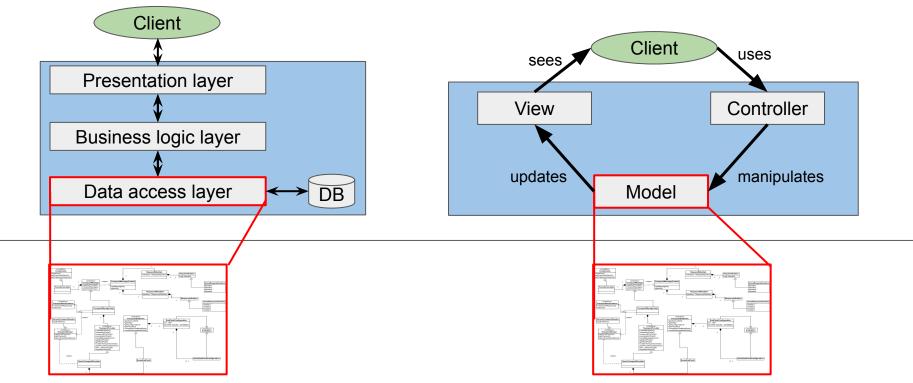
MVC vs. MVP vs. MVVM



MVP



Software architecture vs. design: summary



Architecture and design

- Components and interfaces: understand, communicate, reuse
- Manage complexity: modularity and separation of concerns
- Process: allow effort estimation and progress monitoring